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Birth Order, Child Labor and Schooling: Theory and Evidence from Cameroon[1]

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This paper examines the determinants of schooling in developing countries with a special emphasis on birth order effect. We present a theoretical model accounting for the dynamics of birth order and its interaction with credit constraints. We show that since elder children are the only source of additional income when constraints get tighter in poor families, they work more than their younger siblings and end up with lower levels of education. This discrimination is not at work among wealthier families. We test these predictions on the 2001 LSMS Cameroon Household Survey. Controlling for household fixed effects, gender and age, our results confirm that earlier-born children's education levels are relatively lower in poor households, and not in richer ones. These results are robust to various measures of birth order and household wealth.

In developing countries, the pressure on poor households' scarce resources increases with their total number of children. This results in a competition between children for these resources (Garg & Morduch, 1998), notably through uneven distribution of health care or nutrition (Behrman, 1988 and Horton, 1988). Another dimension of discrimination within households pertains to schooling and child labor (Basu, 1998). If resources become scarce, parents may send some of their children to work while the others attend school and concentrate on studying.

The question of which factors affect households' decisions to send a child to work or to school is not fully elaborated. Gender bias has been observed in African countries, where discrimination at the expense of girls in terms of child labor and schooling is apparent (Dar et al., 2002).

In this paper, we investigate the potential role of birth order in this discrimination pattern. More specifically, the question we want to address is whether birth order may be a factor through which discrimination between children arises in terms of education and child labor, and, if so, in favor of which children.

Until recently, the common view in the empirical literature was that parents invest more in the education of the first child. Several arguments support this view. First, the psychological literature has pointed out that earlier born children have higher IQ's and cognitive abilities. Various models developed in this literature provide justifications of this statement (Zajonc & Markus, 1975, Zajonc & Sulloway, 2007, Blake, 1981 and Downey, 2001)[2]. The economic implication of this statement is that parents should invest more resources in the education of the child whose return to education is the greatest, that is, the first-born. Yet, the validity of this point of view is still hotly debated, as suggested by Rodgers et al. (2000) and Wichman et al. (2007).

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[2] *Here is a non-exhaustive summary of the mechanisms presented in these models. Unlike later-born children, first-borns do not have to share parental resources such as money, personal attention and cultural objects. Also, as more children enter the household, the intellectual environment becomes less mature. For instance, first-borns are exposed to more adult language. Finally, early-born siblings may, by tutoring their younger siblings, improve their verbal abilities and their capacity to cognitively process information.*

Second, Horton (1988) shows that first-born children might be favored due to cultural factors, such as funeral rites. Third, without relying on favoritism towards the first-born, Hanushek (1992) finds in an empirical study of the quality-quantity tradeoff (Becker & Lewis, 1973), that early born children benefit from an advantage because they are more likely to evolve in a small family.

The view that earlier-born children receive more education than their younger siblings has, however, been challenged in more recent works. Indeed, recent contributions claim that later-born children are favored (more educated) against earlier born children. First, according to Ejrnaes & Pörtner (2004), this result follows once fertility decisions are made endogenous. The model they present combines some uncertainty about future children's returns to education, parental taste for their offspring's human capital and their aversion to inequality. The birth order effect stems from the fact that if parents are not too averse to inequality, they are more likely not to have any additional children when the last born has a high ability level[3]. However, contrary to , Ejrnaes & Pörtner (2004), Black et al. (2005) conjecture that a model of optimal stopping could reach the opposite conclusion, that is, a negative "last-born effect", as parents continue to have children until they have a less able child.

Second, with exogeneous fertility, Emerson & Souza (2002) and Edmonds (2006) reach the same conclusion as Ejrnaes & Pörtner (2004). Their papers study households behaviour in a static context where children potentially differ in innate ability and labor productivity. Their modelling strategy generates general arbitrage conditions on the optimal allocation of schooling and child labor on the basis of innate ability and productivity. However, it fails to identify explicitly the role of birth order, although birth order is implicitly represented through labor productivity.

In this paper, we formalize the idea that, when parents are credit constrained, they choose to send their earlier born children to work. Our model accounts explicitly for the dynamics of birth order and shows how birth order interacts with credit constraints. Apart from being born (and as a result becoming productive) at different moments, all children have the same potential return to education and labor productivity. Taking into account a dynamic perspective toward the household allows us to highlight the fact that different periods are characterized by different household sizes, different levels of pressure over resources and different numbers of potential working children. Our main results can be stated in the following way. As long as a household's optimal savings are strictly positive, i.e. it is not credit constrained, all children receive the same education level. On the other hand, if a household faces credit constraints, the first-born child works more and receives less education than her younger sibling. The latter ends up with a higher level of human capital. The intuition behind our result is that as the pressure on household budget gets tighter following the birth of each new child, only earlier born children can be sent to work to generate additional income and soften budget constraints[4].

The main prediction of our model is that in poor households, elder children exhibit a relatively lower level of human capital. No such discrimination is at work among richer households, so that all children end up with the same level of human capital. We test these predictions on the 2001 Cameroon Household Survey database. Controlling for household fixed effects, gender and age, our results confirm that later-born children's educational levels are relatively higher. Furthermore, we observe no discrimination within wealthier households. These results are robust to alternative definitions of birth order, indicators of wealth, and other robustness checks.

The paper is organized as follows: In Section 2, we present a simple model in which households allocate labor and education between children born at different periods. In Section 3, we present the data, including our measures of birth order and the empirical model. In Section 4, we provide the main estimation results and their interpretation and confirm their validity through robustness checks. In Section 5, we give some concluding comments. Tables presenting the regression results related to the robustness checks are available in the Appendix.

3 *Anticipations by parents about the ability of young children seem plausible, as motivated by Currie & Stabile (2007).*

4 *While this argument seems at first glance similar to the argument presented by Hanushek (1992) (as the number of children increases, the pressure on resources is stronger), our conclusion is opposite. Because additional children increase the pressure on resources, but children can help relax the resource constraint, first-borns are penalized once one accounts for the possibility of child labor. Instead of benefiting from the period where they were alone in the household, first-borns are actually penalized as they are the first to be able to relax constraints that get tighter as new siblings appear.*

I. The model

The model builds on Baland & Robinson (2000) to introduce the dynamic role of birth order. The household is composed of one parent and two children $i \in \{1,2\}$. The parent lives for 2 periods $p \in \{1,2\}$. Children live two periods inside the household. During her first period in the household, a child is fully dependent, i.e. she can neither study nor work. In her second period however, the child is an adolescent and is endowed with one unit of productive time that parents decide to allocate between labor l_i and schooling $e_i = 1-l_i$. In each period, child i consumes a fixed quantity k of the numeraire good at each period. Parents supply their own labor inelastically and parental labor has y efficiency units in each period, while child labor productivity is constant and equal to 1. Child labor revenues contribute to household income. The timing of our model is the following: at period 1, child 1 is already an adolescent while child 2 is still in childhood. Child 1 leaves the household at the end of period 1. At period 2, child 2 becomes an adolescent. At the end of period 2, child 2 leaves the household and the parent dies.

The children's income levels upon reaching adulthood depend on the acquired level of human capital through the time spent at school. The human capital technology is denoted $H(e):[0;1] \to \mathrm{R}^+$. We will use the following notations extensively: $H_i \equiv H(e_i)$, $H_i^{'} \equiv \frac{\partial H(e)}{\partial e}|_{e_i}$ for all $i \in \{1,2\}$[5]. Children who spent all their childhood working have a single efficiency unit of labor as an adult: $H(0) = 1$. The marginal return to schooling time is strictly positive ($H'>0$) and strictly decreasing ($H''<0$). Child i's future income $Y(H_i) = H_i$ allows her to consume H_i units of the numeraire good. Child i's utility is noted $V(H_i)$. Parental utility is denoted $\Pi(c_1, c_2, V(H_1), V(H_2))$ where c_1 and c_2 are parental consumption levels in periods 1 and 2 respectively. The parental utility function is assumed separable so that

$$\Pi(c_1, c_2, V_1, V_2) = U(c_1) + U(c_2) + \beta(V(H_1) + V(H_2)), \quad (1)$$

where both U(·) and V(·) are continuously differentiable, strictly increasing, strictly concave functions and $\beta \in [0;1]$ is a parameter measuring parental altruism towards children. Again, we will make use of the following notations: $U_p \equiv U(c_p)$, $U_p^{'} \equiv \frac{\partial U(c)}{\partial c}|_{c_p}$ for all $p \in \{1,2\}$ and $V_i \equiv V(H_i)$, $V_i^{'} \equiv \frac{\partial V(H)}{\partial H}|_{H_i}$ for all $i \in \{1,2\}$[6].

Apart from choosing their children's labor times l_i for all $i \in \{1,2\}$, parents decide whether to transfer income across periods through savings s. Capital markets are imperfect, so that savings are cannot be negative. Parents start period 1 with an initial wealth level W coming from previous savings or bequests. Therefore, they face the following budget constraints:

$$c_1 = y + l_1 - 2k + W - s, \quad (2)$$
$$c_2 = y + l_2 - k + s \quad (3)$$

For simplicity, we assume that there exist interior optimum levels of child labour l_1, l_2 for which the first order conditions are respectively:

$$U'_1 = \beta V'_1 H'_1, \quad (4)$$
$$U'_2 = \beta V'_2 H'_2. \quad (5)$$

The first-order condition with respect to s is:

$$U'_1 = U'_2 \text{ and } s > 0 \text{ or} \quad (6)$$
$$U'_1 = U'_2 \text{ and } s = 0 \quad (7)$$

The optimal level of savings is $\frac{l_1 - l_2 + W - k}{2}$.

Therefore, savings will be interior only if W and/or child discrimination at the expense of the first-born are sufficiently large.

Proposition 1 *If household wealth is sufficiently high ($W > k$), s is interior and birth order does not affect schooling and child labor decisions. Children receive the same level of education: $e_1 = e_2$*

If, on the contrary, household wealth is too low ($W \leq k$), birth order does affect schooling and child labor decisions. The first-born child receives less education than the second-born: $e_1 < e_2$. However, child discrimination tends to decrease as wealth increases: at equilibrium, $e_2 - e_1 < k - W$.

Proof. Let us start by analysing the case where $W > k$. Let us consider three classes of optimum candidates, namely $l_1 = l_2$, $l_1 > l_2$ and $l_1 < l_2$. We need to show that only $l_1 = l_2$ can yield an optimal allocation.

Consider first the case where $l_1 > l_2$. This implies that optimal savings, $\frac{l_1 - l_2 + W - k}{2}$, are strictly positive.

Consequently, equations (6), (4) and (5) imply that $V_1'H'_1 = V_2'H'_2$. Since both $V(\cdot)$ and $H(\cdot)$ are continuously differentiable, strictly increasing, strictly concave functions, $V'H'(e)$ is a strictly decreasing function of e. Indeed,

$$\frac{\partial V'H'}{\partial e} = V''(H')^2 + V'H'' < 0.$$

As a result, $V_1'H'_1 = V_2'H'_2$ implies that $e_1 = e_2$ and we have a contradiction.

[5] *The model makes the implicit assumption that leaving school is irreversible: once the child has left school at the end of her education/labor period, she no longer has the possibility to increase her human capital. This assumption is in line with the observation, made among others by Cameron and Heckman (2001), that school dropouts almost never re-enroll later.*

[6] *Even though the altruism component in parental utility assumes separability in the utilities of children, the concavity of implies that when parents's choices are not constrained, they equalize the education levels of both children.*

Consider the second case where $l_1 < l_2$. Two possibilities emerge: either $\frac{l_1 - l_2 + W - k}{2} > 0$, in which case we have a contradiction for the same reason as above, or $\frac{l_1 - l_2 + W - k}{2} < 0$, which implies that savings are at a corner. In the latter scenario, (7), (4) and (5) imply that $V_1'H'_1 > V_2'H'_2$. As shown above, this inequality holds if and only $e_1 < e_2$, which contradicts with $l_1 < l_2$.

Finally, if $l_1 = l_2$, optimal savings, $\frac{W - k}{2}$, are strictly positive. Consequently, by equations (6), (4) and (5), $V_1'H'_1 = V_2'H'_2$. The latter equality holds if and only if $e_1 = e_2$, or equivalently, $l_1 = l_2$.

Let us now study the case where $W \leq k$. Again, let us consider three classes of optimum candidates, namely $l_1 = l_2$, $l_1 > l_2$ and $l_1 < l_2$. We need to show that only $l_1 > l_2$ can yield an optimal allocation.

Consider first the case where $l_1 < l_2$.

Here, $\frac{l_1 - l_2 + W - k}{2} < 0$, which implies that savings are at a corner. (7), (4) and (5) imply that $V_1'H'_1 > V_2'H'_2$. As shown above, this inequality holds if and only $e_1 < e_2$, which contradicts with $l_1 < l_2$. Consider the second case where $l_1 = l_2$. Since $\frac{W - k}{2} \leq 0$, savings are at a corner. Consequently, by (7), (4) and (5), $e_1 > e_2$ and we have a contradiction.

Finally, if $l_1 > l_2$, two possibilities emerge. Either $\frac{l_1 - l_2 + W - k}{2} > 0$ or less discrimination at the expense of the first-born occurs so that $\frac{l_1 - l_2 + W - k}{2} < 0$. If $\frac{l_1 - l_2 + W - k}{2} > 0$, savings are interior, which by (6), (4) and (5), implies $e_1 = e_2$ and we have a contradiction.

On the contrary, if $\frac{l_1 - l_2 + W - k}{2} < 0$ (which is equivalent to $e_2 - e_1 < k - W$), savings are at a corner, which by (7), (4) and (5), implies $e_1 < e_2$, or equivalently, $l_1 > l_2$.

An important feature of our model is that at period 1, the pressure on resources is more important than in period 2: in the first period, two children consume but only one is able to bring additional resources to the household, while only one child consumes at period 2. If parents are sufficiently rich, the constraint on resources at period 1 is not binding, so that they do not need the first-born to work more than her younger sibling. When the household is poor, this constraint is binding in period 1, and savings are at a corner. This leads the household to make the first-born child work more because he is the only child able to relax the constraint.

There is no discounting of the future by any agent, nor any interest rate. Introducing these features to the model reinforces the first-born discrimination result. Indeed, with discounting, the parent values period 1 more than period 2. Therefore, it may even be the case that with interior savings, the parent will choose to make the first-born work more than the second-born, as the former contributes to consumption in period 1, while the latter contributes to consumption in period 2.

These results are robust to the introduction of various extensions. One example is to raise the number of periods where children live in the household to three, with two education/labor periods. Potentially working children then coexist in the household over one period. The introduction of bequests that might relax inequalities between children does not change our result either. Also, one could think that, rather than altruism, parents care about education because they expect their children to have higher wages in the future, hence benefit from higher remittances in old age. Even under the assumption that this strategy is exempt of commitment issues, this motive for educating children produces the same result. Indeed, the only thing that produces discrimination between the children is the resource constraint in period 1. The expectation of higher future remittances has no different impact than parental altruism on this mechanism.

II. The data and the empirical model

1. The data

1.1 Education in Cameroon

The Cameroonian education system is publicly and privately provided. The country has French and English as official languages and accordingly two sub-systems of education. Differences between the two systems are related to the language of tuition, program content and the number of grades in primary and secondary schools. In the English sub-system, primary school has 7 grades and secondary school has 7. In the French sub-system, primary school has 6 grades and secondary school has 7. We follow the Cameroonian National Institute of Statistics in considering that in the English system, the first grade of primary school corresponds to nursery. In general children start primary school at 6 and they are expected to complete secondary school at 19. The country has adopted two measures to promote primary school. The first was in 1996 when primary school became compulsory and the second in 2000 when tuition fee in primary school were suppressed. However parents still have to pay for Parent-Teacher Association fees and to cover other school expenditures (books, pens, uniforms,... .).

1.2 Data

We use data from the second LSMS Survey on Cameroonian Households (SCH) conducted by the World Bank in 2001. We focus on households where the eldest child living in the household is 18 years old or less. This subsample consists of 5,813 individuals from about 1,928 households.

A limitation of our data is that household surveys do not report children who no longer live with their parents. However, in our sample, the age difference between two children of consecutive birth order is in general smaller than 3 (80% of cases) and the median is 2, which is also the national median[7]. This suggests that the information we use to construct our birth order measures is reasonably exempt of measurement errors associated with the phenomenon of children moving out. We also implicitly assume that households do not have a child of more than 18 living elsewhere. In the estimation part, we check the robustness of our results by restricting the sample to households that did not witness any migratory flows over the past 5 years prior to the survey.

We use three different measures of the birth order. The first one is categorical and is based on a set of dummy variables: one for the first-born, one for the second-born, one for the third-born and a fourth one for the fourth or latter born children. We use only four dummy variables because the birth order of only 14% of children in the sample is higher or equal to 4. The second measure is the absolute birth order (Horton (1988)). The value for the absolute birth order of the first-born child is one, that of the second-born child is 2 and so forth. Most of the variation in this measure is due to the size of the family. The third measure is the relative birth order (Behrman (1988)).

It is defined as $\frac{r-1}{n-1}$ where r is the absolute order of birth and n the number of children in the household. The relative birth order of the first-born is zero and that of the last-born is 1, irrespective of the number of children[8]. The relative birth order for a given child can be easily interpreted as the share of elder siblings he/she has in the household.

Having defined the various measures of birth order, it is now necessary to discuss how our dependent variable, the schooling performance, should be measured. The right hand side variable is measured in two different ways. The first dependent variable is the number of completed grades of education. This variable is easy to interpret but suffers of two limitations. First it is right-censored as some children are still at school. Children are still in the process of accumulating human capital and we do not know what their final education level would become. Second, it is an integer variable and therefore does no fulfil standard assumptions required for linear models.

The second is a standardized education level. The education level of a given child is compared to the education level of children of his age and normalized by the dispersion of the education level of children of his age. This type of measure is called z-score in the nutrition literature[9]. We define the educational z-score

by $zscore_{i,j} = \frac{EL_{i,j} - \mu_{age}}{\sigma_{age}}$

where $EL_{i,j}$ is the current education level (measured by the number of completed years of education) of a child i in household j, μ_{age} is the conditional average education level given the age and σ_{age} the conditional standard deviation of education level given the age[10]. This measure expresses the divergence of the education level of a child from the average education level of children of her age, standardized by a measure of dispersion. It is real valued and completely realized. It overcomes some drawbacks of the number of completed years of education.

The main prediction of Section 2 is that in poor households, first-born children reach a smaller education level compared to later-borns, while this discrimination does not occur in wealthier households. Figure 1 gives a first indication supporting this distinction by wealth. It presents the average zscores of children from

7 *From the "Enquête Démographique et de Santé, Cameroun 2004".*

8 *Unlike other birth order measures, the relative birth order is not sensitive to the number of children. This measure is interesting as parents' fertility decisions are likely to be correlated with household unobserved characteristics. Note that [15] study the impact of birth order on schooling centering their theory on the endogeneity of fertility choices.*

9 *Two examples are weight and height z-score of young children.*

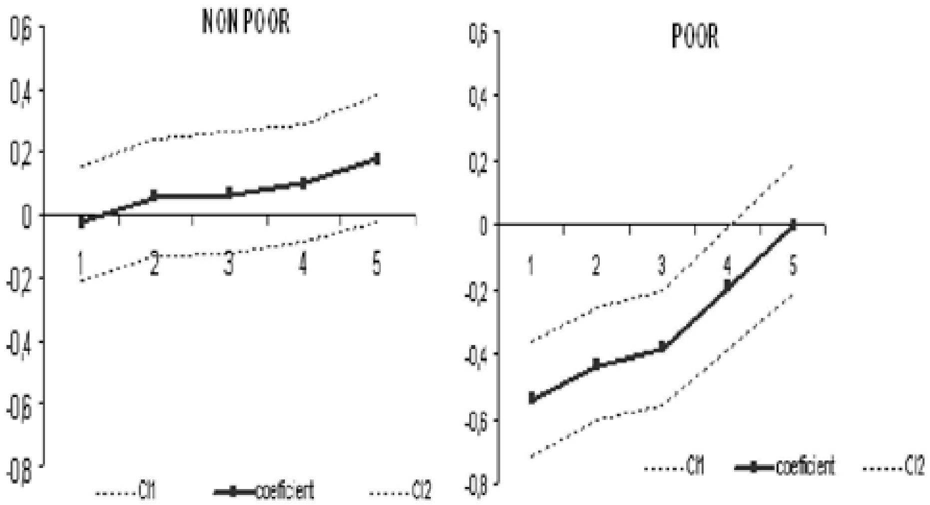
10 *The z-score is defined alternatively with the median instead of the mean and the interquartile range instead of the standard deviation because the median and the interquartile range are less sensitive to extreme values. We used this alternative definition of the z-score in the empirical part and the results were qualitatively similar.*

poor and non-poor[11] households by birth order[12]. It indicates that on average, in poor households, being among the earlier born children seems to adversely affect their education level (relative to the reference of their age), while fourth-borns and later-borns seem not penalized. In richer households, this discrimination appears to be very small (the average slope of the curve is very flat, and much flatter than that of poor households). Furthermore, all children from richer households appear to have significantly the same education level as their reference.

Table 1 presents descriptive statistics of our variables. Households have at most 8 children aged between 6 and 18 years. There may however be more children inside the household, since these statistics do not take into account children who are less than 6. The latter phenomenon explains the relatively low values for the average absolute and relative birth orders, as well as the large proportion of first and second-born children (0.3). Boys and girls are almost represented in the same proportions. The number of completed years of education is comprised between 0 and 12, meaning that no child in our sample has completed secondary school. The number of younger siblings also encompasses the siblings below 6 years of age, with an average of 2.3. The number of children within households is at most 13, while the average is approximately 4.

We have shown in Section 2 that household wealth is determinant in the decisions leading to child discrimination. Empirically measuring household wealth in developing countries is rather problematic. We proxy household wealth by the logarithm of current household expenditures per capita[13]. Current expenditures per capita are computed by dividing households' annual expenditures (housing, food, health care,...) by the household size. This wealth proxy is normalized so that its

F1 **Average educational zscores by household waelth and absolute birth order**



T1 **Descriptive Statistics**

	Mean	Std. Dev.	N
Child characteristics			
Absolute BO	2.22	1.21	5813
Relative BO	0.36	0.34	5813
Age	10.95	3.45	5813
Gender (Male=1)	0.51		5813
Education (years)	5.34	3.07	5813
Zscore	0.01	2.08	5813
Firstborn (firstborn=1)	0.33		5813
Second born (Second born=1)	0.33		5813
Third born (Third born=1)	0.19		5813
Fourth born (Fourth born or more =1)	0.14		5813
# of younger boys sibling	1.20	1.14	5813
# of younger girls sibling	1.17	1.16	5813
Household characteristics			
Number of children	4.12	1.66	1928
Household wealth indicator	2.00	0.55	1915
Dummy poor	0.37		1928

The number of observations related to households characteristics is the number of households in the sample. The mean of a dummy variable represents a proportion. The dummy poor is defined according to the poverty line of the country.

[11] *A household is considered as "poor" if it is living below the country's poverty line.*
[12] *Figure 1 plots the estimated coefficients of the birth order - and their 95% confidence interval - from a reduced form household fixed effect linear regression. The dependant variable is the zscore and explanatory variables are dummies of birth order only.*
[13] *Alternatively we use the estimated values of current expenditures per capita. Current expenditures per capita. Actual values are regressed on a set of long term variables including parental education, assets owned, professional activity of the parents, and regional dummies. The fitted values are then used as an independent variable measuring household wealth in a behavioral household equation.*

value for the poorest household in the data is zero. Finally, on the basis on the national poverty line criterion, our sample is composed of 35% of poor households.

2. The empirical model

The main prediction of Section 2 is that in poor households, first-born children have reached a lower education level compared to later-borns, while this discrimination does not occur in wealthier households. We test this prediction using the the number of completed years of education as the dependant variable[14]. The specification is based on the following fixed effect model:

$$E_{i,j} = BO_{i,j}\alpha + BO_{i,j} \; x \; HW_j\beta + C_{i,j}\gamma + \mu_j + \varepsilon_{i,j} \qquad (M1)$$

where $BO_{i,j}$ is the dummy first born, HW_j is household j's indicator of wealth and $C_{i,j}$ are control variables. The treatment of household wealth discussed in the previous subsection allows us to interpret α as the effect of birth order in the poorest household. The control variables $C_{i,j}$ are the child's age, gender and number of younger brothers and sisters. The term μ_j captures a household-specific fixed effect. It also accounts for household unobserved heterogeneity and household characteristics common to all children: parental education and professional activity, presence of servant in the household, living area, as well as preferences on children's education. The predictions of the theoretical model can be translated into the following tests:

1. In "poor" households, firstborn children reach relatively lower levels of human capital.
   $H_0 : \alpha = 0 \quad H_A : \alpha < 0$
   Under the null, being the firstborn has no impact, while under the alternative, being the first born implies a lesser performance than that of latter born children.
2. As household wealth increases, the impact of birth order on schooling is attenuated.
   $H_0 : \beta = 0 \quad H_A : \beta > 0$
   Under the null, wealth does not affect the impact of birth order on schooling. Under the alternative, the negative effect of being a firstborn is attenuated by household wealth.

Alternatively, instead of using only the firstborn dummy as measure of birth order, we use a set of three birth order dummies (second-born, third-born, fourth-born or more). Now the reference category is firstborn and we expect the coefficients α_1, α_2 and α_3 to be positive and the coefficients β_1, β_{12} and β_3 to be negative. This specification allows to check whether the discrimination between children is sorted according to birth order. In other words, does the discrimination rise from the second to the fourth-born ($0 < \alpha_1 < \alpha_2 < \alpha_3$)? Or are latter born affected equally ($\alpha_2 = \alpha_2 = \alpha_3$)?

When the absolute or the relative birth order is used to measure birth order, the interpretation of the results is similar to what we have just described. Namely, the coefficient on the absolute or relative birth order is expected to be positive while the interaction term should be negative.

III. Empirical results

We study the role of birth order on children's educational attainments at a given age. We present here the most important results, based on regressions using the birth order dummies. We estimate the model on the whole sample as well as on urban and rural areas sub-samples. Furthermore, we check the robustness of these results in several dimensions. In each of them, we are able to confirm the predictions of our theoretical model.

1. Main results

Results of the estimation of model (M1) with birth order dummies are provided in table 2. In column 1, the coefficient on firstborn is negative and significant. This means that a firstborn child in a poor household has a smaller number of years of education compare to later born children. In column 3, the firstborn child is the reference group and the coefficients on later born dummy variables are shown. The coefficients on the second, third and forth born are all positive and significant. So being a later born (compared to the firstborn) has an advantage. Such a child has a higher number of completed years of education. Note that the magnitude of the birth order effects is increasing. This seems to validate the use of the two other measures of birth order, namely the absolute and the relative birth order, as they imply an increasing relationship between birth order and schooling. Also, the difference between the coefficients of second-born and third-born is statistically different from zero, and so is the difference between the coefficients of third-born and fourth-born. Again, this result is in line with the one obtained in the regression using the absolute birth order measure, as its coefficient in this case represents the (constant) effect of a change in one order of birth.

Secondly, in column 1 the coefficient on the interaction term between birth order and household expenditures per capita is positive and significantly different from zero. This means that, the negative effect of being the firstborn is attenuated as household wealth increases. Since expenditures per capita equal 0 for the poorest household, one can easily see that for a sufficiently rich household, being a first-born child no longer implies a lower education level. It may even imply a relatively better education level.

Similarly, in column 3, the coefficient on the interaction term between birth order and household expen-

[14] *The results with the zscore are in appendix.*

ditures per capita is negative and significantly different from zero. This means that, the positive effect of being a later is attenuated as household wealth increases. Interestingly, the birth order effect seems to be similar for boys and girls. In columns 2 and 4 of table 2, the interactions between birth order coefficients and gender are not significant. The use of age dummies allows us to make sure that our birth order effects do not incorporate an age effect[15].

Finally, note that the results are not robust to the urban/rural distinction, as presented in the Appendix in Table 3. It suggests that in rural areas, children from poor households are equally penalized, irrespective of their birth order. Birth order effect seems to be less important.

2. Robustness checks

Table 4, which is available in the Appendix, presents coefficient estimates of equations with alternative measures of the birth order, namely the absolute and relative birth orders. In these regressions, the coefficients of birth order are positive: as the order of birth increases (for instance from the first-born to the second-born), the number of completed years of educational increases. The interaction term between birth order and household expenditures per capita has an opposite effect, confirming our previous results.

As previously mentioned, our results are also robust to different measures of the dependent variable. Columns 1-3 of table 5 presents results based on educational zscore. The coefficient on firstborn is negative and significant. This means that, at a given age, a firstborn child in a poor household has a lower stock of human capital (compared to the average level of children of the same age) than if he/she were of later birth order. As noted earlier, this firstborn effect is attenuated as the household expenditure per capita increases.

T2 Regression results with birth order dummies

	Number of years of education completed			
	(1)	(2)	(3)	(4)
Firstborn (firstborn=1)	-1.518 (8.43)***	-1.608 (8.30)***		
Firstborn * Expend. per capita	0.605 (9.45)***	0.607 (9.47)***		
Firstborn * Gender		0.166 (1.38)		
Second born (Second born=1)			0.970 (4.82)***	1.026 (4.74)***
Third born (Third born=1)			1.628 (5.46)***	1.717 (5.58)***
Fourth born of more			3.051 (7.50)***	3.140 (7.48)***
Second born * Expend. per capita			-0.409 (6.17)***	-0.411 (6.18)***
Third born * Expend. per capita			-0.745 (8.11)***	-0.747 (8.12)***
Fourth or more * Expend. per capita			-1.346 (11.69)***	-1.345 (11.64)***
Second born * Gender				-0.106 (0.83)
Third born * Gender				-0.176 (1.20)
Fourth born * Gender				-0.196 (1.21)
Gender (Male=1)	0.089 (1.48)	0.013 (0.16)	0.110 (1.85)*	0.187 (2.08)**
# of younger boys sibling	0.260 (3.87)***	0.233 (3.30)***	0.217 (2.14)**	0.188 (1.81)*
# of younger girls sibling	0.159 (2.45)**	0.182 (2.71)***	0.082 (0.84)	0.105 (1.06)
12 age dummies included but not shown				
Constant	2.111 (24.79)***	2.152 (24.00)***	2.333 (7.42)***	2.302 (7.29)***
Observations	5813	5813	5813	5813
Number of id0	1928	1928	1928	1928
R-squared	0.65	0.65	0.66	0.66

Figures between parentheses indicate robust t-statistics. *, ** and *** indicate that variable is significant respectively at 10% (20%), 5% (10%) and 1% (2%) on the basis of a two-tailed (one-tailed) test. Note that our test strategy relies on one-tailed tests on birth order dummies and their interactions with household wealth. We compute one-tailed test to compare two by two the coefficients of birth order dummies and we find that $\alpha_1 < \alpha_2 < \alpha_3$ with significance levels of at most 6%.

[15] *We use four age dummies representing the 8-9, 10-12, 13-14 and 15-18 categories, while the reference category represents the 6- and 7-year old children. Results are very similar if the age variable is simply used.*

[16] *Table 9 shows the estimation results.*

One might also think that the reference level of education in the zscore varies with wealth. As robustness check, we define the reference level of education based on age and wealth - by means of a dummy variable that determines whether the household is below or above the poverty line - instead of age only. This modification does not change our results, as shown in columns 4 to 6 of Table 5.

Another issue that was pointed out in our introduction to the data is that if some children have migrated before the date of the survey, our measure of birth order might be flawed. Table 6, also available in the Appendix, presents coefficient estimates of equation (M1) after exclusion of households in which there has been a migration flow in the last five years. Results are very robust to this subsampling procedure. We also look at the robustness of our results to changes in the sample based on fertility characteristics. More specifically, we do the regressions on subsamples where the head of the household is at most 40 years of age, and also where he is at least 50. While in the first case, fertility need not be fully accomplished, it could be considered as fixed in the second. The fact that results are extremely similar in both subsamples should be a good sign that fertility is not an issue in our analysis.

We also obtain similar results using an alternative measure of wealth, namely estimated[16] expenditures per capita and the households housing expenditures. Results are presented in table 7.

One might also attribute discrimination in terms of education at the expense of the first-born to land inheritance. In some countries, it is indeed not uncommon that parents decide to give land to their firstborn child and compensate their other children by offering them a better education. On the one hand, this observation would not explain why wealthier households discriminate less between their children. On the other hand, results in Table 8 show that the birth order discrimination that we describe in this paper is observed among landless as well as landowner households according to a very similar pattern, suggesting that the household distribution of land is not the driving force behind birth order discrimination.

Finally this paper uses data from Cameroon. As such, one might think that our empirical results are specific to this country. In Appendix B, we reproduce the results of Tenikue & Verheyden which prove general to other Sub-Saharan African countries.

IV. Concluding remarks

The objective of this paper was to evaluate the role of birth order in the household allocation of work and schooling to children in developing countries. Until recently, the common view was that earlier born children receive a better education than their younger siblings. In this analysis, we bring some new insights to this discussion by highlighting the impact of household wealth. We show that poor households provide their elder children with less education, while richer households do not discriminate. Our simple model shows that unless the household is sufficiently wealthy, the pressure on resources at the time when only the first-born child is able to work leads parents to invest less in her education.

Our empirical results confirm that earlier born children receive less education in poor households. Furthermore, we find that this discrimination decreases as household wealth increases. These results are robust to various measures of birth order, education and wealth.

[16] *Table 9 shows the estimation results.*

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Table 3: Regression results by rural/urban

	Number of completed years of education			
	Rural		Urban	
	1	2	5	6
Firstborn (firstborn=1)	0.183 (0.47)	0.087 (0.21)	-1.588 (6.95)***	-1.656 (6.84)***
firstborn * Expend. per capita	-0.076 (0.44)	-0.079 (0.46)	0.597 (7.87)***	0.599 (7.87)***
Firstborn * Gender		0.188 (0.83)		0.128 (0.92)
Gender (Male=1)	0.334 (3.03)***	0.245 (1.63)	0.010 (0.15)	-0.047 (0.52)
# of younger boys sibling	0.263 (2.11)**	0.235 (1.80)*	0.242 (3.16)***	0.220 (2.72)***
# of younger girls sibling	-0.007 (0.06)	0.026 (0.19)	0.157 (2.18)**	0.173 (2.34)**
12 age dummies				
Constant	1.504 (9.85)***	1.546 (9.69)***	2.449 (24.65)***	2.481 (23.62)***
Observations	2095	2095	3718	3718
Number of id0	703	703	1225	1225
R-squared	0.52	0.52	0.72	0.72

Figures between parentheses indicate robust t-statistics. *, ** and *** indicate that variable is significant respectively at 10%, 5% and 1%.

Table 4: Regression results with absolute and relative birth order

	Number of completed years of education			
Absolute BO	0.815 (2.55)**	0.835 (2.65)***		
Absolute BO * Expend. per capita	-0.383 (11.72)***	-0.383 (11.69)***		
Absolute BO * Gender		-0.050 (1.12)		
Relative BO			2.283 (7.76)***	2.353 (7.50)***
Relative BO * Expend. per capita			-0.953 (10.59)***	-0.955 (10.58)***
Relative BO * Gender				-0.128 (0.74)
Gender (Male=1)	0.114 (1.93)*	0.210 (2.00)**	0.089 (1.50)	0.122 (1.65)
# of younger boys sibling	0.178 (0.57)	0.151 (0.49)	0.249 (3.59)***	0.234 (3.23)***
# of younger girls sibling	0.036 (0.12)	0.049 (0.16)	0.142 (2.12)**	0.156 (2.21)**
12 age dummies				
Constant	2.636 (1.85)*	2.616 (1.86)*	2.221 (13.99)***	2.203 (13.69)***
Observations	5813	5813	5813	5813
Number of id0	1928	1928	1928	1928
R-squared	0.66	0.66	0.65	0.65

Figures between parentheses indicate robust t-statistics. *, ** and *** indicate that variable is significant respectively at 10%, 5% and 1%.

Table 5: Alternative measures of education

	Zscore (Mean)			Zscore (Mean Poverty)		
	1	2	3	4	5	6
Firstborn (firstborn=1)	-1.567 (9.16)***	-1.645 (8.90)***		-0.347 (10.07)***	-0.363 (9.76)***	
firstborn * Expend. per capita	0.628 (10.25)***	0.629 (10.26)***		0.139 (11.26)***	0.140 (11.27)***	
Firstborn * Gender		0.144 (1.23)			0.029 (1.23)	
Second born (Second born=1)			0.980 (5.17)***			0.226 (5.92)***
Third born (Third born=1)			1.727 (6.08)***			0.381 (6.67)***
Fourth born of more			3.268 (8.37)***			0.694 (8.83)***
second born * Expend. per capita			-0.414 (6.59)***			-0.095 (7.55)***
third born * Expend. per capita			-0.782 (8.87)***			-0.172 (9.68)***
fourth or more* Expend. per capita			-1.429 (12.91)***			-0.304 (13.60)***
Gender (Male=1)	0.033 (0.58)	-0.032 (0.42)	0.056 (0.98)	0.006 (0.52)	-0.007 (0.46)	0.011 (0.94)
# of younger boys sibling	0.234 (3.59)***	0.210 (3.07)***	0.198 (2.04)**	0.046 (3.56)***	0.042 (3.04)***	0.039 (1.99)**
# of younger girls sibling	0.157 (2.51)**	0.178 (2.72)***	0.084 (0.90)	0.033 (2.61)***	0.037 (2.82)***	0.018 (0.94)
12 ages dummies						
Constant	0.022 (0.27)	0.057 (0.65)	0.226 (0.75)	-0.429 (25.80)***	-0.422 (24.02)***	-0.385 (6.40)***
Observations	5813	5813	5813	5813	5813	5813
Number of id0	1928	1928	1928	1928	1928	1928
R-squared	0.04	0.04	0.07	0.65	0.65	0.66

Figures between parentheses indicate robust t-statistics. *, ** and *** indicate that variable is significant respectively at 10%, 5% and 1% on the basis of a two-tailed test.

Table 6: Robustness checks: migration and fertility controls

	Number of completed years of education		
	Migration	Head over 50	Head under 40
Firstborn (firstborn=1)	-1.393 (6.53)***	-1.380 (3.56)***	-1.472 (5.60)***
firstborn * Expend. per capita	0.583 (7.62)***	0.575 (3.92)***	0.574 (6.00)***
Gender (Male=1)	0.174 (2.35)**	0.091 (0.66)	0.149 (1.72)*
# of younger boys sibling	0.283 (3.39)***	0.254 (1.82)*	0.290 (3.01)***
# of younger girls sibling	0.178 (2.19)**	0.026 (0.19)	0.231 (2.42)**
12 age dummies			
Constant	1.935 (18.18)***	2.064 (9.84)***	2.011 (17.24)***
Observations	3960	1368	2536
Number of households	1297	433	895
R-squared	0.63	0.58	0.67

Figures between parentheses indicate robust t-statistics. *, ** and *** indicate that variable is significant respectively at 10%, 5% and 1%.

Table 7: Alternative measures of wealth.

	Number of completed years of education	
	Estimated expenditures per capita	Housing expenditures
Firstborn (firstborn=1)	-1.771 (9.78)***	-1.955 (10.09)***
Firstborn * Expend. per capita		
Firstborn * Estimated Exp. pc	0.888 (11.09)***	
Firstborn * Housing exp.		0.634 (11.01)***
Gender (Male=1)	0.096 (1.61)	0.089 (1.48)
# of younger boys sibling	0.295 (4.46)***	0.204 (3.04)***
# of younger girls sibling	0.187 (2.91)***	0.092 (1.41)
12 age dummies		
Constant	2.076 (24.61)***	2.152 (25.35)***
Observations	5774	5813
Number of id0	1915	1928
R-squared	0.65	0.65

Figures between parentheses indicate robust t-statistics. *, ** and *** indicate that variable is significant respectively at 10%, 5% and 1% on the basis of a two-tailed test.

Table 8: Results by land ownership.

	Number of completed years of education	
	Land owner	Landless
Firstborn (firstborn=1)	-1.141 (4.54)***	-1.845 (6.72)***
Firstborn * Expend. per capita	0.484 (4.98)***	0.669 (7.31)***
Gender (Male=1)	0.270 (3.30)***	-0.093 (1.08)
# of younger boys sibling	0.252 (2.87)***	0.363 (3.67)***
# of younger girls sibling	0.128 (1.40)	0.179 (1.98)**
12 age dummies		
Constant	1.755 (14.61)***	2.483 (21.86)***
Observations	3271	2542
Number of id0	1068	860
R-squared	0.60	0.72

Figures between parentheses indicate robust t-statistics. *, ** and *** indicate that variable is significant respectively at 10%, 5% and 1% on the basis of a two-tailed test.

Table 9: Household wealth instrumentation

	Log (expenditures per capita)
Land value in million CFA	0.003 (5.13)***
Head education	0.017 (12.34)***
Head sex (Male=1)	-0.025 (1.72)*
Head age	0.000 (0.17)
# of types of durables owned	0.115 (49.07)***
# of 0- to 4-year olds	-0.168 (26.33)***
# of 5- to 9-year olds	-0.118 (18.71)***
# of 10- to 14-year olds	-0.105 (16.32)***
# of 15- to 19-year olds	-0.078 (13.00)***
# of 20- to 24-year olds	-0.067 (9.86)***
# of 25- to 59-year olds	-0.062 (10.47)***
# of 60-year olds and older	-0.084 (6.83)***
# of spouses	-0.011 (0.97)
# of head's children (offspring)	-0.008 (1.98)**
# of head's income generating activities	0.015 (1.81)*
Walls with brick with cement or concrete	0.134 (3.32)***
Walls with Local brick	-0.055 (1.38)
Walls with Mud	-0.100 (2.44)**
Walls with wood	0.028 (0.67)
Constant	12.593 (255.05)***
Households	10960
R-squared	0.55

Figures between parentheses indicate robust t-statistics. *, ** and *** indicate that variable is significant respectively at 10%, 5% and 1% on the basis of a two-tailed test. The unit of observation is the household. This regression is based on the full sample available in the survey. It also includes province dummies.

Appendix B

Tenikue & Verheyden (2009) estimate equation (M1) on Demographic and Health Survey data from 12 countries over a period ranging from 2003 to 2007. The sample of every country is made of children aged between 6 and 18 years and only households where the eldest child is at most 18 years old are considered. The measure of birth order is the dummy firstborn. The wealth indicator is built from the set durable goods owned by a household following Filmer and Pritchett (2001). The following table summarizes the results:

	Benin	Burkina Faso	Cameroon	Ghana	Kenya	Mali	Niger	Senegal	Tanzania	Uganda	Zambia	Zimbabwe
Year of the survey	2006	2003	2004	2003	2003	2006	2006	2005	2004	2006	2007	2005
Number of completed years of education												
Firstborn	-0.45***	-0.32***	-0.43***	-0.44***	-0.18***	-0.50***	-0.36***	-0.60***	-0.12**	-0.04	-0.20***	-0.01
Firstborn * wealth	0.31***	0.39***	0.33***	0.45***	0.34***	0.36***	0.41***	0.41***	0.22***	0.18***	0.22***	0.11***
Gender (Male=1)	0.53***	0.37***	0.13**	-0.12	-0.07	0.26***	0.34***	0.13**	-0.23***	-0.05	-0.14***	-0.23***
# of younger boys sibling	0.06	-0.04	-0.03	-0.07	-0.09	0.09**	0.08	0.10	0.15**	0.34***	0.27***	0.03
# of younger girls sibling	-0.05	-0.13***	-0.10*	0.11	0.07	0.00	-0.03	0.01	0.26***	0.38***	0.26***	0.11*
12 age dummies												
Constant	0.39***	0.10*	0.43***	0.41***	0.27***	-0.08	-0.14*	0.04	0.14**	-0.10*	0.01	0.28***
R-squared	0.38	0.20	0.66	0.64	0.69	0.30	0.30	0.35	0.68	0.71	0.79	0.88
Observations	15344	9924	6915	3955	5981	12968	8278	6022	6965	7894	5150	4980

Sources of data : DHS Data sets
Figures between parentheses indicate robust t-statistics. *, ** and *** indicate that variable is significant respectively at 10%, 5% and 1%.

The coefficient on the firstborn dummy is negative for the 12 countries and significant in 10 countries. The coefficient on the interaction term (firstborn and wealth) is positive and highly significant in the 12 countries. Thus the pattern described in table (T2) seems to be reproduced in many other sub Saharan African countries.

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