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Sibling Rivalry: Child Endowment and Intrahousehold Allocation ☆

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Abstract

Using a unique longitudinal survey from Ethiopia, this paper investigates whether resource constrained parents reinforce or attenuate differences in early abilities between their children, and whether parental investment behavior varies across socioeconomic status. To overcome the potential endogeneity associated with measures of endowment, we construct a measure of human capital at birth that is plausibly net of prenatal investments. Furthermore, to reduce the bias due to unobserved family-specific heterogeneity, a sibling fixed-effects model is estimated. Preliminary results suggest that parents reinforce educational inequality, as inherently healthy children are more likely to attend preschool, be enrolled in elementary school, and have more expenses incurred towards their education. Health inputs, on the other hand, are allocated in a compensatory manner. That is, while the allocations of health inputs compensate for initial differences, educational input allocations reinforce such differences.

Keywords: Cognitive ability, Health Endowment, Intrahousehold Allocation, Sibling Rivalry
JEL: D13, I14, I24, J13

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☆The data used in this study come from Young Lives, a 15-year study of the changing nature of childhood poverty in Ethiopia, India (Andhra Pradesh), Peru and Vietnam.

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1. Introduction

A large body of the human capital literature studies how parents allocate specific investments among their children in response to the onset of a child's human capital endowment. Economic theory suggests that the pattern of parental investment can be neutral, compensating or reinforcing depending on efficiency concerns and parents' aversion to inequality between children (Becker and Tomes, 1976; Behrman, 1988). Under the assumption that marginal returns to investing are higher for better-endowed children than they are for lesser-endowed children, efficiency concerns will induce parents to reinforce early ability differences by investing more in more able children. Equity concerns, on the other hand, might drive parents to act in a compensatory manner by investing relatively more in their low ability children.

The empirical evidence, however, is not conclusive of the direction of response by parents to their children's early endowments. Some earlier empirical studies from developing countries find evidence of reinforcing behavior (Rosenzweig and Wolpin, 1988; Rosenzweig and Schultz, 1982; Behrman et al., 1994), whereas the studies from the developed world rely on adult outcomes such as completed education as a proxy for parental investments and found that parents compensate for differences in their children's endowments (Ashenfelter and Rouse, 1998; Behrman et al., 1982; Griliches, 1979). Other studies have mainly focused on family responses to specific measures of health endowments, such as birth weight (Datar et al., 2010; Aizer and Cunha, 2012; Rosenzweig and Zhang, 2009), and have found evidence in line with Becker and Tomes's (1976) efficiency arguments. Few recent studies highlight that family investment responses vary by socioeconomic status (Hsin, 2012; Restrepo, 2011).

Even though a large number of studies examine how child endowments influence parental investment in the human capital of children, two important factors are yet to be addressed adequately: multiple dimensions of endowments and heterogeneity in investment responses. Models of human capital formation posit that child endowment could include dimensions of health, cognitive abilities and non-cognitive skills (Heckman, 2007). Recent empirical work, however, afforded little attention to the multi-dimensionality in investments and capacity. The question of whether parental investment responses differ by parental socioeconomic status is also equally vital, as recent evidence indicates that poorly endowed children fare worse in the long run relative to their better-endowed siblings (Currie and Moretti, 2007; Aizer and Cunha, 2012). Empirical evidence on whether parental investment behavior varies across socioeconomic status (SES) is still lacking.

The present study examines the nature of the association between children's cognitive and health endowment and parental investment in human capital development using a unique longitudinal survey from Ethiopia. In particular, the study asks: (i) Do parents reinforce or compensate for early ability differences between children? (ii) Do parents respond differently to endowment differences with respect to cognitive ability and health shocks? (iii) Does parental behavior vary by family socioeconomic status (SES)?

Understanding how parents respond when faced with endowment differences among their children is far from obvious; a fact reflected in the considerably growing literature that studies intra-household resource allocation. Recent studies have combined insights from an earlier theoretical literature on household resource allocation (Becker and Tomes, 1976) with improved identification strategies to capture causal effects of early life health shocks.[1]

There are a few fundamental methodological questions that plague attempts to measure intrahousehold resource allocation and establish a causal link between early endowments and parental response thereof. First, there has not always been a valid measure of the endowment of children that reflects exogenous differences. Birth weight has been most often used as a proxy measure of endowment, albeit with limitations. It is not clear how much of the difference in birth weight is due to child endowment and how much of it is driven by prenatal investment.

Second, just as with child endowments, it has proved difficult to find an unambiguous measure of parental investment that reflects a behavioral response to ability differences. Completed years of education, breastfeeding, preschool enrollment, and time spent with children have all been used as possible indicators of parental investment. The problem with these

[1]See Currie and Almond (2011); Almond and Mazumder (2013) for a comprehensive review of the theoretical and empirical literature.

indicators is that their outcomes could be influenced by factors unrelated to parental decision making. For instance, children can influence their schooling and breastfeeding and parental time with children maybe governed by unobserved circumstances (Almond and Mazumder, 2013). The third and perhaps the most daunting challenge is devising a valid method that identifies a causal relationship of parental response and child ability.

A review of the current state of the literature by Almond and Mazumder (2013) identifies three most often used types of methodological approaches: family fixed effects, twin fixed effects, and natural experiments. Family fixed effects approach relates sibling differences in endowment to parental investment responses (e.g. Datar et al., 2010; Hsin, 2012; Aizer and Cunha, 2012; Del Bono et al., 2012). The main concern with this approach is its reliance on the assumption that there are no sibling specific unobserved differences that could influence the endowment differences as well as the subsequent parental response.

Twin fixed effects approach does well in controlling for such potential confounders. For this reason, the method has been well utilized in the empirical literature (e.g. Currie and Almond, 2011; Royer, 2009; Bharadwaj et al., 2010). This approach, however, is limited since postnatal investment decisions are different for twins than singletons, and parental favoritism in response to endowment differences is hard to identify.

Different natural experiments have also been employed in the related literature. Among these methods are: exposure to influenza epidemic (Kelly, 2011), regression discontinuity around low birth weight (Bharadwaj et al., 2013), tropical diseases and timing of investment (Venkataramani, 2012), and in-utero iodine supplement (Adhvaryu and Nyshadham, 2014).

The findings of these papers regarding parental responses to endowments, however, is far from conclusive. Using twin fixed effects on data from the US, Currie and Almond (2011) and Royer (2009) report finding no effects of birth weight differences on parental investment behavior. Bharadwaj et al. (2013) use data from Chile and Norway to implement a regression discontinuity design around the 1500 grams birth weight cutoff and find no evidence of preferential parental investment. Bharadwaj et al. (2010) on the other hand find evidence of compensating behavior for birth cohorts in Chile. Aizer and Cunha (2012) and Datar et al. (2010) for the US, Akresh et al. (2012) for rural Burkina Faso and Rosenzweig and Zhang

(2009) for China, use a family fixed effects framework and find evidence of reinforcing behavior. Similarly, using in-utero exposure to radiation in Sweden and in-utero iodine supplementation in Tanzania as natural experiments, Almond et al. (2009) and Adhvaryu and Nyshadham (2014) respectively, find reinforcing responses by parents.

Few other studies find mixed evidence in favor of both compensating and reinforcing behavior. This is mainly the case when researchers consider a multidimensional measure of endowment. Yi et al. (2014); Ayalew (2005); Hsin (2012) and Restrepo (2011) all find compensating responses to health shocks and reinforcing investment to cognitive endowment.

This paper offers several contributions to the existing literature. First, it uses a direct measure of children's health and cognitive endowment as well as parental investments in the human capital of children. Second, the study considers multiple dimensions of child endowment. Children's birth weight, anthropometric measures at the age of one, and health shocks suffered before the age of one are used to measure children's health stock. Cognitive development assessment tests administered at the age of five are used to gauge child cognitive ability. In addition to observed investment indicators (such as breastfeeding, inoculation, preschool enrollment, and educational and medical expenses) parental perception of their children's health and educational performance are also considered. Third, the study analyzes how parental investment in the human capital of children differs by parental socioeconomic heterogeneity.

Furthermore, alternative estimation methods are employed to address the problem of endogeneity. The study uses a measure of exogenous variation in resource availability correlated with physical health as an instrument (crop yield in-utero and childhood). It also controls for a possible correlation between unobserved prenatal and postnatal behavior, and construct a measure of human capital at birth that is plausibly net of maternal investments during the prenatal period. Alternatively, using measures of maternal prenatal investments, it is possible estimate a health production function and calculate the residual, which arguably consists of the child's endowment and an idiosyncratic child specific error term.

It is also worth mentioning that this study is in a developing country context, in which resource constraints on investments in children are likely more binding than in developed countries. Ethiopia is one of the poorest countries in Africa with a population of over 90 million. Despite international commitments and sustained economic growth, the United Nations still ranks Ethiopia 173 out of 187 countries in terms of human development. Forty four per cent of children under 5 are stunted (short for their age), 11 per cent are wasted (thin for their height), and 38 per cent are underweight. Even though 82 per cent of children in Ethiopia are now enrolled in primary schools, literacy levels are still low and only 18 per cent of older children have completed primary school by age 15 (UNDP, 2014). On top of that, almost 84 per cent of children are engaged in some form of work and almost 2.8 million children are missing from school entirely (Woldehanna et al., 2011).

Over 30 per cent of Ethiopians survive on less than 1.25 USD a day (UNDP, 2014). Eighty-five per cent of Ethiopians are dependent on agriculture for their livelihood but rises in food prices and regular droughts mean that many families are unable to buy or grow enough food to feed themselves (Woldehanna et al., 2011). For resource constrained households trying to maximize the returns to their human capital investments, parents' decisions will depend on their perceptions about the returns to school for a given child and that child's ability (Akresh et al., 2012). Hence, understanding the behavioral response of parents is critical for developing policy prescriptions to improve child wellbeing. The main findings are as follows.

First, consistent with predictions of a household production model where older children work more because they are better at household production, the study finds a strong relationship between sibling composition and child labor. The estimates suggest that increasing birth order is positively related to both market and domestic work; thus, older children in the household spend more time in these activities than their siblings, with some observable difference across gender.

Second, with regard to intrahousehold resource allocation, the results indicate that parents adopt a reinforcing strategy and are driven by efficiency concerns when investing in educational inputs; but they follow a compensatory strategy in the case of health inputs, suggesting that they are more concerned about equity. These findings are consistent with other studies that have examined the effects of multiple measures of child endowments on parental investments.

The remainder of the paper is organized as follows. Section 2 presents the conceptual framework about sibling rivalry and the intra-household investment decision. Section 3 describes the empirical identification strategy. Section 4 describes the survey data used in the analysis, and Section 5 presents the main results and discussions as well as robustness tests. Section 6 concludes.

2. Conceptual Framework

Early models of household utility maximization identify various mechanisms that influence the household's socio-economic choices and decision making process. Household production models suggest that households maximize their welfare given their resource constraints (see Behrman, 1997, for an extensive discussion).

One of the choices that households make is the human capital investment of children through the distribution of resources. The seminal work of Becker and Tomes (1976) laid the foundation for the study of parental allocation of resources to children with different endowments. They propose the *wealth model* where parents are assumed to maximize the total wealth of each child through bequests and investment in education. Under this model parents invest in a child's human capital until the marginal rate of return on the investment equals the market rate of interest. Hence, in their model, parents allocate child-specific parental investment in a manner that reinforces specific endowments; i.e., parents invest more in children with larger endowments to achieve "efficiency". Parents will then use transfers (e.g., inter vivos, gifts) to achieve "equity" in income distribution.

Behrman et al. (1982), qualified this model by incorporating the effect of inequality aversion. Their *Separable Earnings Transfer (SET)* model proposes that parents potentially have separate preferences over the distribution of earnings and wealth across their children. Hence, depending on the level of aversion, the investment decision could be neutral, compensating or reinforcing. For example, the SET model predicts that if the marginal returns to investment were greater for children with greater endowments, parents may adopt a compensating or reinforcing strategy, depending on whether equity or productivity concerns were dominant.

We consider a simple one-period model in which parents (represented as a single household) care about their own consumption and the quality of their children. They choose their level of consumption, level of investment towards their children, and the children's time-allocation. We assume that children can either study, and improve the level of their cognitive skills (quality) or they can work at home and contribute to the overall income of the household. Parental investment in children also increases the children's level of cognitive skills, but it decreases the level of household's consumption. We also assume that parents only allocate the total investment to all children, and the children determine the level of individual investment via conflict. We now formalize the parental utility maximization problem.

2.1. Parental Investment and Home Production

Suppose that parents get utility directly from consumption and the quality (or cognitive ability) of their n children, that is represented by the isoelastic utility function

$$u(c,q) = \frac{c^{1-\lambda}-1}{1-\lambda} + \frac{q^{1-\lambda}-1}{1-\lambda}, \tag{1}$$

which is separable in consumption c and overall child quality q. λ is the aversion parameter such that $\lambda = 1$ represents the case of log-utility. The overall child quality, q, in turn, is the CES aggregator of the individual child's quality

$$q = (\alpha_1 q_1^r + \ldots \alpha_n q_n^r)^{\frac{1}{r}},$$

where $q_i,\ i = 1, \ldots, n$ is the cognitive ability or quality of the individual child. The parameter r allows us to determine whether children are considered "gross complements" ($r < 0$) or "gross substitutes" ($r > 0$). α_is represent the share of an individual child in parents' utility. The cognitive level of each child depends on how much time children spend studying (either school or home-education), on the investment they receive from parents, and on initial level of their cognitive ability. Formally, we assume that the production function of a child's quality is given by

$$q_i = I_i^{\gamma_1} s_i^{\gamma_2} q_i^0, \tag{2}$$

where s_i determines how much time child spends studying (instead of working), q_i^0 is some initial given quality of a child (at birth). γ_1 and γ_2 are chosen so that the more time children spend on study (s_i) the higher their cognitive ability becomes, and the more likely for them to get investment from parents. I_i is parental investment in child i, and is given by

$$I_i = p_i I,$$

where p_i is share of investment each child i gets from parents and is determined within children via conflict.

We also assume that children are endowed with a total of 1 unit of time, which they can allocate to studying or to working. The time constraint of child i is

$$s_i + l_i = 1.$$

The child's working time contributes to the home-production of the household. Formally, let hp denote home-production of a single good, that is produced with some production function f with children's labor (l_i) as an input:

$$hp = f(l_1, \dots, l_n),$$

Assume that households earn some fixed income y and they decide to allocate it between consumption c or investment into children I. Parents can also sell or consume the home production good hp. Without loss of generality we can assume that the price of home-produced good is 1. Therefore, the household's budget constraint is

$$c + I = y + hp, \tag{3}$$

In the next subsection we formally define how the individual share of investment p_i is determined between children.

2.2. Sibling Rivalry

Suppose that parents decide to invest a total of I investment to all children, and suppose that children must exert some effort so that the share of I is allocated to them. Denote by F_i the effort level of individual child. The share of investment p_i is determined as

$$p_i = \frac{F_i}{\sum\limits_{j=1}^{n} F_j},$$

so that each child gets his relative share of effort she exerted. Suppose that children care directly how much of the investment they get from parents, but exerting effort for them is costly. Let this cost be γ_i.[2] Then, the utility function of child i is given by

$$V_i = p_i I - \gamma_i F_i.$$

Following Havnes (2010), the optimal share p_i is given by

$$p_i^* = 1 - \frac{\gamma_i Q}{I}, \tag{4}$$

where $Q = \sum_{j=1}^{n} F_j$ is the intensity of the conflict. Havnes (2010) also formally outlined how much effort children need to exert. Using the fact that $\sum_{j=1}^{n} p_i = 1$, we can sum equation (4) over individual children to get

$$Q = Q(n, \overline{\gamma}, I) = \frac{I}{\overline{\gamma}} \frac{n-1}{n},$$

which determines the total intensity of the conflict as a function of number of children n, parental investment I and mean cost of effort across children $\overline{\gamma}$. Havnes (2010) calls this the extent of conflict. Finally, following Mehlum and Moene (2002), the optimal fighting effort of child i satisfies

$$F_i^* = Q(n, \overline{\gamma}, I) \left[1 - \frac{n-1}{n} \frac{\gamma_i}{\overline{\gamma}} \right],$$

which shows that the effort an individual child exerts is proportional to the extent of conflict and is decreasing in child's advantage relative to the average among all children.

2.3. Parental Maximization Problem

We can now set up the parental maximization problem where they take p_i's as given and determined by children:

$$\max_{I, c, \{s_i\}_{i=1}^{n}} u(c, q),$$

[2]We slightly abuse the notation here, as these γ_i's are different from the parameters of child's production function q_i.

s.t.

$$c + I = y + f(1 - s_1, \ldots, 1 - s_n),$$
$$q_i = (p_i I)^{\gamma_1} s_i^{\gamma_2} q_i^0.$$

The FOC with respect to s_i is

$$\frac{du}{ds_i} = c^{-\lambda} f_i'(-1) + q^{-\lambda} \frac{1}{r} \left(\alpha_1 q_1^r + \ldots \alpha_n q_n^r\right)^{\frac{1}{r}-1} r \alpha_i q_i^{r-1} \frac{dq_i}{ds_i} = 0. \tag{5}$$

Consider two children, i and j, for whom equation 5 above holds. After some simplification, we get the following ratio

$$\frac{f_i'}{f_j'} = \frac{\alpha_i}{\alpha_j} \left(\frac{q_i}{q_j}\right)^r \frac{s_j}{s_i}.$$

Suppose that child i is better endowed than child j, so that $q_i > q_j$, and suppose that $r > 0$ - children are "gross substitutes". Also, suppose that parents care more about the better endowed children, so that $\alpha_i > \alpha_j$. Hence, the model implies that if child j, who is not as able as child i is more productive at home ($f_i' < f_j'$), then child j will spend less time studying and more time working than child i,

$$s_j < s_i.$$

The FOC of the parental maximization problem with respect to I is

$$\frac{du}{dI} = c^{-\lambda}(-1) + \sum_{i=1}^{n} \frac{dq}{dq_i} \frac{dq_i}{dI_i} \frac{dI_i}{dI} = c^{-\lambda}(-1) + \sum_{i=1}^{n} \frac{dq}{dq_i} \frac{dq_i}{dI_i} p_i = 0. \tag{6}$$

In other words, the simplified equation 7

$$c^{-\lambda} = \sum_{i=1}^{n} \frac{dq}{dq_i} \frac{dq_i}{dI_i} p_i \tag{7}$$

implies that marginal investment is set equal to marginal consumption of the parents, so that parents optimize in terms of overall investment. Sibling rivalry, however, implies that the allocation within children will be determined by the outcome of the conflict. Thus, if the assumptions of the FOC (in equation 5) hold, and parents prefer to invest more in the more able children, then the allocation is efficient from the parents' perspective as better endowed children get more investment from the parents (as long as better endowed children incur less cost in conflict - γ_i is lower). If, on the other hand, the better endowed children perform worse in the conflict, then they will get less investment from their parents which would be inefficient from the parents' perspective. If parents would rather equalize the quality of their children and invest equally in all of them, then again, the conflict creates inefficiency since children of different abilities (depending on how they perform in the conflict) would get different amount of investment ($p_i \neq p_j$ unless there is no sibling rivalry or the costs of engaging in conflict are different).

In summary, both the theoretical prediction and the empirical evidence are mixed regarding how parental investments respond to child endowment differences. There is no consensus on whether the efficiency motive or the equity concern govern parents' behavioral responses. This study intends to contribute to this growing literature by studying child health and cognitive endowments in a developing country and by analyzing a measure of financial, time and behavioral investments, which has not been adequately studied before.

3. Empirical Strategy

3.1. Sibling Composition and Child Outcomes

A natural place to start investigating the role of intrafamily resource allocation is by looking at how birth order, sex composition and age spacing affect children's human capital indicators. The literature has recognized that sibling structure is an important determinant of schooling, health and child labor patterns among children in a household (Parish and Willis, 1993; Garg and Morduch, 1998; Morduch, 2000; Edmonds, 2006; Dammert, 2010). Understanding sibling composition effects is relevant for policy subscriptions as sibling differences in long-term outcomes can emanate from varying investment in early childhood.

Studies of sibling rivalry in human capital typically use counts of the number of siblings that a child has and their gender composition to explain different child outcomes (such as school attendance or attainment) as follows:

$$I_{if} = \varphi_0 + \varphi_1 SIB_{if} + \alpha_0 X_{if} + \alpha_1 Z_{if} + \varepsilon_{if} \quad (8)$$

where I_{if} is investment measure for child i in household f, SIB_{if} is a proxy for birth order, sex composition or age gap, X_{if} denotes a vector of individual characteristics such as age and gender that might influence parental investments, and Z_{if} is a vector of household characteristics. ε_{if} is a random, idiosyncratic error term.

This simple specification can still be modified to account for different sibling composition relationships by adding specific interaction terms as:

$$\begin{aligned} I_{if} = \varphi_0 + \varphi_1 SIB_i + \varphi_2 FEM_i + \varphi_3 SIB_i \times FEM_i \\ + AGE_i + AGE_i \times FEM_i + H_i + \varepsilon_i \end{aligned} \quad (9)$$

where AGE_i is a vector of dummies for each child in the investigated age range (e.g. 6-15) that takes on a value of 1 for child i's age and H_i is a household fixed effect. The term SIB represents the sibling composition variable of interest. Hence, we can run separate regressions to document the effects of birth order, the number of younger (older) siblings, as well as the gender of these younger (older) siblings. The total effect (within the household) of the relevant sibling composition variable on child status is thus given by φ_1 for males and by $\varphi_1 + \varphi_3$ for females. The age-female interaction allows for the age effect to vary by sex.

Assigning age rank based on the child's birth order among resident siblings, for example, the relationship between birth order and child outcomes can be analyzed. The coefficient of age rank is interpreted as the average change in the outcome associated with increasing age rank within a household due to the inclusion of the fixed effect and age-gender interaction terms.

3.2. Child Ability and Responsive Investments

Having established the role siblings play in determining parental human capital investment decisions, we then move on to expand on the sibling rivalry model in equation 8 to control for the child's (and her siblings') ability and the home environment that might influence intra-household allocation decision. The empirical approach is based on the underlying economic model discussed in section 2 in which health, educational, and other types of postnatal parental investments (I) made at a particular point in time in child i belonging to family f depend on the child's own endowment (e_i), the endowments of other siblings present in the family at the time of investment in child i (e_{-if}), and other time-varying child and family characteristics (X_{if}) that influence parental investments. The average birth endowment of siblings present in the household is measured by e_{-if}; and the endowment of each of child i's siblings present in the home at a particular time is assumed to have the same effect on investment in child i.

A linear specification of this model takes the following form:

$$I_{if} = \beta_0 + \beta_1 e_{if} + \beta_2 e_{-if} + \alpha_0 X_{if} + \gamma_f + \phi_i + \varepsilon_{if} \tag{10}$$

where γ_f is the household fixed effect that captures all characteristics about the household that are constant across siblings; ϕ_i represents unobserved child-specific factors capturing the child's individual endowment and other unobserved determinants of investments that vary across siblings within a family; and ε_{if} is an idiosyncratic error term not captured by a child's own ability, e_{if}, or her sibling's ability, e_{-if}.

This within-family estimate compares a child's own ability to the average ability of all the other children in the household to examine if parents do the same comparison when making human capital investment decisions. The effect of other siblings' endowments on investments in child i is of interest because it is likely to impact the amount of investment parents make in child i. The coefficients β_1 and β_2, respectively, give an estimate of the impact of child i's own ability and her sibling's ability on investment in child i. β_1 measures whether parents invest more or invest less in children with higher endowments compared with children with lower endowments. β_2 measures the effect of within-family differences in the endowments of other siblings present in the household at the time of the investment.

A positive (negative) sign on β_1 would indicate that parental investments are reinforcing (compensating). A positive (negative) sign on β_2 would indicate that parents invest more (less) in children who have siblings with higher endowments present in the household at the time of the investment. Two alternative measures of sibling ability are widely used in the related literature: absolute and relative measures. Absolute measures use the highest sibling ability to provide insight into the role of the level of sibling ability in a household. The average level of sibling ability is also informative of parental decision-making in the presence of sibling rivalry for limited resources.

3.3. Potential Threats to Identification

Ordinary least squares (OLS) estimation of equation (10) could potentially yield biased estimates if either (i) $E(e_{if}, \gamma_f) \neq 0$ or (ii) $E(e_{if}, \phi_i) \neq 0$. A violation of condition (i) could arise if there are unobservable household characteristics that simultaneously explain why some families are more likely to raise healthy, well-educated, children. For instance, parents who care a lot about child quality might have better-endowed children, and may also invest more in their children after birth. In this case, γ_f would be correlated with birth endowments and OLS estimates would be biased. In turn, a violation of condition (ii) could arise if child-specific unobservables might be correlated with its endowment.

To eliminate the bias due to unobserved family-specific heterogeneity, the following model is specified by taking within-family differences:

$$\Delta I_{if} = \Delta\beta_1 e_{if} + \Delta\beta_2 e_{-if} + \Delta\alpha_0 X_{if} + \Delta\phi_i + \Delta\varepsilon_{if} \tag{11}$$

where $\Delta K = K_{if} - \bar{K}_f$, $K \in \{I, e, X, \varepsilon\}$ and $\bar{K}$ is the within family mean of K_i.

A potential bias could still emanate from the sibling-specific unobserved heterogeneity ($\Delta\phi_i$) that remains in the error term. Child endowment differences across siblings may be endogenous due to prenatal investment. One alternative to address this concern is to control for prenatal investments in the child using indicators such as month of first prenatal care visit and shocks that the mother suffered during pregnancy, since these are choices that are correlated with endowment and postnatal investments.

In specifications where endowment is measured at an older age (e.g. test scores in primary school), it is likely that these results already embody a significant component of prior parental investment. The child who has already been benefiting from greater parental investment will appear to have a greater endowment. In addition, if there is some serial correlation in parental behavior, the child is likely to continue to receive more substantial investments. This will generate an upward bias in the estimated coefficients. There are a couple of alternative approaches to eliminate this bias.

First the study adopts the "residual method", where the unexplained part of estimated health (cognitive) production function is taken as the child's genetic ability endowment (Rosenzweig and Wolpin, 1988; Aizer and Cunha, 2012). This method is used to construct a residual component that can be thought of as an endowment measure that is net of key prenatal and early investments. In this approach an equation such as the following is estimated:

$$Y^k_{if} = \beta^k_0 + \beta^k_1 Z_{if} + \beta^k_2 W_{if} + e_i + \epsilon_{if} \quad (12)$$

where the superscript k denotes the production function of interest (health, cognitive), the dependent variable Y is the health (cognitive) status indicator, Z includes individual specific exogenous variables (e.g., sex and age), W represents child-specific as well as parental endogenous variables that affect child outcome directly (e.g., incidence of illness, age of the mother, whether the mother reports she was trying to conceive child). The error term is composed of child-specific age invariant component (e_i) and a pure random component (ϵ_{if}). The measure of endowment (e_i) is computed by averaging the error terms over time for each individual. It is equivalent to the individual fixed component of a simple fixed-effect estimator.

3.4. Socioeconomic Status and Intrahousehold Resource Allocation

One of the objectives of this paper is to investigate whether there are differences in investment behavior by socioeconomic status (SES). If low SES parents are more resource-constrained they may be more likely to invest in the better endowed child, reinforcing early ability differences. For high SES families, however, it is not clear which investment strategy they would choose. On the one hand, they have the resources to afford a compensatory strategy that equalizes their children's outcomes. On the other hand, they are more likely to reinforce early child ability by investing more in the human capital of the more able child and giving more gifts and transfers to the less able child. As a result, wealthier parents will reinforce using human capital investments but compensate with their non-human capital transfers. Hence, the socioeconomic heterogeneity in parental responses to early child investments is very much an empirical question.

One can analyze this issue by estimating an investment equation in which the endowment measures are interacted with indicators of SES such as household wealth index, caregivers' education level and urban (rural) residency.

$$\begin{aligned} I_{if} = \beta_0 + \beta_1 e_{if} + \beta_2 e_{-if} + \beta_3 e_{if} \times Z_{if} + \\ \beta_4 e_{-if} \times Z_{if} + \alpha_0 X_{if} + \gamma_f + \phi_i + \varepsilon_{if} \end{aligned} \tag{13}$$

where Z_{if} is the indicator of SES (e.g. mother's education, wealth index). A positive β_3 indicates that high SES parents invest more in high ability children than do lower SES parents.

4. Data and Measurement

4.1. Data

The data for this study are from the *Young Lives Project*, a study tracking the lives of children in four countries: Ethiopia, India (Andhra Pradesh district), Peru and Vietnam. In each study country, the *Young Lives* (hereinafter YL) surveys involve tracking 3,000 children in two cohorts. The younger cohort consists of 2,000 children who were born between January 2001 and May 2002. The older cohort consists of approximately 1,000 children from each country born in 1994-95. Currently, three survey waves are available: the baseline round in 2002 and two followâĂŘups in 2006-7 and 2009.[3]

The survey contains one 'panel' or 'index' child per family (which determines the panel dimension of the survey), but also collects detailed information on other family members in the household. During the surveys, the index children were aged 6-20 months, 4-6 and 7-8 years of age, respectively. The present study uses data from the Ethiopia part of the project.

The data are clustered and cover 20 sites in each country across rural and urban areas. The sampling procedure adopted sentinel site surveillance, where the sites were purposefully selected to meet study objectives,

[3]The Younglives survey team has completed fieldwork for the Round 4 survey in early 2014 and have recently released preliminary findings. Following data cleaning, the data is expected to be archived for use in mid 2016.

such as its poverty-centered focus, and to reflect the diverse socio-economic conditions within the study countries. This was followed by random sampling of households within each site. Even though the samples are not statistically representative for the country, comparisons with representative datasets like the Demographic and Health Survey (DHS) and Welfare Monitoring Survey (WMS) samples do show that the data contain a similar range of variation as nationally representative datasets (Barnett et al., 2013; Outes-Leon and Sanchez, 2008).

Attrition rates between rounds are very low by international standards. In the Ethiopian sample only 4.4% of the children lost or dropped out between the first two rounds in total and a further 1.5% between rounds two and three (Barnett et al., 2013). Further assessment of the attrition based on two alternative child welfare models by Outes-Leon and Dercon (2008) found that attrited households are not systematically different from the retained households based on observable characteristics. The Cohort Profile Report of the first three rounds also concludes that the current attrition was highly unlikely to bias research inferences (Barnett et al., 2013).

4.2. Measurement Variables

The measures of postnatal investments considered in this study are the health and educational investments that parents make in their children's early years. The focus on investments in early childhood is motivated by empirical evidence that early investment is a critical determinant of outcomes over the life course (Currie and Almond, 2011).

The child's weight measured at ages 1, 5 and 8 are used as proxies for his/her own health endowments and use anthropometric data of a younger sibling present in the household at the time of investment as a measure of sibling endowment. Cognitive endowments of the child and his/her sibling are measured by the score on a test of cognitive ability. The index children in the YL study completed Peabody Picture Vocabulary Test (PPVT) in rounds 2 and 3 (at ages 5 and 8). In the third round of the survey, one of the siblings of the YL child, in many cases the most proximate in order of birth, also took the PPVT and his/her score was recorded in the survey.

Parental human capital investment is viewed from three angles: direct monetary expenditures on education and health of the child, basic postnatal health related investment (e.g., number of balanced meals provided, completed vaccination), schooling (preschool enrollment until the age of 5 and primary education by age 8), and child work. The household questionnaire collects data on expenditures within the last 12 months.[4] Assignable expenditures include clothes, footwear, school uniform, school fees, private classes, books, transportation to school, doctors, medicine and entertainment. Schooling is measured primarily by current enrollment, which equals one if the child was enrolled in school at the time of survey, zero otherwise. A child's completed years of schooling as of survey date (grade completed) measures schooling achievement and is constructed as an alternative schooling investment measure.

The YL survey questionnaires in rounds 2 and 3 contain a separate section on children's time use, which collected detailed information on the hours spent by the child on various activities on a typical day during the week prior to the survey. The activities included, among others, work for pay, on family farm or business, and on various chores. Making use of this information, one can measure child work both at the extensive and intensive margin. Based on the standard definition in the child labor literature, the extensive margin of 'Work status' is defined as a dummy variable that equals one if the child reported non-zero hours on paid work (hired or self) or on family farm/business, zero otherwise. Conditional on participation, the number of hours spent on market work is used to measure the intensive margin of child work.

The YL survey also collects information on demographic characteristics of all household members. Among these variables, the following are used in the study: child's age (month and year of birth), gender and birth order; mother's age, parental educational attainment in years, household's total size, number of siblings, and urban/rural status.

The means and standard deviations of the parental investment and other explanatory variables are reported in Table A.1 in the appendix. About half of the sample is composed of females. Parents' years of

[4]The 12 month recall has the disadvantage of recall bias but this is likely to be outweighed by the advantage of more complete reporting compared to diary-based data collection that only records expenditures over a few weeks.

schooling are very low, with an average of about 3 and 5 years for the mother and father respectively. On average, a child lives in a household with 6 members and is expected to have about 5 siblings. Caregivers to about 66 per cent of the one-year-old children report that they consider their kids to be of similar or better health relative to other children of the same age. This number increases to close to 90 per cent by the time the children reach age 5. However, about 30 per cent on average report that their children had experienced serious illness in their first year.

5. Results and Discussion

5.1. Sibling Composition and Child Outcomes

In this section, we consider the relationship between sibling composition and child outcomes even when parents care equally about their children, and make investments in their children based solely on expected economic returns. OLS estimations that show the effect of sibling composition and birth order on child outcomes are marred by potential endogeneity problems. Unobserved factors such as parental taste for large families and child labor may drive the correlation between sibling composition and child labor. Causality could also run the other way where resource constrained families respond by increasing the number of children they bear, so that children's contribution in the home production supplements family income. Hence, in this section, we will mainly focus on documenting the statistical association between different activities of children and sibling composition without fully addressing the endogeneity of household composition. By including household fixed effects in the estimations, however, we are able to account for time and child invariant unobserved household characteristics that affect all children in the same household similarly.

The theoretical and empirical literature have identified several mechanisms through which sibling composition may affect children's outcome. Biological factors imply that younger children have older mothers, which might have a negative effect on birth weight. Since birth weight is correlated with ability and access to resources, children born later may fare worse (Dammert, 2010). In credit constrained households where siblings compete with each other for scarce resources, older siblings may be forced to leave school early to help provide resources for the family, while younger children go to school (Morduch, 2000). As family income grows over the life cycle, younger siblings might benefit from higher parental earnings and savings (Parish and Willis, 1993).

Edmonds (2006) shows that regardless of the presence of credit constraints, the existence of household production implies that the age and sex composition of siblings affects a child's labor supply. If the return to education is the same for two children in a household, the older child will tend to work more because she has comparative advantage in household production. In addition to birth order, sibling sex composition plays a vital role (Garg and Morduch, 1998). If, for instance, both children have equal productivities in household production, but the return to education for boys is greater than the return to education for girls, we will observe boys performing less work and receiving more education. Furthermore, if parents are more altruistic toward their sons than their daughters, the total investments in sons' schooling will be larger (Dammert, 2010).

Table 1 reports results from linear regressions of children's work status (weekly hours worked) on gender and different sibling environments. We refer to the household questionnaire to draw information on all children between the ages of 6 and 17 years. We consider three sibling composition indicators: relative birth order, number of siblings, and number of younger siblings. Relative birth order is defined as $(birthorder - 1)/(number\ of\ siblings)$. Thus, the oldest relative order equals one and the youngest relative order equals zero. Relative birth order is used instead of absolute birth order to account for bigger variations due to larger families (Ejrnæs and Pörtner, 2004). All specifications control for age, mothers' education, household size, wealth index and place of residence (rural dummy). All regressions also include a dummy for each age rank and their interactions with the female dummy.

The results in Panel A of Table 1 suggest that increasing birth order is positively related to increased hours of work; implying, older children in the household spend up to a total of 11 hours more per week in work activities than their siblings. The results also show that all of the interacted terms on the Female $\times$ Relative birth order are significant, rejecting the hypothesis that the effects of age rank are the same for boys and girls. The estimates suggest that increasing birth order is positively related to both market and domestic work; thus, older children in the household spend more time in these activities than their siblings, with some observable difference across gender. Older girls are found to spend six hours more on domestic work and five hours less on market work per week.

Panel B and C in Table 1 show results from estimation of child outcomes on number of siblings and number of younger siblings respectively. We observe a strong correlation between the number of younger siblings other than child i in the household and number of hours per week children spend on different work activities. There is also a clear gender divide in the amount and type of work children perform. An increase in the number of younger siblings by one is associated with an increase of market work for boys by almost three hours, with statistically insignificant effects on hours of domestic chores. Girls, on the contrary, experience a 2.3 hours increase in their domestic work and a 3.3 hours decrease in their market work activities.

Table 1: Estimation of Children's Activities on Sibling Composition

A.	Total Hours	Domestic Work	Market Work
Female	0.230	13.02***	-12.77***
	(3.244)	(2.352)	(2.922)
Relative birth order	10.88***	7.143***	3.736**
	(1.408)	(1.002)	(1.309)
Female × Relative birth order	0.739	5.723***	-4.999**
	(1.786)	(1.419)	(1.576)
Observations	5246	5247	5246
Adjusted R^2	0.316	0.315	0.312
B.	**Total Hours**	**Domestic Work**	**Market Work**
Female	3.531	6.194*	-2.661
	(3.485)	(2.697)	(3.081)
Relative birth order	11.28***	6.602***	4.679***
	(1.402)	(1.001)	(1.306)
Female × Relative birth order	0.122	6.969***	-6.857***
	(1.775)	(1.412)	(1.577)
Number of siblings	2.187***	0.118	2.071***
	(0.377)	(0.326)	(0.317)
Female × Number of siblings	-0.704*	1.497***	-2.199***
	(0.335)	(0.311)	(0.317)
Observations	5246	5247	5246
Adjusted R^2	0.322	0.321	0.321
C.	**Total Hours**	**Domestic Work**	**Market Work**
Female	2.075	8.708***	-6.621*
	(3.344)	(2.507)	(2.992)
Relative birth order	5.425***	7.317***	-1.896
	(1.635)	(1.196)	(1.522)
Female × Relative birth order	2.474	1.339	1.119
	(2.025)	(1.661)	(1.767)
Number of younger siblings	2.475***	-0.292	2.768***
	(0.494)	(0.399)	(0.468)
Female × Number of younger siblings	-0.959	2.326***	-3.284***
	(0.519)	(0.476)	(0.498)
Observations	5246	5247	5246
Adjusted R^2	0.321	0.321	0.320

Standard errors clustered at household level in parentheses. Relative birth order is defined as $(birthorder - 1)/(number\ of\ siblings)$. Higher values of birth order are assigned to older children among resident siblings. Controls include mother's years of education, household wealth index, household size, rural dummy, age and age gender interactions.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

These results are in line with previous research in a developing country context. Rosenzweig and Schultz (1982) argue that in rural India, daughters bear a larger proportion of housework than sons do when the expected employment of women in the labor market is relatively low. Using data from Nepal, Edmonds (2006) remarks any difference could arise because of the comparative advantage of birth order as well as a gender bias towards specific types of work. Dammert (2010) finds that in Nicaragua and Guatemala, older boys spend more time engaged in market and domestic work, whereas older girls spend more time in domestic work than their younger siblings. She also finds girls to be more sensitive to changes in family composition.

5.2. Child Ability and Intra-household Allocation

In this section we present estimation results of how parental investments respond to child endowments. We consider several measures of parental investment and different measures of child endowment. The first measure of endowment we consider is height-for-age, normalized to a Z-score. Height-for-age is widely used in the literature as a measure of endowment and a summary indicator of physical robustness, and it is correlated with a range of physical and cognitive indicators (Leight, 2010). The second endowment measure we take into account is parents' perceptions of their child's healthiness compared to their peers. This indicator is chosen on the back of the assumption that parents know more about their children's endowment, and whether their perception is correct or not, it is likely to inform and affect their decision about investment in their children (Akresh et al., 2012). We also consider that height-for-age may be endogenous because it already reflects maternal prenatal investments and use instead the residual from a health production function that includes a host of prenatal characteristics. Cognitive endowments of the child and his/her sibling are measured by the score on two tests of cognitive ability: Peabody Picture Vocabulary (PPVT) test and Cognitive development assessment (CDA) test. To account for the potential bias from using cognitive test scores, we once again employ the "residual method".

Table 2 reports estimates of the effect of own endowment on parental educational investments. The results suggest that parents reinforce educational inequality as inherently healthy children are more likely to attend preschool, be enrolled in elementary school, and have more expenses incurred towards their education. We find a positive relationship between what parents think about their child's health and their preschool attendance. The likelihood of a child to be enrolled in preschool increases by 10 percentage points and educational expenses by 18 per cent when their parents believe (perceive) that their children are better endowed. This finding is confirmed even when the endowment is measured by the residual method. Higher residual ability raises the probability that a child is enrolled in preschool.

Cognitive endowment also increases the likelihood of attending preschool (table 2, lower panel), although the magnitude of the estimated coefficient is quite low. School enrollment decisions are not affected by any of the endowment indicators; probably due to the fact that most public schools in Ethiopia are tuition free and the country is achieving universal primary education. When we control for the abilities of siblings, the estimates still indicate reinforcing pattern of parental investments, but the magnitude of the coefficients is slightly reduced.

Table 2: Child's Own Endowment and Educational Investment

	Attended Preschool	School Enrollment	Educational Expenses
Own Health Endowment			
Parental Perception: Better than peers	0.095**	-0.007	0.178*
	(0.031)	(0.025)	(0.063)
Height-for-age z-score	0.008	0.013*	0.015
	(0.009)	(0.007)	(0.027)
Residual health endowment	0.086**	-0.017	0.167*
	(0.030)	(0.027)	(0.064)
Sibling Health Endowment			
Own health	0.072**	-0.021	0.160*
	(0.024)	(0.027)	(0.056)
Sibling health	0.000	0.009	0.024
	(0.002)	(0.007)	(0.016)
Own Cognitive Endowment			
PPVT Score	0.005**	0.001	0.017***
	(0.002)	(0.002)	(0.004)
CDA Score	0.024***	0.008	0.066***
	(0.006)	(0.004)	(0.015)
Residual PPVT Score	0.000	0.000	0.013**
	(0.001)	(0.002)	(0.004)
Sibling Cognitive Endowment			
Own PPVT score	0.004**	-0.000	0.018***
	(0.001)	(0.002)	(0.004)
Sibling PPVT score	0.000	0.001	0.002*
	(0.000)	(0.000)	(0.001)

Each cell corresponds to a different regression of the outcome (indicated in each column) on endowment indicators and a set of controls that include mother's years of education and age at birth, household wealth index, household size, rural dummy, marital status, number of siblings and birth order. Marginal effects from *probit* estimations are reported in columns (2) and (3). OLS estimation of the natural logarithm of annual educational expenses reported in column (4). Standard errors clustered at community level in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Estimation results of parental investment in health inputs are reported in Table 3. The results suggest that, when it comes to health inputs, parents compensate the inherently weak child. Children whose parents perceive them as weak are six percentage points more likely to receive complete vaccinations. They also get 28 per cent more expenses incurred towards their health. Children that suffer early health shocks are also more likely to be immunized. We did not find any evidence linking children's cognitive endowments and parental health investment. We do, however, observe a marginal positive link between higher PPVT score and being provided with a balanced meal. The presence of a better endowed sibling does not seem to alter the direction of parental investment response.

Table 3: Child's Own Endowment and Health Investment

	Completed Vaccination	Balanced Meal	Medical Expenses
Own Health Endowment			
Parental Perception: Worse than peers	0.057*	0.003	0.277*
	(0.027)	(0.036)	(0.131)
Child suffered early health shock	0.083*	-0.038	0.316
	(0.035)	(0.028)	(0.157)
Residual health endowment	-0.020	0.022	-0.053
	(0.025)	(0.032)	(0.086)
Sibling Endowment			
Own health	0.055*	0.006	0.528*
	(0.025)	(0.046)	(0.203)
Sibling health	0.002	0.005	0.006
	(0.003)	(0.005)	(0.017)
Own Cognitive Endowment			
PPVT score	0.000	0.006**	0.004
	(0.001)	(0.002)	(0.005)
Residual PPVT score	-0.001	0.006**	0.003
	(0.001)	(0.002)	(0.006)

Each cell corresponds to a different regression of the outcome (indicated in each column) on endowment indicators and a set of controls that include mother's years of education and age at birth, household wealth index, household size, rural dummy, marital status, number of siblings and birth order. Marginal effects from *probit* estimations are reported in columns (2) and (3). OLS estimation of the natural logarithm of annual medical expenses reported in column (4). Balanced meal is a dummy variable (= 1) if ≥ 5 different food groups eaten in the last 24 hours. Standard errors clustered at community level in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In addition to educational and health inputs towards the human capital production of children, we have also considered whether parents consult to the ability of their children in making decisions about the allocation of a child's time. The results, reported in Table 4 show that better abled children spend slightly less hours in work activities. A one point increase in PPVT score is associated with a decline in weekly hours of market work by 21 minutes. The health endowment of the child seem to have no effect in altering parental decisions of child time allocation. When we control for sibling abilities, we find that the presence of a sibling with higher cognitive ability reduce the amount of hours the index child does by 40 minutes and market hours by 55 minutes a week.

Table 4: Child Endowment and Weekly Hours of Child Work

	Total Hours	Market Hours	Total Hours	Market Hours	Total Hours	Market Hours
Parental perception of child health:						
Better than peers	-0.266	-2.200				
	(0.837)	(1.962)				
Worse than peers	0.690	-1.094				
	(0.956)	(1.392)				
PPVT score			-0.015	-0.205*	-0.016	-0.174*
			(0.036)	(0.081)	(0.044)	(0.088)
PPVT score of sibling					-0.040***	-0.055***
					(0.009)	(0.016)
Observations	1806	1806	1761	1761	1412	1412

Each column represents coefficients from separate *tobit* regression of the outcome (indicated in each column title) on endowment indicators and a set of controls that include mother's years of education and age at birth, household wealth index, household size, rural dummy, marital status, number of siblings and birth order. Standard errors clustered at community level in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

To estimate how parental human capital investments respond to child endowments within family, we regress our measures of educational and health investments as well as time allocation decisions on different measures of health and cognitive endowments including household fixed effects. This approach allows us to partially address the potential bias arising from unobserved child or household characteristics that may be evident in the specifications discussed so far. Due to data limitations, we are not able to measure medical expenses (investment) towards the siblings of the panel child in our sample. We do, however, observe educational expenses, school enrollment status as well as time-use information. Estimates in Table 5 are from a household fixed effects models that include additional covariates intended to control for sibling-specific differences in parental resources available for investing in children. The estimates on the endowment indicators can now be interpreted as the impact on a child's status of a between-sibling difference in ability.

The results lend further support to the evidence in the baseline regressions of household investment that reinforces differences in children's perceived ability. A higher ability child (measured by higher PPVT score) is likely to work fewer hours than a lower ability sibling. Such a child is also more likely to be enrolled in school, and have more expenses directed towards her education. Parental investments, however, were on average not statistically different between children who have better height-for-age z scores and their less healthy counterparts.

Table 5: Child Ability and Parental Investment: Household Fixed Effects Estimates

	Total Hours	Market Hours	Domestic Hours	School Expenses	School Enrollment
Height-for-age z-score	0.751	0.406	0.345	-0.154	0.023*
	(0.434)	(0.377)	(0.308)	(1.774)	(0.009)
Observations	2579	2579	2580	3013	3014
Adjusted R^2	0.247	0.251	0.325	0.001	0.223
PPVT score	-0.065*	-0.076**	0.011	1.016*	0.004***
	(0.027)	(0.022)	(0.019)	(0.454)	(0.001)
Observations	2547	2547	2548	2968	2969
Adjusted R^2	0.264	0.293	0.331	0.024	0.270

Each cell corresponds to a different regression of the outcome (indicated in the column title) on endowment indicators, female dummy and dummies for age in completed years, as well interaction terms of gender and endowment measures. Coefficients from a linear probability model are reported for school enrollment. Standard errors clustered at community level in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

One of the objectives of this paper is to investigate whether investment behavior varies by parental education and income. To this effect, we estimated an investment equation in which the endowment measures are interacted with indicators of household wealth index, and mothers' education level. The estimates in Table A.2 in the appendix show that the response of educational investment to a higher ability child is modestly increasing in income. Together with the main effect, these estimates imply that educational investments in children are slightly reinforcing in high-income families. Investment differences across families by maternal education are statistically insignificant. We also do not detect any heterogeneity in child time allocation.

6. Conclusions

In this study, we examine whether parents choose to invest differentially in their children in response to a child's health and cognitive endowment. Parental response to early child ability differences may be more important in a developing country context, in which resource constraints on investments in children are likely more binding than in developed countries. In the absence of formal insurance, social security and pension system, resource constrained parents may base their intrahousehold allocation decisions on efficiency rather than on equity concerns.

The results indicate that parents invest more in the education of children with better health and cognitive abilities, which suggest they adopt a reinforcing strategy and are driven by efficiency concerns. We have also found evidence that parents invest more health inputs in inherently weaker children. Hence, parents follow a compensatory strategy in the case of health inputs, suggesting that they are more concerned about equity. Such behavior is justified from the perspective of the resource constrained households considered in our sample. Health inputs often involve a question of survival while inputs towards education do not. These findings are consistent with other studies that have examined the effects of multiple measures of child endowments on parental investments (Ayalew, 2005; Yi et al., 2014).

Our findings are robust to using alternative objective measures of cognitive ability and health endowments (including parental perceptions) and to addressing potential feedback effects between observed investment and measures of ability. The results also hold even after we include controls for sibling-specific heterogeneity in parental resources.

The study also considers the relationship between sibling composition and child labor. The estimates suggest that increasing birth order is positively related to both market and domestic work; thus, older children in the household spend more time in these activities than their siblings, with some observable difference across gender. Older girls are found to spend six hours more on domestic work and five hours less on market work per week. The results also suggest a strong correlation between the number of younger siblings in the household and number of hours per week children spend on different work activities with a clear gender divide. These results are consistent with predictions of a household production model where older children work more because they are better at household production (Edmonds, 2006; Dammert, 2010; Garg and Morduch, 1998).

Our findings have some important policy implications. First, the role of the family must be considered when designing public policies to remedy the effects of early inequality. As parents invest more educational human capital in the more able children, demand-side policies, such as conditional cash transfers or school feeding programs, might be more effective than supply side interventions. Second, we have highlighted the role of home production in explaining sibling differences in child labor. Hence, even demand side policies (such as conditional transfers) that target children should take into account the impact of domestic work, family size, and sibling composition.

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Appendix A.

Table A.1: Descriptive Statistics

Variable	Mean	Std.dev
Family Characteristics		
Child is female	0.47	0.50
Rural dummy	0.60	0.49
Household size	6.19	1.98
Number of siblings	4.84	2.13
Father's years of education	4.66	4.21
Mother's years of education	2.84	3.80
Caregiver depression (prenatal)	0.34	0.47
Marital status: Permanent partner	0.86	0.35
Wealth index (at age 1)[a]	0.21	0.17
Wealth index (at age 5)[a]	0.28	0.18
Wealth index (at age 8)[a]	0.33	0.18
Child Health Endowment		
Normal birth weight	0.43	0.49
Low birth weight	0.30	0.46
High birth weight	0.27	0.45
Height-for-age z-score at age 1	-1.58	1.96
Height-for-age z-score at age 5	-1.45	1.13
Height-for-age z-score of younger sibling[c]	-1.49	2.86
Had serious illness/injury at age 1	0.30	0.46
Had serious illness/injury at age 5	0.21	0.41
Longterm health problem	0.10	0.30
Healthier than peers at age 1[b]	0.38	0.48
Less healthier than peers at age 1[b]	0.24	0.43
Healthier than peers at age 5[b]	0.36	0.48
Less healthier than peers at age 5[b]	0.09	0.29
Child Cognitive Endowment		
PPVT score at age 5	21.42	12.39
PPVT score at age 8	79.20	44.24
PPVT score of younger sibling[c]	63.54	60.17
Math test score at age 5	8.24	3.01
Math test score at age 8	6.58	5.39
Early Childhood Parental Investments		
Birth Attended by professional	0.22	0.42
Had antenatal care	0.51	0.50
Pregnancy was wanted	0.62	0.48
Child was breastfed	0.98	0.13
Ever enrolled in preschool	0.25	0.43
Immunized against measles[d]	0.96	0.20
Annual educational expenditure at age 5	246.01	580.29
Annual medical expenditure at age 5	135.72	461.40
Hours per day spent on work activities at age 5	1.19	2.26
Hours per day spent on work activities at age 8	4.00	2.71

[a] Index constructed based on component indices for housing quality, consumer durables, and services (0 to 1)
[b] Based on caregivers' perception of the healthiness of their child
[c] Younger siblings were 4-6 years old at the time of measurement
[d] The last Completed Vaccinationation that a child receives

Table A.2: Child Endowment and Investments by Socioeconomic Status

	Educational Expenses		Hours of Work	
	(1)	(2)	(3)	(4)
PPVT	0.006	0.006	-0.131	-0.131
	(0.007)	(0.006)	(0.083)	(0.083)
Wealth index	1.837*	1.397	-34.705***	-34.277***
	(0.745)	(0.745)	(8.002)	(8.226)
Mother's years of education	0.078***	0.106***	-0.450*	-0.477
	(0.016)	(0.026)	(0.177)	(0.293)
PPVT × Wealth index	0.031*	0.049*	0.347	0.329
	(0.014)	(0.017)	(0.209)	(0.224)
PPVT × Mother's education		-0.001		0.001
		(0.001)		(0.008)
Constant	2.483***	2.501***	28.857***	28.844***
	(0.370)	(0.371)	(4.955)	(4.973)
N	1427	1427	1761	1761
Adj. R^2	0.482	0.482		

Each column corresponds to a different regression of the outcome (indicated in the column title) on endowment indicators and a set of controls that include gender, marital status, mother's age, household size, rural dummy, number of siblings and birth order. OLS estimation of the natural logarithm of annual educational expenses reported in columns (1) and (2). Columns (3) and (4) represent coefficients from separate *tobit* regressions. Standard errors clustered at community level in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.3: Predicting Health and Cognitive Endowment

	(1) Health	(2) PPVT	(3) CDA
Wealth index	0.199	13.154**	2.641*
	(0.156)	(4.047)	(0.947)
Caregiver depression	-0.065*		
	(0.031)		
Age of mother	0.000		
	(0.002)		
Mother's education	0.025***	0.637**	0.091**
	(0.006)	(0.191)	(0.028)
Household size	0.002	0.039	-0.026
	(0.005)	(0.198)	(0.042)
Marital status: Permanent partner	-0.009	-0.605	0.020
	(0.041)	(0.862)	(0.297)
Rural dummy	0.014	0.294	-0.056
	(0.073)	(1.477)	(0.422)
Child is female	0.013	-0.693	0.150
	(0.020)	(0.531)	(0.139)
Birth Attended by professional	0.055		
	(0.045)		
Antenatal visits during pregnancy	0.016		
	(0.027)		
Wanted to have the child	0.025		
	(0.027)		
Difficult pregnancy	0.085*		
	(0.032)		
Female $\times$ Mother's education		0.022	-0.048
		(0.235)	(0.030)
Height-for-age z-score		-0.099	0.097*
		(0.169)	(0.037)
Early Health Shock		-0.048	-0.199
		(0.591)	(0.124)
Number of siblings living at home		0.070	0.023
		(0.242)	(0.058)
Child is first born		-0.149	-0.183
		(0.764)	(0.170)
Time spent on working		-0.059	0.014
		(0.092)	(0.038)
Constant	0.173	16.039***	7.280***
	(0.130)	(2.049)	(0.685)
Observations	1745	1760	1787
Adjusted R^2	0.082	0.231	0.164

Standard errors clustered at community level in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$