Working Paper in Economics No. 700

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Department of Economics, December 2018

ISSN 1403-2473 (Print)
ISSN 1403-2465 (Online)

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Within-Family Inequalities in Human Capital Accumulation in India*

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Abstract

We investigate within-family inequalities in human capital accumulation in India. We consider both indicators of the child's current stock of human capital and of investment into their continued human capital accumulation, distinguishing between time investments and pecuniary investment into school quality. We develop a theoretical framework that demonstrates how credit constraints and opportunity cost of child time matter differently for time investments and pecuniary investments into human capital. We employ a within family model using sibship fixed effects, and find mostly negative birth order effects, i.e. earlier born children are better off. This is more in line with previous results from developed countries rather than from developing countries. However, for time investments, which are influenced by the opportunity cost of child time, birth order effects are more in line with what has previously been found in developing countries. Hence, we demonstrate that patterns of birth order effects differ by measure of human capital.

JEL codes: D13, I20, J16, O15

Keywords: Birth order, Gender, Human Capital, Education.

*We gratefully acknowledge financial support from the Swedish Research Council. We are also thankful for insightful comments from Rohini Somanathan, and from participants at presentations at University of Gothenburg, New Delhi School of Economics, Lund University, the Swedish National Conference in Economics, the Canadian Economic Association's Annual Conference, the Nordic Conference in Development Economics, and the Annual Conference on Economic Growth and Development.

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1. Introduction

Human capital formation has long been considered a central component in explaining economic development and economic inequalities. Much of the early research on human capital formation tended to emphasize the household as the primary unit of analysis, and focused on differences between households in order to explain variations in outcomes. More recently, however, within-household inequalities in human capital formation have gained greater attention. One aspect of within-household inequality that has proven significant is birth order, as educational outcomes have repeatedly been shown to differ systematically along this dimension. There is an extensive literature showing negative birth order effects on human capital in developed countries, i.e. first-born siblings fare best. The literature from developing countries is much smaller, but suggests the opposite relationship. Later-born children tend to have better educational outcomes (Ejrnæs and Pörtner, 2004; Tenikue and Verheyden, 2010; De Haan et al, 2014).

In this paper we investigate birth order effects on the development of children's human capital in India. Our data on education inputs and outcomes is unusually rich, allowing us to investigate both indicators of the child's current stock of human capital and of investment into their continued human capital accumulation. We can further distinguish between time investments and pecuniary investment into school quality. We also examine the impact of birth order on child labor. While not an educational variable per se, child labor is relevant in understanding educational human capital accumulation.

Higher birth order children are found in larger families. An analysis of birth order effects thus has to address the close relation between birth order and family size. To control for family size and other differences across families, we employ a within family model using sibship (i.e. groups of full siblings) fixed effects. Following Black et al. (2005), we also estimate separate regressions for each sibship size (still with sibship fixed effects, since families can differ in other important ways than family size). While within-family models are standard in the large literature on birth order effects from developed countries, and used in some of the best developing country studies, it has not been used in earlier studies from India. A within household analysis is the only way to completely avoid confounding birth order effects with systematic differences between families. This is especially important in the Indian context where we can expect systematic relationships between gender, birth order and family size.

In India, girls tend to live in larger families on average. This is because of gender-specific fertility stopping rules, i.e. parents that continue having children until they get a son (Jensen,

2003). Furthermore, there is a systematic relationship between birth order and gender within (some) families, due to sex-selective abortions, which is more common at higher birth orders when fertility approaches or exceeds parents' desired fertility (Basu, 1999; Rosenblum, 2013; Pörtner, 2013). To estimate causal effects of birth order on human capital accumulation outcomes the child gender control is therefore essential. Similarly, an estimation of gender effects has to control for birth order and family size. We further investigate if birth order effects vary systematically by gender by including a model where birth order is interacted with gender.

Our results show that birth order effects are mostly negative in India. This is more in line with the findings in developed countries than with those in developing countries. First-born children more often attend a private school, and their families spend more on their education. They have completed more grades, and they perform better on reading, writing and math tests. The exception to this pattern is the results for time investment indicators, which are more similar to the typical developing country pattern. Birth order effects are similar for girls and for boys.

Having established negative birth order effects, we attempt to reconcile these results with positive birth order effects in other developing countries. The suggested explanation behind positive birth order effects in earlier papers from developing countries is resource constraints combined with increasing family income over time, in particular if older siblings can contribute to household income (Parish and Willis, 1993; Sawada and Lokshin, 2009). Morevoer, the previous literature has mostly estimated effects on time investment indicators, though completed grades has also been used. We include a much wider range of indicators of both investment into human capital accumulation and the current human capital stock. A simple model highlights that credit constraints matter for both time investment and pecuniary investment, but that time investment is also affected by the opportunity cost of child time (in particular the interaction between credit constraints and opportunity costs of child time). As mentioned, our results for time investment indicators indeed show a similar pattern as in the previous literature from developing countries. Birth order effects on child labor are negative, and birth order effects on enrollment and school hours are positive in large families. This suggests that opportunity cost of child time matters for human capital investment decisions, but that credit constraints alone are less important to explain within-family differences.

Similar to previous studies from developing countries we investigate the general importance of credit constraints for birth order effects by estimating heterogeneity of birth order effects with respect to income. Our results suggest that credit constraints and poverty only matter in the case

of time investments. Again, this speaks for shifting focus from credit constraints in general towards opportunity costs of child time as an explanation behind positive birth order effects in poor families. We also estimate birth order effects in a sample where both credit constraints and opportunity cost of child time should be most important: poor rural households. Even in these families, birth order effects are mostly negative.

Our results also indicate that girls are disadvantaged within families, both with regard to investment into their human capital accumulation and with regard to the human capital stock that they possess. The one exception where girls do not appear to be disadvantaged is with regard to completed grades. This is despite the fact they are disadvantaged with regard to school enrollment as well as hours spent on schooling, and thus suggests that girls might be better provided with some ability of importance for academic success. Girls are not equally disadvantaged in all families: they are less so in small families and in rich families. This disadvantage is not driven by differential birth order effects.

This paper contributes to the existing literature in several ways. Foremost, we contribute to the small but growing literature on birth order effects on education in developing countries. In addition to using the most convincing empirical strategy (family fixed effects), we employ a wider range of measures of human capital compared to most of the existing literature, including both measures of children's human capital stock and of different forms of education investment. This allows for a more nuanced picture of the relationship between birth order and human capital development. We can thus shed further light on both the extent to which birth order effects in developing countries differ from those in developed countries, and on the reasons behind such differences. In particular, we show that birth order effects are not always positive in developing countries, and that they might differ depending on the type of education indicator. Positive birth order effects are more likely for time investment, since these are influenced by the opportunity cost of child time. They are less likely for indicators of pecuniary investments into school quality or for indicators of children's accumulated human capital stock. Ours is the first study to point out that credit constraints are likely to matter differently for time investment compared to pecuniary investment.

An additional contribution is that this is, to the best of our knowledge, the first paper that investigates the effect of birth order on educational attainment in India using only within family variation. This is particularly important in the Indian context where family size is systematically

related not only to birth order but also to gender. Prior studies on birth order effects in India have employed different methods and come to conflicting results.

The remainder of the paper is structured as follows: Section 2 reviews the previous research, section 3 introduces the theoretical framework, section 4 presents the data, variables and the empirical model, while section 5 presents the main results. Section 6 investigates the role of credit constraints, and section 7 discusses and concludes the paper.

2. Review of previous research

Empirical findings on birth order effects

A large body of literature uses within family variation to find causal effects of birth order in developed countries. These studies consistently show a negative birth order effect. Earlier born children have on average higher educational attainment and perform better on various tests of ability (Black et al, 2005; Conley and Glauber, 2006; Kantarevic and Mechoulan, 2006; Booth and Kee, 2009; De Haan, 2010; Silles, 2010; Hotz and Pantano, 2015). There has been less investigation into the effect of birth order on educational outcomes in developing countries. The existing literature has found positive birth order effects in the Philippines (Ejrnæs and Pörtner, 2004), Ecuador (De Haan et al, 2014), Bolivia (Zeng et al, 2012), sub-Saharan Africa (Tenikue and Verheyden, 2010), Nicaragua and Guatemala (Dammert, 2010), and Ethiopia (Lindskog, 2013). This is the opposite relationship as compared to the results in high income countries. However, in the cases where the above studies have split the sample between relatively rich and relatively poor households, the results in the relatively rich households are weak or even reversed, with a negative relationship between birth order and education outcomes.

While the majority of studies have found a monotonous relationship between birth order and education, there are a few exceptions. Dayioğlu et al (2009) find a non-monotonous relationship between birth order and school attendance in urban Turkey, while Sanhueza (2009) finds a non-monotonous relationship between birth order and years of schooling in Chile. In both cases, middle born children appear to fare worse than both their older and their younger siblings.

There are two studies of birth order effects on education outcomes in India. These studies come to conflicting conclusions. Makino (2018) investigates the relationship between birth order and test scores. She finds that there are no birth order effects for girls, while there are significant negative birth order effects for boys with older brothers. Her main strategy to deal with the correlation between birth order and family size is to estimate separate regressions for each

family size. Since family size is probably the most important difference between families having children of different birth orders, she uses the between-family variation to identify birth order effects for given (so far realized) family sizes. She performs some within-household regressions, but her data include few families with more than one sibling in the relevant age group. Kumar (2016) investigates the relationship between birth order and years of schooling. His results show significant positive birth order effects. He controls for family size and uses gender of the first-born as an instrument. However, the gender of siblings might have an independent effect on educational outcomes in India. Hence, it remains unclear if it is in fact birth order effects that drive his results. Therefore, the effect of birth order on educational outcomes in India remains an open question.

Suggested pathways through which birth order could affect schooling

In developing countries, birth order effects on human capital accumulation have generally been found to be positive. One hypothesis is that credit constraints can explain this positive relationship. Families facing a credit constraint will be unable to fully equalize the amount of resources allocated to each child. They may therefore be more likely to have their early-born children participate in labor or child care and less likely to participate in education (Lafortune and Lee, 2014). Later-born children thus benefit from the extra income generated by their older siblings. They also benefit from the fact that household income tends to increase over time (Parish and Willis, 1993).

As an example, Tenikue and Verheyden (2010) develop a dynamic model of household consumption where birth order effects can either be negative or positive. Under the assumptions of imperfect credit markets and ascending altruism (i.e. children are altruistic towards their parents), the model concludes that parents will invest more in the education of their first born child when they are not faced with credit constraints, but that in the face of binding credit constraints the first child will face higher pressure to work. They test their model empirically on data from twelve sub-Saharan African countries and find that the predictions of the model hold; relatively rich households exhibit negative birth order effects while relatively poor households exhibit positive effects. Similarly, De Haan et al (2014) examine birth order effects on education and child labor in Ecuador and find positive average birth order effects. When they interact birth order with a household poverty index on the one hand and education of the household head on the other, they find that relatively rich households and households where the head has relatively high education have significantly more negative birth order effects.

Ejrnæs and Pörtner (2004) present an alternative explanation to positive birth order effect. In their endogenous fertility model, parents employ a fertility stopping rule dependent on the endowment of their children, meaning they stop having children once a child with a sufficiently high endowment is born. Further, parents choose to reinforce rather than compensate differences between children via investments in human capital. These strategies lead to positive birth order effects, as last-born children will be the children with the highest endowments and thus receive the most human capital investment. This also leads to systematic differences in family size, as families where high endowment children enter at a low birth order will have fewer children.

Several theories address the negative relationship between birth order and educational attainment that has been found in developed countries. One hypothesis is that biological factors drive the observed relationship. The general argument is that earlier born children are healthier for reasons relating to mothers' health and behavior during pregnancy. Empirical results on this theory tend to conflict.[1] Furthermore, Kristensen and Bjerkedal (2010) find that IQ scores of Norwegian military conscripts are dependent on the individuals' social rank within the family, not strict biological birth order. Similarly, Barclay (2015) finds a negative birth order effect in a sample restricted to families where all siblings are adopted. This indicates that biological factors do not play a key role, thus the biological view does not seem to be the most relevant.

A model that is more in line with the results found in Kristensen and Bjerkedal (2010) and Barclay (2015) is the confluence model, which posits that the intellectual environment within the family is crucial for the intellectual development of children (Zajonc and Markus, 1975; Zajonc, 1976; Zajonc et al. 1979). The intellectual environment, in turn, is modelled as a weighted average of the parents' and children's intelligence. Since each child added to the family enters into a lower intellectual environment compared to the previous child, there are negative birth order effects.

Another postulated explanation for negative birth order effects is the resource dilution hypothesis. This hypothesis is similar to the confluence model, but in this case the important inputs to child development are parents' time and material resources. As family size increases, there will be less time and money per child. First-born children will therefore have the

[1] Lehmann et al (2018, JHR) find for example that mothers reduce their cigarette consumption less with later-born children. In contrast, Black et al (2011) in a study on birth order and IQ in Norway find that early born children have, if anything, a slight disadvantage at birth.

advantage of relatively more parental resources, at least during the period when they are the only child. The advantage faced by earlier born children is exacerbated by the fact that early-life investments in human capital have a persistent positive impact on educational outcomes. It also increases the productivity of future investments (Cunha and Heckman, 2007).

3. Theoretical framework

In this section we sketch a theoretical framework for current human capital stock and investment into continued human capital accumulation. This serves to guide the structure and interpretation of our empirical results. Starting with the human capital stock, there is now compelling evidence of the importance of early life investment and complementarities between early and late childhood. Hence, we use the human capital production function in Cunha and Heckman (2007) as our point of departure.

Human capital, in the form of different cognitive and non-cognitive skills and abilities, depends on parental characteristics, initial endowments and investments. Formally, human capital of sibling *i* in the next period $h_{t+1,i}$ is a function of home environment, ω, current human capital, $h_{t,i}$, and various investments, $I_{t,i}$: $h_{t+1,i} = f(\omega, h_{t,i}, I_{t,i})$. Home environment includes sibling interactions, implying that ω differs across siblings.

The current stock of human capital, which is what we estimate empirically, is the outcome of initial endowments of the child, home environment, and all prior investments in the child's human capital;

(1) $$h_{\tau,i} = f(\omega_i, h_{0,i}, I_{t\epsilon(0,\tau),i}).$$

We do not observe the arguments of the human capital production function, but estimate the reduced form effects of birth order and gender. While, as has been demonstrated by the empirical literature from developed countries, there are no reasons to expect that initial endowments $h_{0,i}$ should differ systematically with gender or birth order, ω_i will differ by birth order if it includes sibling interaction. Earlier investments $I_{t\epsilon(0,\tau),i}$ might vary with both birth order and gender. Note that current human capital could be viewed both as the outcome of human capital formation up until data collection and as arguments in the human capital production function.

Next, to arrive at an expression for education investment, we assume the simplest possible model. There are two periods: the current (late childhood of the children) and the future (when

the children are grown-up). Parents invest in children's human capital in the current period to maximize the sum of their utility over the two periods. Parents receive utility from household consumption in the current period, c_1, and from household consumption and grown-up children's human capital in the next period, c_2 and $h_{2,i}$. We abstract from discount rates and interest rates to simplify. Parents' utility function is $U = u(c_1) + u(c_2, \theta_i h_{2,i})$. The θ:s are the value to parents of grown-up children's human capital, and can vary across children. It can be thought of as including both altruism and different types of transfers to the parents.[2] The human capital production function of each child is $h_{2,i} = f(\omega_i, h_{2,i}, I_{j,i})$. Parents maximize total expected utility subject to the human capital production functions of their children and subject to the current and future period budget constraints. The current period budget constraint is $y_1^p + \sum_i y_{1,i} = c_1 + \sum_{i,j} p_j I_{i,j} + s$, where parents' income, y_1^p, is given, but where child income, $y_{1,i}$, depends on child labor, and thereby on the time they invest in education. Let w_i be the child wage rate. Then $y_{1,i} = w_i(1 - I_{i,j})$ for time investments. Further, p_j is the pecuniary cost of investment *j*, and *s* is savings. The future period budget constraint is $y_2^p + s = c_2$. Substitution of constraints into the utility function and maximization with respect to human capital investments gives the following first order condition for time investments and pecuniary investment into school quality respectively:

(2) $$\theta_s \frac{\delta f(\cdot)}{\delta I_{i,j}} = \frac{\delta u(\cdot)}{\delta c_1}(w_s + p_j),$$

(3) $$\theta \frac{\delta f(\cdot)}{\delta I_{i,j}} = \frac{\delta u(\cdot)}{\delta c_1} p_j,$$

where the left hand side is the parents' marginal benefit of investment *j* for child *i* and the right hand side is the marginal cost of that investment. The marginal benefit increases with θ_i, parents' valuation of increased human capital for child *i*, and with $\frac{\delta f(\cdot)}{\delta I_{i,j}}$, the marginal productivity of investment *j* in increasing child *i*'s human capital. If, as in the model of Cunha and Heckman, we assume that $\frac{\delta^2 f(\cdot)}{\delta I \delta h} > 0$, then an investment will increase human capital more among children who already possess higher human capital, creating an equality-efficiency trade-off. Turning to the marginal cost of investment *j*, it increases with p_j, the pecuniary cost, and, for time investments, w_i, the opportunity cost of child time. The impact of these costs on

[2] Transfers to parents could have been modeled as part of future period income instead, but we prefer to keep it as simple as possible.

parents' marginal utility also increases with $\frac{\delta u(\cdot)}{\delta c_1}$, the marginal utility of increased current period consumption. This term is higher among credit constrained households, creating a downward pressure on educational investment in these families.

Again, we estimate the reduced form effects of birth order and gender. With the exception of p_j, all other terms can differ with birth order and gender. Parents' valuation of child human capital, θ_i, can differ either because of differential degrees of altruism, or because children are expected to contribute differently to parents in their old age. The marginal productivity of the investment, $\frac{\delta f(\cdot)}{\delta I_{i,j,}}$, differs if the current human capital stock differs. The marginal utility of current period consumption, $\frac{\delta u(\cdot)}{\delta c_1}$, differs with birth order if the family is credit constrained and family income, as has been suggested, increases over time. The marginal cost depends on the interaction between the marginal utility of current period consumption and the opportunity cost and the pecuniary cost respectively. Edmonds (2006) shows that children of different birth order and gender have different comparative advantages, with older children more productive in child labor. While younger siblings should be equally productive when they reach a certain age, this will influence their educational investments less if the family is by then less credit constrained. Depending on context, there might also be differences in returns to child labor between boys and girls.

4. Data, variables and empirical model

Data

Our data comes from the 2004 - 05 and 2011 - 12 rounds of the India Human Development Survey (IHDS). This is a nationally representative survey of 42152 households covering 1420 villages and 1042 urban neighborhoods in India. The data has been collected as part of a joint project between the University of Maryland in the United States and the National Council of Applied Economic Research in India. The surveys were administered via interviews conducted in the local language, and cover a wide variety of socioeconomic topics. We have information that links each child to their mother. In order to determine the birth order of a child, we make use of the eligible women file. This includes the birth history of all women in the sample between the ages 15 and 49. We restrict the sample to cases where both the mothers and their husbands have not been previously married, creating a sample of full siblings (i.e. without half

siblings or step-siblings).[3] As there are cases where extended families are living in one household, we observe cases where there is more than one sibship per household. We exclude multiple birth children (twins, triplets), since their birth order is not well-defined. For the sake of our analysis, we further restrict our sub-sample to families where the sibship size is between 2 and 6.[4]

The estimation sample differs across different dependent variables. Test scores are only available for children age 8-11, but all other dependent variables are estimated on children aged 6 to 17. Since we are using a within-family model, there needs to be non-missing data from at least two children in a sibship for it to be included in the estimation sample. Often there is data on more than one child from each of the two surveys. Sibships are also included if there is data from one child in 2004-05 and another child in 2011-12. This substantially increases the test scores estimation sample.

Variables

Our main explanatory variable is absolute birth order. We construct dummy variables for birth orders one, two, three and four plus, the last of which takes a value of one if the child's birth order is 4, 5 or 6 and zero otherwise. A particular strength of the data set is that it includes an unusually rich set of educational information. As mentioned earlier, our dependent variables can be categorized into indicators of the child's current human capital stock and investments into the child's continued human capital accumulation. The indicators of current human capital are the scores on reading, writing and mathematics tests and the number of completed grades.

Cunha and Heckman (2008) show that test scores are not only influenced by cognitive, but also non-cognitive skills. The same is likely to hold for completed grades. In our regressions we use standardized test scores[5] - on tests administered by the interviewer as part of the survey - and number of completed grades, such that they measure age-specific standard deviations from the mean, using the sample population as the age-specific reference.[6]

[3] Divorce is very unusual in India, and only 3.9% of children have one or two previously married parents.
[4] We exclude larger families, since they are not common, and since we do not want unusual families to drive the high birth order results. Families that have 7 or more children make up 2.15% of the original sample.
[5] The test scores variables are the same as Makino (2018) uses in her analysis. We have an additional round of data from 2010-11 and thus have a much larger sample of families with at least two children in the data. This allows us to rely on a within-sibship analysis.
[6] The *reading score* runs from 0 (cannot read) to 4 (read a story), with the intermediate values 1 (letter), 2 (word) and 3 (paragraph). The *writing score* is equal to 0 if the child cannot write and 1 if the child can write with 2 or less mistakes. The *math score* runs between 0 (cannot count) and 3 (division), with the intermediate values 1 (number) and 2 (subtraction).

Our indicators of investments are *enrollment*, *child labor*, *total hours*, *private school* and *expenses*. The first three are indicators of time invested in schooling, where the total hours most directly corresponds to what we intend to measure.[7] Though not an educational variable, the information on child labor is relevant since it represents an alternative use of child time. Child labor is also studied in much of the earlier literature from developing countries. As has been conventional we will interpret child labor as the opposite of investing in child human capital. It is, however, possible that child labor is an investment into human capital. In particular among rural oldest sons who are likely to inherit the family land, learning by doing at the field can be an investment into his human capital (Congdon Fors et al., 2015; Lindskog, 2017; Fernando, 2016; Kosec et al., 2017). *Enrollment*, and *child labor* are dummy variables taking a value of 1 if the child is enrolled in school or works more than 240 hours a year,[8] respectively, and zero otherwise. *Total hours* combines the hours of school, hours of homework and hours of private tuition per week used by the child.[9] Though *total hours* is only collected for children who are enrolled, we set it to zero for all children who are not enrolled and estimate it on the full sample.

Table 1: Descriptive statistics

Variable	N	Mean	Std dev	Min	Max
Dependent variables					
Enrollment	66,095	0.869	0.338	0.000	1.000
Child labor	66,164	0.083	0.276	0.000	1.000
Total hours spent on school in a week	59,732	36.787	19.147	0.000	216.000
Private school	53,516	0.299	0.458	0.000	1.000
School expenses in rupees	48,284	3146.792	6057.788	0.000	201000
Completed grades	66,086	4.739	3.202	0.000	16.000
Reading test score	7,871	2.546	1.367	0.000	4.000
Writing test score	7,787	0.708	0.455	0.000	1.000
Math test score	7,849	1.496	1.003	0.000	3.000
Explanatory variables (enrollment sample)					
Birth order 1	66,095	0.288	0.453	0.000	1.000
Birth order 2	66,095	0.338	0.473	0.000	1.000
Birth order 3	66,095	0.212	0.409	0.000	1.000
Birth order 4 to 6	66,095	0.162	0.369	0.000	1.000
Age 7	66,095	0.084	0.278	0.000	1.000
Age 8	66,095	0.076	0.266	0.000	1.000
Age 9	66,095	0.072	0.258	0.000	1.000

[7] While it is possible that children are enrolled without actually attending school, less than 1% of our enrolled sample report spending zero hours on schooling, and approximately 90% report spending at least 29 hours a week on schooling.

[8] The 240 hours a year cut-off is from the data, which does not include the continuous hours worked in both surveys.

[9] Private tuition depends on pecuniary investment, but we still choose to include it to count all hours equally. If children did not study with private tutors they could instead study alone or with someone else.

Age 10	66,095	0.103	0.304	0.000	1.000
Age 11	66,095	0.072	0.258	0.000	1.000
Age 12	66,095	0.118	0.323	0.000	1.000
Age 13	66,095	0.091	0.287	0.000	1.000
Age 14	66,095	0.095	0.293	0.000	1.000
Age 15	66,095	0.080	0.271	0.000	1.000
Age 16	66,095	0.070	0.256	0.000	1.000
Age 17	66,095	0.062	0.256	0.000	1.000
Girl	66,095	0.480	0.500	0.000	1.000
Year 2011	66,095	0.468	0.499	0.000	1.000
Income per capita in 100,000 rupees	65,177	0.151	0.180	0.000	1.500
Poor	66,088	0.252	0.434	0.000	1.000
Urban	66,095	0.314	0.464	0.000	1.000

Private schooling and school expenses are indicators of investment into school quality.[10] *Private school* and *Expenses* is also collected only for children who are enrolled in school, and in the main estimations we estimate them on the conditional samples. Thus the estimation samples for these outcomes are endogenous. [11] We run robustness estimations were we have coded the expenses and the private school attendance as zero for all children who are not enrolled in school, but prefer to keep the estimations based on the conditional samples in the main analysis since they are easier to interpret. *Private school* is a dummy variable taking a value of 1 if the child attends a private school, and 0 if the child attends a public school. *Expenses* measures the cost of school fees, books, uniforms, bus fare and private tuition fees in rupees.

Table 1 provides descriptive statistics on all variables used in our analysis.[12] Enrolment is rather high, at 86.9% and child labor rather low, at 8.3%. Note, however that children have to work at least four hours a week to be considered as child laborers, and that household chores (which we do not have information on) are not counted as work.

Empirical model

We are interested in within-household inequalities in human capital formation. Are there any systematic inequalities related to birth order? By necessity birth order is correlated with family

[10] Though the effect of these investments on human capital accumulation remain unclear, parents are likely to make them with the intent to improve the child's human capital.
[11] Note that this, for example, implies that a family is dropped if only one child has attended school, even if there are more children of the right ages in the data. However, these families are included in the robustness estimations on the unconditional sample.
[12] Table A1 provides descriptive statistics for the dependent variables by sibship size.

size, and in India gender has also been shown to be so (Jensen, 2003). We use sibship fixed effects[13] (where siblings in a sibship have the same mother and father) in order to ensure that we do not confuse within-family inequalities with differences in human capital accumulation across families, which depend for example on family size and the systematic relationship between family size, gender and birth order. Furthermore, since gender is not completely exogenous in India, but systematically related to birth order, it is essential to control for gender to estimate causal birth order effects.

In addition to sibship fixed effects and the female control, we control for a full set of age dummies and survey round. The basic model is

$$y_{ist} = \alpha + \beta_1 * birthorder2_{is} + \beta_2 * birthorder3_{is} + \beta_3 * birthorder4to6_{is} + \beta_4 * female_{is} + \sum age_{ist}\pi + \varphi_t + \gamma_s + \varepsilon_{ist}$$

where y_{ist}, the outcome of child *i* in sibship *s* at time *t*, are our measures of children's current human capital stock and of investment into their continued human capital accumulation. age_{ist} is a full set of child age dummies, and φ_t is a survey round dummy controlling for, among other things, the expansion of schooling over time. γ_s are sibship fixed effects, which captures differences in family size, and all other time constant differences across families.

Even if only within family variation is used for identification of birth order effects, all families will not contribute to the estimation of all birth order effects. In particular, only large families can contribute to the high birth order effects. If birth order effects differ with family size, this will affect the pattern of birth order effects that we estimate. To deal with this we follow Black et al. (2005) and estimate separate regressions for each sibship size (2, 3, 4. 5 and 6). Note, however, that fertility might not be completed in all families, making the division into family sizes somewhat blurry.[14,15]

[13] There are cases where there are more than one sibship in a household. Using household fixed effect does not qualitatively change our results, but since birth order is defined within the sibship, we use sibship fixed effects.
[14] We have also run sibship-size-specific estimations only for sibships whose size is at least as large as the mother's expressed preferred number. This reduces the sample mostly for sibships of size 2, but to some degree also for sibships of size 3. The results of these estimations (not presented but available from the authors) are very similar to the results of estimations including also sibships whose size is smaller than the mother's expressed preferred number of children. In addition we have run estimations only on the sample where the mother was at least 35 or at least 40 years. This reduces the sample substantially, and effects for test scores (which has the smallest sample sizes) are no longer significant. Otherwise results are similar to the main estimations. Results from these estimations are also available from the authors.
[15] The fact that fertility is not completed in all families is also a reason to use absolute birth order dummies rather than measures of relative birth order (see, for example Booth and Kee (2009) and Ejrnaes and Portner (2004)).

Along similar lines, families that do not use sex-selection contribute more to the identification of the female effect. These are likely either to have weaker son preferences or to more often use gender-specific fertility stopping rules to ensure the birth of a son. The estimated female effect will therefore differ from a hypothetical one where gender was truly random. However, it does still describe how girls are treated differently within families.

To estimate a within-family model we need within-family variation in birth order in the estimation sample. Since the data on educational outcomes is restricted to an age-delimited subsample of children, our estimation sample could differ systematically from Indian families in general. However, the fact that we have a panel with 7 years in-between reduces this problem substantially. We lose very few observations to lack of within-family variation in birth order, even for test scores. Observed characteristics are extremely similar in our estimation sample and in a sample that also include observations from families without variation in birth order.[16]

While the sibship fixed effects control for all time constant differences between families, they do not control for time-varying factors that vary systematically with birth order. The time-varying controls included in the regressions are therefore important for the interpretation of birth order effects. Importantly we control for the survey year. This is crucial since within families higher birth order children will be school-age later, and thus face a different environment where schooling opportunities are likely to have improved (Barclay, 2018). Other time-varying differences that have been suggested to drive systematic birth order effects are credit constraints and maternal age and behaviors. The literature from developed countries has largely refuted the idea that systematic birth order effects are due to biological differences related to maternal age or behaviors during pregnancy. Systematic differences in credit constraints over time is, however, the main reason suggested to be behind birth order effects in developing countries. We therefore investigate the role of credit constraints in explaining birth order effects.

In our main estimations we use linear sibship fixed effects regressions for all outcomes. For the binary outcomes, *enrollment*, *child labor* and *private school* we therefore estimate the linear probability model. We estimate alternative models as a robustness check (the conditional logit and the correlated random effects probit). Standard errors are always clustered at the sibship level. A well-known shortcoming of the fixed effects model is that attenuation bias due to

[16] This comparison is available from the authors on request.

measurement error is amplified. Estimated birth order effects can therefore be viewed as lower bounds of the true ones.

5. Main results

Starting with the indicators of children's current human capital stock (Table 2), the results show clear negative birth order effects across the board. The higher the birth order, the fewer grades she has completed, and the lower her scores on the reading-, writing- and math tests. In the case of education investment indicators (Table 3) the pattern is mixed. For private schooling and school expenses - the indicators of pecuniary investment into school quality - the pattern is the same as for human capital stock indicators: there are clear negative birth order effects. Time investment indicators show a different pattern, especially for child labor. While birth order effects on child labor are expected to have the opposite sign of those on education variables, our results show that birth order effects on child labor are strictly negative. Birth order effects are also negative for school enrolment and total hours, but there is a tendency towards non-monotonic effects. Children of birth orders 4 to 6 do not appear to be disadvantaged in comparison to the first-born for enrolment. The difference in birth order effects on time investments compared to on pecuniary investments into school quality indicates that opportunity cost of child time could be influential. While negative birth order effects for both child labor and enrolment may seem counterintuitive, the two activities are not mutually exclusive: circa 48% of children participating in child labor are also enrolled in school. Further, participation in child labor is relatively low, at approximately 8% of the sample.

Table 2: The effect of birth order on indicators of current human capital stock – coefficients from linear sibship fixed effects estimations

	Completed grades	Reading	Writing	Math
Second born	-0.212***	-0.145***	-0.137***	-0.155***
	(0.010)	(0.035)	(0.038)	(0.033)
Third born	-0.376***	-0.255***	-0.214***	-0.285***
	(0.018)	(0.062)	(0.066)	(0.057)
Fourth to sixth	-0.475***	-0.339***	-0.346***	-0.428***
	(0.029)	(0.096)	(0.097)	(0.086)
Female	0.004	-0.059**	-0.078***	-0.133***
	(0.007)	(0.023)	(0.025)	(0.023)
R^2	0.06	0.02	0.02	0.02
N	66,086	7,871	7,787	7,849
Sibships	21,242	3,751	3,711	3,741

Note: The estimations also include a constant, a full set of child age dummies, a year dummy and sibship fixed effects. * p<0.1; ** p<0.05; *** p<0.01. Standard errors, clustered at the sibship level, within parenthesis.

Table 3: The effect of birth order on educational investment-coefficients from linear sibship fixed effects estimations

	Enrollment	Child labor	Total hours	Private school	School expenses
Second born	-0.028***	-0.007**	-1.742***	-0.020***	-422.041***
	(0.004)	(0.003)	(0.199)	(0.004)	(60.120)
Third born	-0.030***	-0.028***	-2.027***	-0.034***	-617.101***
	(0.007)	(0.006)	(0.351)	(0.008)	(101.192)
Fourth to sixth born	-0.007	-0.060***	-1.163**	-0.048***	-752.706***
	(0.010)	(0.009)	(0.536)	(0.012)	(152.145)
Female	-0.029***	-0.020***	-1.394***	-0.056***	-548.329***
	(0.003)	(0.002)	(0.138)	(0.003)	(38.323)
R^2	0.14	0.11	0.10	0.02	0.15
N	66,095	66,164	59,732	53,516	48,284
Sibships	21,243	21,256	19,586	18,402	16,984

Note: The estimations also include a constant, a full set of child age dummies, a year dummy and sibship fixed effects.
* p<0.1; ** p<0.05; *** p<0.01. Standard errors, clustered at the sibship level, within parenthesis.

Turning to gender differences, girls exhibit a human capital stock disadvantage in comparison to their brothers. They perform worse on the reading-, writing- and mathematics test. Nonetheless, there is one exception: girls are not disadvantaged in terms of the number of completed grades. Girls also receive less education investment than boys. They are less often enrolled, spend fewer hours on schooling, are less likely to attend a private school and have less money spent on their education. However, they are also less likely to participate in child labor. Unfortunately, we do not have information on domestic work, which is likely to be more common among girls. The fact that girls have completed as many grades as boys even though they are less likely to be enrolled means that they repeat grades less, and might be due to girls having been better provided with some unmeasured skill or ability which matters for academic success.

Heterogeneous results across family size

Tables 4 and 5 show family-size-specific birth order and gender effects. These estimations fill two purposes. First, heterogeneity related to family size is interesting in itself. Second, it can be seen as a robustness check, since all families do not contribute equally to all effects in the pooled sample.

Negative birth order effects on human capital stock indicators are found across all family sizes (Table 4), though they are statistically insignificant for reading and writing test scores in 2-child families and for test scores in 6-child families. Turning to educational investment (Table 5), pecuniary investments into school quality also show a similar pattern. There are negative birth

order effects across all family sizes, although the effects are statistically weak for private schooling in many cases. In contrast, the effects of birth order on time investment differ across family sizes. In the largest families there seems to be more of a tradeoff between child work and education, and birth order effects follow the pattern found in other developing countries. In most family sizes there are no statistically significant birth order effects on enrolment or total hours, but there are negative ones for enrolment in 2-child families and for both enrolment and total hours in 3-child families, and there are positive ones for both enrolment and total hours in 6-child families. Thus, the non-monotonic relationship between birth order and time investment into education is not present within given families. Instead, it appears to be driven by more negative birth order effects in small families and more positive ones in large families.

Table 4: The effect of birth order on indicators of current human capital stock in families of different sizes – coefficients from linear sibship fixed effects estimations

	Completed grades	Reading	Writing	Math
Panel I: 2-child families				
Second born	-0.260***	-0.137	-0.029	-0.234**
	(0.021)	(0.102)	(0.111)	(0.116)
Female	0.046***	0.073	-0.044	-0.060
	(0.012)	(0.046)	(0.048)	(0.050)
R^2	0.09	0.01	0.01	0.03
N	15,740	1,408	1,384	1,402
Sibships	6,991	725	713	722
Panel II: 3-child families				
Second born	-0.248***	-0.231***	-0.171**	-0.192***
	(0.019)	(0.065)	(0.085)	(0.070)
Third born	-0.535***	-0.411***	-0.260*	-0.346***
	(0.036)	(0.120)	(0.157)	(0.126)
Female	0.034***	-0.014	-0.024	-0.076*
	(0.011)	(0.040)	(0.044)	(0.041)
R2	0.06	0.04	0.02	0.03
N	21,082	2,393	2,348	2,374
Sibships	7,302	1,214	1,192	1,205
Panel III: 4-child families				
Second born	-0.243***	-0.256***	-0.316***	-0.190**
	(0.024)	(0.085)	(0.106)	(0.085)
Third born	-0.504***	-0.440***	-0.521***	-0.371**
	(0.040)	(0.150)	(0.189)	(0.149)
Fourth to sixth born	-0.755***	-0.732***	-0.819***	-0.694***
	(0.058)	(0.228)	(0.279)	(0.223)
Female	-0.025	-0.096**	-0.114**	-0.166***
	(0.015)	(0.047)	(0.056)	(0.050)
R2	0.05	0.05	0.04	0.05
N	14,867	1,938	1,929	1,946
Sibships	4,566	1,003	999	1,008
Panel IV: 5-child families				
Second born	-0.117***	-0.303***	-0.189*	-0.223**
	(0.033)	(0.107)	(0.110)	(0.102)
Third born	-0.228***	-0.585***	-0.288*	-0.531***
	(0.045)	(0.161)	(0.159)	(0.155)
Fourth to sixth born	-0.410***	-0.702***	-0.422**	-0.682***

	(0.065)	(0.216)	(0.205)	(0.218)
Female	-0.060***	-0.141**	-0.103	-0.197***
	(0.021)	(0.064)	(0.065)	(0.061)
R2	0.07	0.04	0.02	0.05
N	9,049	1,291	1,287	1,286
Sibships	2,431	660	659	658
Panel V: 6-child families				
Second born	-0.047	-0.137	0.096	0.178
	(0.051)	(0.223)	(0.235)	(0.182)
Third born	-0.151**	-0.219	0.130	0.109
	(0.063)	(0.289)	(0.291)	(0.217)
Fourth to sixth born	-0.209**	-0.235	0.060	-0.017
	(0.083)	(0.336)	(0.338)	(0.253)
Female	-0.070**	-0.261***	-0.136	-0.163**
	(0.029)	(0.088)	(0.092)	(0.074)
R2	0.07	0.05	0.04	0.04
N	5,251	838	836	838
Sibships	1,243	430	429	430

Note: The estimations also include a constant, a full set of child age dummies, a year dummy and sibship fixed effects.

* p<0.1; ** p<0.05; *** p<0.01. Standard errors, clustered at the sibship level, within parenthesis.

Table 5: The effect of birth order on educational investment in families of different sizes - coefficients from linear sibship fixed effects estimations

	Enrollment	Child labor	Hours	Private	Expenses
Panel I: 2-child families					
Second born	-0.007	-0.015***	-1.355***	-0.017*	-365.929**
	(0.006)	(0.005)	(0.437)	(0.009)	(154.865)
Female	-0.001	-0.001	-0.036	-0.038***	-561.978***
	(0.004)	(0.003)	(0.230)	(0.006)	(106.534)
R^2	0.06	0.04	0.07	0.01	0.19
N	15,740	15,749	13,843	14,014	13,058
Sibships	6,991	6,996	6,231	6,275	5,875
Panel II: 3-child families					
Second born	-0.031***	-0.028***	-2.196***	-0.016*	-562.978***
	(0.007)	(0.006)	(0.384)	(0.008)	(114.971)
Third born	-0.040***	-0.052***	-3.297***	-0.023	-888.041***
	(0.012)	(0.010)	(0.711)	(0.014)	(195.475)
Female	-0.022***	-0.014***	-1.232***	-0.059***	-586.021***
	(0.004)	(0.004)	(0.228)	(0.005)	(62.944)
R2	0.11	0.08	0.09	0.02	0.15
N	21,084	21,100	19,082	17,547	15,939
Sibships	7,303	7,308	6,740	6,281	5,770
Panel III: 4-child families					
Second born	-0.007	-0.045***	-0.736	-0.011	-369.234***
	(0.010)	(0.008)	(0.502)	(0.011)	(132.151)
Third born	-0.017	-0.065***	-1.088	-0.007	-812.563***
	(0.016)	(0.013)	(0.810)	(0.018)	(260.133)
Fourth to	-0.034	-0.066***	-1.885	-0.009	-897.056**
sixth born	(0.023)	(0.019)	(1.180)	(0.025)	(377.416)
Female	-0.043***	-0.027***	-1.969***	-0.061***	-486.332***
	(0.006)	(0.005)	(0.309)	(0.007)	(58.814)
R2	0.15	0.13	0.11	0.02	0.17
N	14,870	14,884	13,575	11,604	10,315
Sibships	4,566	4,567	4,272	3,839	3,466
Panel IV: 5-child families					
Second born	0.020	-0.045***	0.046	-0.030**	-177.838
	(0.014)	(0.012)	(0.663)	(0.014)	(117.772)

Third born	0.022	-0.063***	-0.517	-0.056***	-420.343***
	(0.018)	(0.016)	(0.860)	(0.020)	(119.799)
Fourth to	0.032	-0.076***	-0.429	-0.057**	-545.204***
sixth born	(0.026)	(0.022)	(1.207)	(0.028)	(171.103)
Female	-0.048***	-0.033***	-1.951***	-0.062***	-460.207***
	(0.009)	(0.007)	(0.405)	(0.009)	(69.333)
R2	0.19	0.16	0.15	0.02	0.10
N	9,053	9,075	8,301	6,554	5,709
Sibships	2,431	2,434	2,285	1,987	1,758
Panel V: 6-child families					
Second born	0.025	-0.025	1.332	0.017	-129.963
	(0.025)	(0.020)	(1.098)	(0.026)	(117.217)
Third born	0.057**	-0.056**	2.518*	0.001	-173.551
	(0.028)	(0.023)	(1.301)	(0.031)	(176.769)
Fourth to	0.058*	-0.052*	2.658*	-0.013	-443.359*
sixth born	(0.035)	(0.028)	(1.614)	(0.037)	(229.371)
Female	-0.061***	-0.031***	-2.560***	-0.068***	-397.073***
	(0.012)	(0.010)	(0.564)	(0.013)	(95.478)
R2	0.19	0.16	0.15	0.03	0.07
N	5,251	5,258	4,856	3,718	3,192
Sibships	1,243	1,243	1,190	1,040	930

Note: The estimations also include a constant, a full set of child age dummies, a year dummy and sibship fixed effects.
* p<0.1; ** p<0.05; *** p<0.01. Standard errors, clustered at the sibship level, within parenthesis.

Girls are less disadvantaged in small families than in large families. In particular, girls in small families fare well in comparison to their brothers on the education related human capital stock indicators. In 2 and 3-child families girls have completed more grades than their brothers and they have similar test scores. In 4-child families, they have completed as many grades as their brothers but have worse test scores. In larger families, girls do worse than their brothers on all indicators. In terms of education investment (Table 5), girls are disadvantaged across all family sizes both with regard to pecuniary investment into school quality and with regard to time investment. The only exception is time investments in 2-child families. Hence, even if girls' human capital stock appears to be at least as good as that of their brothers in small families, the families do not invest as much into the girls' education. Finally, girls work less often in families of all sizes, but as mentioned earlier we do not have information on domestic work, which girls probably participate in more often.

Gender – birth order interactions

So far, we have constrained birth order effects to be the same for boys as for girls. However, costs and expected benefits of investing in child human capital are likely to differ between genders. In addition, these costs could interact with birth order differently across genders. For example, if child labor opportunities are better for boys than girls we might expect stronger birth order effects among brothers than among sisters for child labor, since credit constraints

interact with opportunity costs. If oldest sons work on the land that they will inherit we should also expect strong birth order effects on child labor for boys but not for girls. In general, if labor market and schooling opportunities vary between the genders, birth order effects could also do so. Another reason for differing birth order effects between the genders could be oldest son preferences that play out differently for the genders, as explored in Jayachandran and Pande (2017) for early life outcomes. In short, oldest son preferences could create negative birth order effects among sons simply because the oldest son will be of a lower birth order. It will create negative birth order effects among girls if families continue childbearing until they have a son. The birth of a girl at birth orders at or above the desired total number of children will then increases expected family size, which can be expected to reduce in particular early life investment. Below, in table 6 and 7, we allow different birth order effects for boys than for girls. These results should be interpreted with caution since gender is not completely exogenous in India. They could still be descriptively interesting and potentially shed some light on possible reasons behind birth order effects. Tables A2-A3 show family size specific birth order effects that are allowed to vary across gender.

Table 6: Gender specific birth order effects on indicators of current human capital stock – coefficients from linear sibship fixed effects estimations

	Completed grades	Reading	Writing	Math
Second born	-0.200***	-0.123***	-0.109**	-0.191***
	(0.013)	(0.045)	(0.050)	(0.043)
Third born	-0.365***	-0.201***	-0.199***	-0.301***
	(0.021)	(0.071)	(0.077)	(0.065)
Fourth to sixth	-0.480***	-0.327***	-0.332***	-0.478***
	(0.031)	(0.104)	(0.106)	(0.093)
Female	0.016	-0.015	-0.047	-0.182***
	(0.013)	(0.045)	(0.050)	(0.045)
Second born * female	-0.025	-0.044	-0.058	0.072
	(0.017)	(0.058)	(0.066)	(0.058)
Third born * female	-0.025	-0.110	-0.030	0.030
	(0.020)	(0.067)	(0.075)	(0.066)
Fourth to sixth * female	0.010	-0.026	-0.027	0.096
	(0.023)	(0.074)	(0.079)	(0.070)
R^2	0.06	0.02	0.02	0.03
N	66,086	7,871	7,787	7,849
Sibships	21,242	3,751	3,711	3,741

Note: The estimations also include a constant, a full set of child age dummies, a year dummy and sibship fixed effects. * p<0.1; ** p<0.05; *** p<0.01. Standard errors, clustered at the sibship level, within parenthesis.

Table 7: Gender specific birth order effects on educational investment-coefficients from linear sibship fixed effects estimations

	Enrollment	Child labor	Total hours	Private school	School expenses
Second born	-0.033***	-0.008*	-1.923***	-0.022***	-421.800***

	(0.005)	(0.004)	(0.255)	(0.006)	(79.054)
Third born	-0.032***	-0.029***	-2.071***	-0.029***	-643.182***
	(0.008)	(0.007)	(0.398)	(0.009)	(122.761)
Fourth to sixth born	-0.010	-0.062***	-1.381**	-0.043***	-733.407***
	(0.011)	(0.010)	(0.577)	(0.013)	(165.896)
Female	-0.034***	-0.022***	-1.608***	-0.054***	-554.560***
	(0.005)	(0.005)	(0.259)	(0.006)	(77.599)
Second born * female	0.010	0.003	0.367	0.005	-0.240
	(0.007)	(0.006)	(0.342)	(0.007)	(95.271)
Third born * female	0.004	0.002	0.076	-0.010	56.084
	(0.008)	(0.007)	(0.394)	(0.008)	(109.775)
Fourth to sixth born *	0.006	0.003	0.435	-0.010	-36.623
female	(0.009)	(0.007)	(0.441)	(0.009)	(111.974)
R^2	0.14	0.11	0.10	0.02	0.15
N	66,095	66,164	59,732	53,516	48,284
Sibships	21,243	21,256	19,586	18,402	16,984

Note: The estimations also include a constant, a full set of child age dummies, a year dummy and sibship fixed effects.
* p<0.1; ** p<0.05; *** p<0.01. Standard errors, clustered at the sibship level, within parenthesis.

In general, birth order effects are similar for boys and for girls. In particular, we do not find differences in birth order effects between boys and girls for investment indicators (though all girls are at a disadvantage compared to boys of the same birth order). To investigate if negative birth order effects could still be driven by oldest son preferences, only with a similar impact among girls and among boys, we also followed Jayachandran and Pande (2017) in considering heterogeneity of birth order effects across places and families where son preferences could be expected to be stronger or weaker. We ran various regressions where we interacted birth order indicators and other regressors with indicators of belonging to groups that could be argued to possess stronger or weaker son preferences (i.e., we ran fully interacted models): Hindu, living in Kerala, mothers' reported desire to have more sons than daughters, mothers' education, natural regional sex-ratios, and a high regional score on a 'standing of women and children' index in the state. Birth order effects do not seem to be systematically different in places where we have reason to expect weaker or stronger son preferences. Being a girl is worse in places and families where we should expect stronger son preferences, though. These regressions are not reported, but available from the authors on request.

The family size specific estimations in tables A2-A3 show that birth order effects are indeed stronger among boys than girls in smaller families are. This could be due to better labor market opportunities among boys and/or that oldest sons in rural families work on land that they will inherit. There are also statistically significant gender*birth order interactions for completed grades in some family sizes. In particular, the oldest girl appears to do very well in small families.

Further robustness checks

Table A4 in the appendix uses alternative samples for the estimations on some of the investments. The estimation of total school hours is conditional on any school hours, and the resulting birth order effects on conditional hours are clearly negative. The estimations of the private school choice and expenses are not conditional on enrollment. The birth order effects in these cases are similar to in the estimations on conditional samples, but some of them are of a slightly smaller magnitude.

Tables A5 and A6 in the appendix estimate the binary outcomes using the conditional logit model and the correlated random effects model. Results are similar to those in the main estimations. We have also run regressions using only the 2004 - 05 data, as the period between our two rounds witnessed a large expansion of schooling, including the coming in to force of the 2009 Right to Education Act. Though the test scores sample is too small for any meaningful inference, other results remain qualitatively similar to those in the main regressions. These results are available on request. Regressions with the time-varying household variable number of siblings are also available on request. The inclusion of this control variable does not affect the birth order and gender coefficients.

6. Credit constraints and heterogeneous effects across family incomes

Positive birth order effects on education outcomes in developing countries are typically explained by credit constraints and rising family income over time. In this section, we test whether the pattern of more negative birth order effects in richer families also holds in India. According to the simple model in section 3 we should expect credit constraints to be particularly important for time investment. Credit constraints matter for both pecuniary investment and time investment. However, for time investment credit constraints interact with opportunity cost of child time, which can be expected to vary systematically with birth order, with lower birth order (i.e. older) children expected to be more productive (Edmonds, 2006). For pecuniary costs, credit constraints interact with the price, which should not vary systematically by birth order.

Tables 8 and 9 display results of fully interacted models, where household income per capita has been interacted with birth orders, the female dummy and the control variables (age fixed effects and survey year). To save space, Tables 8 and 9 only report the models estimated on the pooled sample of all sibship sizes. Sibship-size-specific estimations are presented in the appendix (Tables A7-A8).

Table 8: Heterogeneity of birth order effects on indicators of current human capital stock – coefficients from linear sibship fixed effects models fully interacted with income per capita

	Completed Grade	Reading	Writing	Math
Second born	-0.206***	-0.200***	-0.198***	-0.178***
	(0.012)	(0.042)	(0.049)	(0.041)
Third born	-0.367***	-0.300***	-0.287***	-0.302***
	(0.021)	(0.074)	(0.081)	(0.068)
Fourth to sixth born	-0.442***	-0.381***	-0.428***	-0.411***
	(0.031)	(0.111)	(0.116)	(0.100)
Female	-0.031***	-0.129***	-0.105***	-0.190***
	(0.009)	(0.030)	(0.033)	(0.029)
Second born # Income per capita	-0.007	0.428**	0.525*	0.225
	(0.048)	(0.207)	(0.278)	(0.218)
Third born # Income per capita	-0.137*	0.303	0.663	0.229
	(0.077)	(0.362)	(0.445)	(0.381)
Fourth to sixth born # Income per capita	-0.578***	0.071	0.497	-0.171
	(0.112)	(0.493)	(0.598)	(0.484)
Female # Income per Capita	0.254***	0.601***	0.240*	0.494***
	(0.040)	(0.142)	(0.143)	(0.137)
R^2	0.07	0.02	0.02	0.03
N	65,168	7,750	7,668	7,727
Sibships	21,033	3,712	3,673	3,702

Note: The estimations also include a constant, a full set of child age dummies, a year dummy, per capita income, and sibship fixed effects.
* p<0.1; ** p<0.05; *** p<0.01. Standard errors, clustered at the sibship level, within parenthesis.

Birth order effects are indeed more negative in higher income per capita households for enrollment, educational expenses, and completed years. They are more negative among the poor for child labor. Birth order effects do not differ significantly between poor and rich families for the probability to attend a private school, and are if anything somewhat less negative for test scores. Larger effects on expenses among the rich than among the poor is a natural consequence of the fact that richer families afford to spend more. A regression using the share of school expenses out of total family school expenses have no statistically significant interaction effects (not reported but available from the authors). Hence, we do find a difference between poor and rich families for enrolment, child labor, and for completed grades, which is the human capital stock indicator that ought to be most connected to earlier time investment into education. However, the sibship-size-specific estimations in Table A7-A8 show that the pattern of negative interaction terms for time investments do not hold across different family sizes.[17] Smaller families are more often relatively rich and larger ones more often poor. Thus, the differences between rich and poor families in the pooled sample might be driven more by heterogeneous effects across family size and less by heterogeneity due to income per se.

[17] The only reasonably strong effects are for enrollment in 6-child families.

Table 9: Heterogeneity of birth order effects on educational investment-coefficients from linear sibship fixed effects models fully interacted with income per capita

	Enrollment	Child labor	Hours	Private	Expenses
Second born	-0.025***	-0.014***	-1.694***	-0.020***	-154.859
	(0.005)	(0.004)	(0.244)	(0.005)	(99.460)
Third born	-0.027***	-0.037***	-1.783***	-0.035***	-295.050*
	(0.008)	(0.007)	(0.417)	(0.009)	(164.562)
Fourth to sixth born	-0.007	-0.075***	-1.032*	-0.054***	-417.753*
	(0.012)	(0.010)	(0.618)	(0.014)	(225.525)
Female	-0.041***	-0.014***	-1.763***	-0.055***	-373.987***
	(0.004)	(0.003)	(0.183)	(0.004)	(59.128)
Second born #	-0.018	0.052***	0.032	0.002	-2,108.107***
Income per capita	(0.015)	(0.016)	(1.073)	(0.025)	(733.022)
Third born # Income	-0.047*	0.094***	-2.936	0.016	-2,762.444**
per capita	(0.027)	(0.026)	(1.963)	(0.047)	(1,191.175)
Fourth to sixth born	-0.086**	0.189***	-4.852*	0.087	-2,370.674*
# Income per capita	(0.041)	(0.038)	(2.629)	(0.063)	(1,415.250)
Female # Income per	0.086***	-0.034***	2.664***	-0.000	-1,207.736**
capita	(0.013)	(0.012)	(0.807)	(0.019)	(487.938)
R^2	0.14	0.11	0.11	0.02	0.20
N	65,177	65,246	58,914	52,758	47,585
Sibships	21,034	21,047	19,372	18,216	16,805

Note: The estimations also include a constant, a full set of child age dummies, a year dummy, per capita income, and sibship fixed effects.

* p<0.1; ** p<0.05; *** p<0.01. Standard errors, clustered at the sibship level, within parenthesis.

In Tables 10 and 11 we restrict the estimation sample to the rural poor. In this sample credit constraints can be expected to be particularly severe and opportunity cost of child time is likely to be higher in rural than urban areas. The aim is to investigate if birth order effects are more in line with previous developing country results in this restricted sample. The birth order effects on human capital stock indicators are negative and at least as large among the rural poor as in the all India sample. The birth order effects on educational investments also resemble those in the full sample. There are, however, stronger effects on child labor in the rural poor sample, and child labor is also more common in this sample. The birth order effects on enrolment and private schooling are weak or insignificant, and the effect on total hours does not exhibit the same non-monotonic properties as in the main specification.

Table 10: The effect of birth order on indicators of current human capital stock among the rural poor– coefficients from linear sibship fixed effects estimations

	Completed Grades	Reading	Writing	Math
Second born	-0.188***	-0.265***	-0.257***	-0.238***
	(0.027)	(0.091)	(0.096)	(0.078)
Third born	-0.347***	-0.423***	-0.352**	-0.409***
	(0.047)	(0.163)	(0.167)	(0.129)
Fourth to sixth born	-0.484***	-0.597**	-0.689***	-0.769***
	(0.073)	(0.250)	(0.241)	(0.195)
Female	-0.077***	-0.162***	-0.085	-0.174***
	(0.018)	(0.055)	(0.063)	(0.052)

R^2	0.08	0.03	0.04	0.04
N	12,254	1,723	1,707	1,720
Sibships	4,251	940	931	939

Note: The estimations also include a constant, a full set of child age dummies, a year dummy, per capita income, and sibship fixed effects.
* p<0.1; ** p<0.05; *** p<0.01. Standard errors, clustered at the sibship level, within parenthesis.

Table 11: The effect of birth order on educational investment among the rural poor - coefficients from linear sibship fixed effects estimations

	Enrollment	Child labor	Hours	Private	Expenses
Second born	-0.016	-0.034***	-1.324***	-0.013*	-155.679***
	(0.010)	(0.009)	(0.462)	(0.007)	(34.454)
Third born	-0.020	-0.048***	-1.905**	-0.017	-217.526***
	(0.018)	(0.014)	(0.780)	(0.012)	(63.283)
Fourth to sixth	-0.024	-0.077***	-2.526**	-0.028	-278.269***
Born	(0.027)	(0.021)	(1.168)	(0.017)	(101.434)
Female	-0.056***	-0.015**	-2.038***	-0.029***	-87.483***
	(0.007)	(0.006)	(0.330)	(0.006)	(26.278)
R^2	0.20	0.19	0.17	0.01	0.17
N	12,257	12,278	11,209	9,060	8,014
Sibships	4,251	4,253	3,926	3,502	3,124

Note: The estimations also include a constant, a full set of child age dummies, a year dummy, per capita income, and sibship fixed effects.

* p<0.1; ** p<0.05; *** p<0.01. Standard errors, clustered at the sibship level, within parenthesis.

7. Discussion and Conclusion

We have investigated within-household inequalities in human capital accumulation in India. In doing so, we have considered both indicators of the child's current stock of human capital and of investment into their continued human capital accumulation, distinguishing between time investments and pecuniary investment into school quality. A simple model highlight the difference between time investment and pecuniary investment. For time investment, credit constraints interact with opportunity cost of child time, which can be expected to vary systematically with birth order. For pecuniary investment, credit constraints interact with the price, which should not vary systematically with birth order.

Overall, our results show that the effects of birth order on human capital are generally negative in India. They also demonstrate that the type of human capital measure examined is important. Birth order effects on current stock of human capital as well as on pecuniary investment are negative, which is in line with the results from developed countries. The results for time investments into human capital are, however, more in line with previous studies from developing countries. Later-born children are less often child laborers. Later-born children also have an enrolment advantage in the largest families.

Positive birth order effects in developing countries are typically explained by credit constraints. Our results suggest that credit constraints might be important for time investment, for which opportunity cost of child time is important. For these outcomes, birth order effects are more negative in richer households. However, our results do not indicate that credit constraints are important in general and alone in India. First, pecuniary investments should also be affected by credit constraints, but not by opportunity cost of child time. However, birth order effects are consistently negative for pecuniary investment into school quality and for human capital stock indicators. This is true even among the rural poor, where we would expect credit constraints to be most important. Second, household income does not appear to influence the birth order effects on pecuniary investment and human capital stocks, except for completed grades, which is the human capital stock indicator most closely connected to earlier time investments. Finally, it is not certain that income influences birth order effects on time investment when we condition on sibship size. Income is correlated with family size. Thus, differences in effects by family size rather than by income may be driving the differences in birth order effects across rich and poor families, in this as well as in other studies from developing countries.

Much of the previous research on birth order and education in developing countries has focused on outcomes related to time investment, primarily enrollment and child labor (De Haan et al, 2014; Tenikue and Verheyden, 2010). Our results for these outcomes indicate that credit constraints are generally not sufficiently binding to cause positive birth order effects. This is interesting, as India is on average a poorer country than Ecuador, for example. It could be the case that credit constraints do not play as decisive a role in India with respect to educational investments because the pecuniary costs of (early) schooling are relatively low, given the widespread availability of primary schools (Kingdon, 2007; Oxfam India, 2018). We can however only speculate on this front.

The negative birth order effects on pecuniary investments could be interpreted as parents choosing to invest in the most able children. The return to further education investment is likely to be higher for children who already possess more human capital. Lower birth order children have better test scores and grade completion. This could be interpreted as greater accumulated human capital stock. However, these variables are clearly not only measures of the child human capital stock, i.e. of the child's abilities. They are also outcomes of previous human capital investments, and there is no reason to assume that abilities should be systematically correlated with birth order for natural reasons. Indeed, the developed country evidence suggests that the

advantage of first-born is not due to biological reasons (Kristensen and Bjerkedal, 2010; Barclay, 2015).

Turning to gender, girls are generally disadvantaged within the family. An outcome that deviates from the overall pattern of female disadvantage is completed grades, where all girls on average do well in comparison to brothers. In most estimations the female dummy does not have a statistically significant coefficient. We can only speculate as to the reasons, but one possibility is that girls are more motivated to perform well at school. They have more direct control over the amount of effort they exert, compared with other investments that are (mostly) controlled by parents. It could also be related to other non-cognitive skills which girls for some reason are better provided with; for example orderliness, time management, diligence, responsibility, etc.

To sum up, birth order effects on education in India broadly follow the same pattern that has been found in developed rather than developing countries. Child opportunity cost of time, however, appears to matter. As a result, birth order effects follow the typical developing country pattern for time investments. This is especially the case in large families. Reasons for negative birth order effects are probably the same ones which create negative birth order effects in developed countries. Pure dilution of parental resources might be one explanation. Another possibility is that the disease environment at home is negatively affected by more children.

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Appendix

Table A1: Descriptive statistics per sibship size, dependent variables.

	N	Mean	Std dev	Min	Max
2 siblings					
Enrollment	15,740	0.951	0.217	0.000	1.000
Child Labor	15,749	0.039	0.194	0.000	1.000
Total hours spent on school in a week	13,843	42.648	17.068	0.000	216.000
Private school	14,014	0.402	0.491	0.000	1.000
School expenses in rupees	13,058	5165.810	8255.481	0.000	201000.000
Completed grades	15,740	5.057	3.149	0.000	16.000
Reading test score	1,408	3.001	1.150	0.000	4.000
Writing test score	1,384	0.845	0.362	0.000	1.000
Math test score	1,402	1.866	0.901	0.000	3.000
3 siblings					
Enrollment	21,084	0.895	0.306	0.000	1.000
Child Labor	21,100	0.077	0.266	0.000	1.000
Total hours spent on school in a week	19,082	38.400	18.114	0.000	180.000
Private school	17,547	0.301	0.459	0.000	1.000
School expenses in rupees	15,939	3012.366	5872.831	0.000	175800.000
Completed grades	21,082	4.963	3.221	0.000	15.000
Reading test score	2,393	2.725	1.294	0.000	4.000
Writing test score	2,348	0.751	0.433	0.000	1.000
Math test score	2,374	1.5897	0.975	0.000	3.000
4 siblings					
Enrollment	14,870	0.839	0.3678	0.000	1.000
Child Labor	14,884	0.099	0.299	0.000	1.000
Total hours spent on school in a week	13,575	34.477	19.266	0.000	121.000
Private school	11,604	0.248	0.432	0.000	1.000
School expenses in rupees	10,315	2108.404	3833.421	0.000	85800.000
Completed grades	14,867	4.652	3.187	0.000	14.000
Reading test score	1,938	2.477	1.370	0.000	4.000
Writing test score	1,929	0.680	0.467	0.000	1.000
Math test score	1,946	1.452	1.031	0.000	3.000
5 siblings					
Enrollment	9,053	0.778	0.416	0.000	1.000
Child Labor	9,075	0.124	0.329	0.000	1.000
Total hours spent on school in a week	8,301	31.222	20.334	0.000	110.000
Private school	6,554	0.217	0.412	0.000	1.000
School expenses in rupees	5,709	1684.724	3204.986	0.000	99000.000
Completed grades	9,049	4.211	3.169	0.000	15.000
Reading test score	1,291	2.203	1.413	0.000	4.000
Writing test score	1,287	0.614	0.487	0.000	1.000
Math test score	1,286	1.230	0.970	0.000	3.000

6 siblings					
Enrollment	5,251	0.757	0.429051	0	1
Child Labor	5,258	0.128	0.334	0	1
Total hours spent on school in a week	4,856	29.709	20.364	0	130
Private school	3,718	0.218	0.413	0	1
School expenses in rupees	3,192	1518.407	3243.095	0	104000
Completed grades	5,251	4.066	3.150	0	15
Reading test score	838	1.958	1.466	0	4
Writing test score	836	0.567	0.496	0	1
Math test score	838	1.118	0.976	0	3

Table A2: Gender specific birth order effects on indicators of current human capital stock in families of different sizes – coefficients from linear sibship fixed effects estimations

	Completed grades	Reading	Writing	Math
Panel I: 2-child families				
Second born	-0.234***	-0.149	-0.000	-0.266**
	(0.024)	(0.110)	(0.117)	(0.120)
Female	0.081***	0.056	-0.001	-0.106
	(0.020)	(0.073)	(0.075)	(0.076)
Female*2nd born	-0.071**	0.035	-0.087	0.094
	(0.031)	(0.115)	(0.116)	(0.116)
R^2	0.09	0.01	0.01	0.03
N	15,740	1,408	1,384	1,402
Sibships	6,991	725	713	722
Panel II: 3-child families				
Second born	-0.208***	-0.275***	-0.182*	-0.211***
	(0.024)	(0.077)	(0.101)	(0.081)
Third born	-0.506***	-0.427***	-0.231	-0.361***
	(0.039)	(0.125)	(0.167)	(0.133)
Female	0.084***	-0.059	-0.004	-0.103
	(0.021)	(0.074)	(0.088)	(0.077)
Female*3rd born	-0.079***	0.091	0.016	0.041
	(0.027)	(0.093)	(0.113)	(0.096)
Female*4th born	-0.064**	0.021	-0.098	0.036
	(0.031)	(0.116)	(0.127)	(0.113)
R2	0.07	0.04	0.02	0.03
N	21,082	2,393	2,348	2,374
Sibships	7,302	1,214	1,192	1,205
Panel III: 4-child families				
Second born	-0.220***	-0.170	-0.296**	-0.169
	(0.036)	(0.116)	(0.144)	(0.126)
Third born	-0.497***	-0.374**	-0.531**	-0.407**
	(0.048)	(0.176)	(0.218)	(0.177)
Fourth to sixth born	-0.786***	-0.753***	-0.799***	-0.771***
	(0.064)	(0.245)	(0.293)	(0.237)
Female	-0.032	-0.062	-0.093	-0.233**
	(0.035)	(0.112)	(0.138)	(0.117)
Female*2nd born	-0.036	-0.127	-0.036	-0.023
	(0.042)	(0.130)	(0.158)	(0.141)
Female*3rd born	-0.010	-0.088	0.012	0.085
	(0.043)	(0.139)	(0.168)	(0.145)
Female*4th born	0.080*	0.137	-0.061	0.215
	(0.048)	(0.160)	(0.193)	(0.164)
R2	0.06	0.05	0.04	0.05
N	14,867	1,938	1,929	1,946

Sibships	4,566	1,003	999	1,008
Panel IV: 5-child families				
Second born	-0.093*	-0.173	-0.152	-0.253
	(0.054)	(0.190)	(0.193)	(0.166)
Third born	-0.205***	-0.412*	-0.359	-0.517**
	(0.063)	(0.226)	(0.225)	(0.204)
Fourth to sixth born	-0.457***	-0.596**	-0.397	-0.732***
	(0.078)	(0.264)	(0.250)	(0.254)
Female	-0.078	0.052	-0.105	-0.237
	(0.058)	(0.198)	(0.200)	(0.189)
Female*2nd born	-0.045	-0.211	-0.059	0.044
	(0.068)	(0.236)	(0.258)	(0.215)
Female*3rd born	-0.044	-0.285	0.129	-0.030
	(0.068)	(0.233)	(0.254)	(0.219)
Female*4th – 5th	0.082	-0.174	-0.039	0.083
born	(0.065)	(0.221)	(0.223)	(0.207)
R2	0.07	0.05	0.02	0.05
N	9,049	1,291	1,287	1,286
Sibships	2,431	660	659	658
Panel V: 6-child families				
Second born	-0.117	0.164	0.275	0.487
	(0.080)	(0.312)	(0.421)	(0.348)
Third born	-0.290***	-0.044	0.351	0.378
	(0.092)	(0.363)	(0.451)	(0.340)
Fourth to sixth born	-0.399***	-0.199	0.021	0.046
	(0.101)	(0.375)	(0.499)	(0.378)
Female	-0.310***	-0.156	-0.096	0.005
	(0.096)	(0.421)	(0.521)	(0.400)
Female*2nd born	0.108	-0.473	-0.290	-0.481
	(0.109)	(0.454)	(0.498)	(0.430)
Female*3rd born	0.222*	-0.258	-0.352	-0.409
	(0.114)	(0.468)	(0.531)	(0.413)
Female*4th – 6th	0.304***	-0.019	0.081	-0.063
born	(0.100)	(0.421)	(0.531)	(0.413)
R2	0.08	0.06	0.05	0.05
N	5,251	838	836	838
Sibships	1,243	430	429	430

Note: The estimations also include a constant, a full set of child age dummies, a year dummy and sibship fixed effects.
* p<0.1; ** p<0.05; *** p<0.01. Standard errors, clustered at the sibship level, within parenthesis.

Table A3: Gender specific birth order effects on educational investment in families of different sizes - coefficients from linear sibship fixed effects estimations

	Enrollment	Child labor	Hours	Private	Expenses
Panel I: 2-child families					
Second	-0.009	-0.021***	-1.212***	-0.015	-247.107
born	(0.007)	(0.006)	(0.464)	(0.010)	(165.128)
Female	-0.003	-0.009*	0.157	-0.036***	-403.306***
	(0.006)	(0.005)	(0.360)	(0.009)	(151.549)
Female*2nd	0.005	0.015*	-0.390	-0.005	-320.281
born	(0.009)	(0.008)	(0.577)	(0.013)	(211.627)
R^2	0.06	0.04	0.07	0.01	0.19
N	15,740	15,749	13,843	14,014	13,058
Sibships	6,991	6,996	6,231	6,275	5,875
Panel II: 3-child families					
Second	-0.033***	-0.041***	-2.141***	-0.027***	-514.151***
born	(0.009)	(0.008)	(0.474)	(0.010)	(147.072)
Third born	-0.043***	-0.066***	-3.313***	-0.032**	-906.248***
	(0.013)	(0.011)	(0.757)	(0.016)	(217.669)
Female	-0.027***	-0.034***	-1.210***	-0.074***	-572.165***
	(0.008)	(0.007)	(0.430)	(0.009)	(125.974)
Female*2nd	0.006	0.027***	-0.108	0.024**	-92.193
born	(0.010)	(0.010)	(0.544)	(0.011)	(168.090)
Female*3rd	0.007	0.033***	0.060	0.020	67.430
born	(0.012)	(0.010)	(0.638)	(0.013)	(199.393)
R2	0.11	0.08	0.09	0.02	0.15
N	21,084	21,100	19,082	17,547	15,939
Sibships	7,303	7,308	6,740	6,281	5,770
Panel III: 4-child families					
Second	0.002	-0.056***	-0.950	-0.022	-442.333***
born	(0.014)	(0.014)	(0.720)	(0.015)	(158.587)
Third born	-0.016	-0.083***	-1.560	-0.011	-922.856***
	(0.019)	(0.017)	(0.963)	(0.020)	(286.202)
Fourth to	-0.035	-0.092***	-2.307*	-0.009	-815.677**
sixth born	(0.025)	(0.022)	(1.279)	(0.027)	(374.034)
Female	-0.040***	-0.055***	-2.513***	-0.066***	-506.835***
	(0.014)	(0.014)	(0.714)	(0.015)	(114.950)
Female*2nd	-0.014	0.019	0.365	0.017	111.989
born	(0.017)	(0.016)	(0.848)	(0.018)	(135.023)
Female*3rd	-0.001	0.031*	0.835	0.007	180.717
born	(0.017)	(0.016)	(0.860)	(0.018)	(147.165)
Female*4th	0.005	0.053***	0.819	-0.004	-254.901
– 6th born	(0.019)	(0.017)	(0.951)	(0.020)	(166.665)
R2	0.15	0.13	0.11	0.02	0.17
N	14,870	14,884	13,575	11,604	10,315
Sibships	4,566	4,567	4,272	3,839	3,466
Panel IV: 5-child families					
Second	0.013	-0.053**	-0.657	-0.031	-91.435
born	(0.023)	(0.022)	(1.034)	(0.024)	(153.196)
Third born	0.013	-0.084***	-0.959	-0.047*	-370.078**
	(0.026)	(0.023)	(1.171)	(0.028)	(167.822)
Fourth to	-0.002	-0.100***	-2.385*	-0.063*	-499.008**
sixth born	(0.031)	(0.028)	(1.416)	(0.035)	(226.670)
Female	-0.077***	-0.060***	-3.709***	-0.064**	-384.414**
	(0.025)	(0.023)	(1.153)	(0.027)	(193.441)
Female*2nd	0.008	0.012	1.012	0.000	-136.850
born	(0.029)	(0.027)	(1.340)	(0.031)	(190.693)
Female*3rd	0.011	0.032	0.506	-0.015	-76.753
born	(0.029)	(0.026)	(1.361)	(0.030)	(187.294)

Female*4th – 6th born	0.056**	0.039	3.231**	0.011	-69.374
	(0.028)	(0.025)	(1.293)	(0.029)	(251.675)
R2	0.19	0.17	0.15	0.02	0.10
N	9,053	9,075	8,301	6,554	5,709
Sibships	2,431	2,434	2,285	1,987	1,758
Panel V: 6-child families					
Second born	0.003	-0.033	0.138	0.009	-296.576
	(0.040)	(0.036)	(1.847)	(0.044)	(235.692)
Third born	0.006	-0.070*	-0.076	-0.001	-234.549
	(0.042)	(0.038)	(1.901)	(0.047)	(280.251)
Fourth to sixth born	-0.006	-0.074*	-0.572	-0.012	-367.431
	(0.045)	(0.038)	(2.030)	(0.051)	(262.584)
Female	-0.143***	-0.058	-6.708***	-0.069	-365.148*
	(0.045)	(0.041)	(2.045)	(0.052)	(208.893)
Female*2nd born	0.034	0.012	1.819	0.015	274.445
	(0.052)	(0.047)	(2.364)	(0.053)	(275.212)
Female*3rd born	0.081	0.022	4.094*	0.002	102.416
	(0.053)	(0.046)	(2.384)	(0.057)	(276.672)
Female*4th – 6th born	0.103**	0.035	5.188**	-0.001	-122.748
	(0.047)	(0.041)	(2.131)	(0.053)	(262.401)
R2	0.19	0.16	0.15	0.03	0.07
N	5,251	5,258	4,856	3,718	3,192
Sibships	1,243	1,243	1,190	1,040	930

Note: The estimations also include a constant, a full set of child age dummies, a year dummy and sibship fixed effects.
* p<0.1; ** p<0.05; *** p<0.01. Standard errors, clustered at the sibship level, within parenthesis.

Table A4: The effect of birth order and gender on educational investments with alternative samples - coefficients from linear sibship fixed effects estimations

	Hours (sample conditional on any hours)	Private school (unconditional sample)	Expenses (unconditional sample)
Second born	-0.666***	-0.016***	-379.885***
	(0.126)	(0.004)	(48.777)
Third born	-1.154***	-0.024***	-465.859***
	(0.234)	(0.007)	(79.001)
Fourth to sixth born	-1.494***	-0.028***	-481.876***
	(0.359)	(0.010)	(119.614)
Female	-0.104	-0.055***	-498.936***
	(0.075)	(0.003)	(32.783)
R^2	0.09	0.03	0.11
N	49,172	63,621	58,165
Sibships	17,170	20,610	19,301

Table A5: The effect of birth order and gender on binary outcome investments – marginal effects from the conditional logit model

	Enrolment	Child labor	Private school
Second born	-0.007	-0.064***	-0.037***
	(0.009)	(0.012)	(0.010)
Third born	-0.002	-0.103***	-0.064***
	(0.014)	(0.021)	(0.017)
Fourth to sixth born	0.020	-0.136***	-0.094***
	(0.020)	(0.029)	(0.025)
Female	-0.076***	-0.043***	-0.146***
	(0.007)	(0.008)	(0.009)
N	18,903	13,951	12,670

Table A6: The effect of birth order and gender on binary outcome investments – coefficients from the correlated random effects model

	Enrolment	Child labor	Private school
Second born	-0.002	-0.013***	-0.012***
	(0.003)	(0.002)	(0.003)
Third born	0.006	-0.023***	-0.018***
	(0.004)	(0.003)	(0.006)
Fourth to sixth born	0.022***	-0.033***	-0.021**
	(0.006)	(0.005)	(0.009)
Female	-0.029***	-0.018***	-0.052***
	(0.003)	(0.002)	(0.003)
N	65,284	65,352	52,805

Table A7: The effect of birth order on indicators of current human capital stock in families of different sizes – coefficients from linear sibship fixed effects models fully interacted with income

	Completed grades	Reading	Writing	Math
Panel I: 2-child families				
Second born	-0.261***	-0.044	-0.065	-0.194
	(0.026)	(0.144)	(0.155)	(0.160)
Female	0.036**	0.015	-0.044	-0.154**
	(0.017)	(0.064)	(0.068)	(0.066)
Second born # income	-0.021	-0.438	0.052	-0.146
	(0.069)	(0.404)	(0.382)	(0.504)
Female # income	0.041	0.277	-0.005	0.459**
	(0.049)	(0.174)	(0.177)	(0.206)
R^2	0.09	0.03	0.02	0.04
N	15,466	1,387	1,363	1,381
Sibships	6,900	716	704	713
Panel II: 3-child families				
Second born	-0.244***	-0.233***	-0.179*	-0.224**
	(0.022)	(0.081)	(0.105)	(0.092)
Third born	-0.519***	-0.468***	-0.247	-0.393**
	(0.040)	(0.150)	(0.194)	(0.167)
Female	0.003	-0.081	-0.034	-0.122**
	(0.015)	(0.058)	(0.061)	(0.059)
Second born	-0.044	0.129	-0.053	0.365
# income	(0.089)	(0.440)	(0.410)	(0.540)
Third born	-0.092	0.606	-0.339	0.576
# income	(0.151)	(0.796)	(0.735)	(0.985)
Female	0.222***	0.579**	0.070	0.487
# income	(0.073)	(0.284)	(0.275)	(0.321)
R2	0.07	0.04	0.03	0.03
N	20,781	2,346	2,304	2,327
Sibships	7,220	1,193	1,172	1,184
Panel III: 4-child families				
Second born	-0.260***	-0.307***	-0.428***	-0.185*
	(0.030)	(0.106)	(0.135)	(0.108)
Third born	-0.523***	-0.382**	-0.565**	-0.303
	(0.047)	(0.186)	(0.242)	(0.189)
Fourth to sixth born	-0.746***	-0.548*	-0.761**	-0.451
	(0.067)	(0.279)	(0.354)	(0.281)
Female	-0.059***	-0.216***	-0.234***	-0.234***
	(0.021)	(0.064)	(0.076)	(0.065)
Second born	0.106	0.658	2.119**	-0.009
# income	(0.175)	(0.875)	(0.989)	(0.956)

Third born	0.062	-0.583	1.927	-0.750
# income	(0.239)	(1.523)	(1.886)	(1.622)
Fourth to sixth born #	-0.135	-1.825	1.705	-2.308
income	(0.325)	(2.084)	(2.598)	(2.176)
Female	0.313**	1.300***	1.255***	0.685
# income	(0.134)	(0.491)	(0.482)	(0.438)
R2	0.06	0.07	0.06	0.06
N	14,717	1,913	1,904	1,921
Sibships	4,526	991	987	996
Panel IV: 5-child families				
Second born	-0.142***	-0.295**	-0.187	-0.199
	(0.043)	(0.138)	(0.144)	(0.129)
Third born	-0.253***	-0.537**	-0.378*	-0.592***
	(0.057)	(0.209)	(0.211)	(0.192)
Fourth to sixth born	-0.424***	-0.600**	-0.541*	-0.867***
	(0.081)	(0.286)	(0.296)	(0.277)
Female	-0.103***	-0.152*	-0.107	-0.208**
	(0.027)	(0.088)	(0.095)	(0.089)
Second born	0.170	0.108	-0.125	-0.601
# income	(0.374)	(1.088)	(1.217)	(1.061)
Third born	0.011	-0.295	1.072	0.889
# income	(0.444)	(1.722)	(1.670)	(1.563)
Fourth to sixth born #	-0.066	-1.098	1.182	2.561
income	(0.553)	(2.704)	(2.460)	(2.694)
Female	0.504***	0.187	0.054	0.109
# income	(0.190)	(0.733)	(0.805)	(0.858)
R2	0.08	0.05	0.02	0.05
N	8,922	1,275	1,271	1,270
Sibships	2,403	654	653	652
Panel V: 6-child families				
Second born	-0.107*	-0.145	0.403**	0.139
	(0.062)	(0.208)	(0.189)	(0.206)
Third born	-0.241***	-0.322	0.572*	0.280
	(0.079)	(0.324)	(0.312)	(0.282)
Fourth to sixth born	-0.251**	-0.374	0.450	0.177
	(0.103)	(0.372)	(0.346)	(0.312)
Female	-0.135***	-0.357***	-0.115	-0.157
	(0.040)	(0.118)	(0.139)	(0.122)
Second born # income	0.677	-1.044	-4.532*	0.098
	(0.641)	(2.254)	(2.469)	(2.114)
Third born # income	1.069	1.704	-7.568*	-4.269
	(0.780)	(4.756)	(4.454)	(4.048)
Fourth to sixth born	0.206	2.219	-6.874*	-4.021
# income	(0.964)	(4.180)	(3.742)	(3.673)
Female # income	0.865***	1.532	0.173	-0.173
	(0.321)	(1.253)	(1.377)	(1.210)
R2	0.09	0.08	0.08	0.06
N	5,186	826	823	825
Sibships	1,232	426	425	426

Note: The estimations also include a constant, a full set of child age dummies, a year dummy and sibship fixed effects.

* p<0.1; ** p<0.05; *** p<0.01. Standard errors, clustered at the sibship level, within parenthesis.

Table A8: The effect of birth order on educational investment in families of different sizes - coefficients from linear sibship fixed effects models fully interacted with income

	Enrollment	Child labor	Hours	Private	Expenses
Panel I: 2-child families					
Second born	-0.004	-0.018***	-1.714***	-0.018	-50.249
	(0.008)	(0.006)	(0.573)	(0.012)	(259.004)
Female	-0.003	0.004	-0.213	-0.035***	-634.439***
	(0.005)	(0.005)	(0.343)	(0.008)	(159.879)
Second born # income	-0.016	0.015	1.580	0.008	-1,467.361
	(0.018)	(0.019)	(1.793)	(0.041)	(1,165.213)
Female # income	0.017	-0.027**	1.023	-0.018	280.570
	(0.012)	(0.012)	(1.032)	(0.026)	(889.029)
R^2	0.08	0.05	0.08	0.02	0.23
N	15,466	15,475	13,601	13,760	12,819
Sibships	6,900	6,905	6,147	6,191	5,794
Panel II: 3-child families					
Second born	-0.031***	-0.032***	-2.340***	-0.025**	-178.452
	(0.008)	(0.007)	(0.487)	(0.010)	(247.070)
Third born	-0.037**	-0.058***	-3.432***	-0.041**	-524.921
	(0.015)	(0.012)	(0.887)	(0.019)	(367.782)
Female	-0.034***	-0.005	-1.630***	-0.055***	-220.965**
	(0.006)	(0.005)	(0.322)	(0.007)	(88.709)
Second born # income	0.003	0.037	1.604	0.075	-2,788.891
	(0.032)	(0.034)	(2.144)	(0.052)	(1,987.483)
Third born # income	-0.001	0.037	2.518	0.129	-2,549.724
	(0.053)	(0.054)	(3.994)	(0.097)	(2,582.913)
Female # income	0.072***	-0.051**	2.273	-0.028	-2,672.345***
	(0.026)	(0.024)	(1.619)	(0.036)	(731.564)
R2	0.12	0.09	0.09	0.02	0.20
N	20,783	20,799	18,812	17,297	15,706
Sibships	7,221	7,226	6,662	6,211	5,702
Panel III: 4-child families					
Second born	-0.015	-0.052***	-1.343**	-0.026*	-474.626**
	(0.012)	(0.010)	(0.614)	(0.013)	(188.409)
Third born	-0.034*	-0.074***	-1.868*	-0.028	-652.960**
	(0.018)	(0.016)	(0.970)	(0.022)	(299.037)
Fourth to sixth born	-0.054**	-0.080***	-3.144**	-0.037	-960.902**
	(0.026)	(0.022)	(1.391)	(0.032)	(448.205)
Female	-0.058***	-0.022***	-2.573***	-0.063***	-327.528***
	(0.008)	(0.007)	(0.424)	(0.009)	(107.748)
Second born # income	0.064	0.112*	5.083	0.184*	1,567.119
	(0.068)	(0.066)	(3.786)	(0.097)	(1,791.615)
Third born # income	0.142	0.154*	6.321	0.283*	-521.024
	(0.092)	(0.093)	(5.724)	(0.164)	(2,317.356)
Fourth to sixth born # income	0.183	0.187	11.129	0.362*	1,287.366
	(0.122)	(0.128)	(7.865)	(0.218)	(3,174.479)
Female # income	0.152***	-0.031	6.209**	0.044	-1,268.485
	(0.052)	(0.048)	(2.937)	(0.061)	(1,141.595)
R2	0.16	0.13	0.12	0.03	0.23
N	14,720	14,734	13,440	11,483	10,205
Sibships	4,526	4,527	4,236	3,804	3,435
Panel IV: 5-child families					
Second born	0.033*	-0.041**	0.479	-0.006	-58.968
	(0.018)	(0.016)	(0.804)	(0.018)	(143.963)
Third born	0.024	-0.049**	-0.198	-0.033	-298.872*
	(0.024)	(0.021)	(1.093)	(0.024)	(166.091)
Fourth to sixth born	0.035	-0.058**	-0.038	-0.044	-381.679
	(0.033)	(0.029)	(1.560)	(0.035)	(252.969)
Female	-0.058***	-0.009	-2.156***	-0.051***	-246.204***

	(0.011)	(0.009)	(0.507)	(0.011)	(90.049)
Second born # income	-0.220*	-0.007	-6.424	-0.296*	-1,269.271
	(0.118)	(0.135)	(5.204)	(0.178)	(1,526.693)
Third born # income	-0.074	-0.094	-4.427	-0.231	-1,599.266
	(0.170)	(0.149)	(7.727)	(0.211)	(1,741.891)
Fourth to sixth born	-0.096	-0.162	-5.895	-0.125	-2,073.178
# income	(0.219)	(0.200)	(10.631)	(0.274)	(2,299.350)
Female # income	0.133*	-0.283***	2.239	-0.107	-2,169.556**
	(0.069)	(0.073)	(3.454)	(0.089)	(1,021.370)
R2	0.19	0.17	0.15	0.03	0.12
N	8,926	8,948	8,183	6,467	5,629
Sibships	2,403	2,406	2,258	1,963	1,738
Panel V: 6-child families					
Second born	0.048	-0.022	2.324*	0.003	-364.957
	(0.030)	(0.024)	(1.305)	(0.029)	(271.535)
Third born	0.089**	-0.076***	3.662**	0.012	-421.698
	(0.036)	(0.029)	(1.597)	(0.037)	(295.370)
Fourth to sixth born	0.088**	-0.069**	3.698*	-0.027	-742.373*
	(0.044)	(0.035)	(2.030)	(0.046)	(402.042)
Female	-0.081***	-0.016	-2.908***	-0.073***	-248.904
	(0.015)	(0.013)	(0.697)	(0.017)	(165.871)
Second born	-0.552**	0.136	-20.142*	0.230	3,394.773
# income	(0.249)	(0.194)	(11.842)	(0.285)	(3,488.353)
Third born	-0.717**	0.533**	-22.455*	-0.145	3,283.586
# income	(0.312)	(0.228)	(13.606)	(0.300)	(3,505.931)
Fourth to sixth born #	-0.685*	0.504*	-21.276	0.196	3,356.170
income	(0.360)	(0.258)	(17.349)	(0.353)	(4,484.245)
Female	0.268***	-0.176*	5.521	0.081	-1,860.610
# income	(0.099)	(0.096)	(4.948)	(0.153)	(2,069.500)
R2	0.20	0.17	0.16	0.04	0.08
N	5,186	5,193	4,803	3,673	3,156
Sibships	1,232	1,232	1,181	1,030	922

Note: The estimations also include a constant, a full set of child age dummies, a year dummy and sibship fixed effects.

* p<0.1; ** p<0.05; *** p<0.01. Standard errors, clustered at the sibship level, within parenthesis.