

Birth order, child labor and schooling: Evidence from Cameroon

Work In Progress

Michel Tenikue and Bertrand Verheyden

March 9, 2007

Abstract

This paper examines determinants of child labor and school attendance with a special emphasis on birth order and sibling age structure. We present a theoretical model accounting for the dynamics of birth order and its interaction with credit constraints. We show that poor - credit-constrained - parents send their elder children to work relatively more. The reason is the following: first borns are the only available source of additional income when constraints on resources become more binding. First borns end up with a lower level of human capital compared to their younger siblings. On the other hand, wealthier parents do not discriminate between their children on the basis of birth order. 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 find that wealthier households do not make use of birth order to discriminate between children's education levels than poor ones. These results are robust to various measures of the birth order.

1 Introduction

In developing countries, the number of children in poor households may tighten constraints on intra-household allocation of resources. As a result, a competition between children for available resources may appear. This competition may express itself by a discrimination between children on the basis of nutrition or health care (Behrman, 1988) [2]. Another dimension of intra-household discrimination regards the access to schooling and child labor (Basu & Van, 1998) [1]. If resources become scarce, parents may send some of children to work and others to attend school and concentrate on studying.

Economics research on the determinants of this discrimination in the domain of child labor and school attendance are vivid. Yet, the question of what factors affect households' decision to send a child to labor market or at school is not fully elaborated. The specialization of children based on gender or "gender bias", has been observed in a large empirical literature on child labor and schooling in African countries. It is observed that girls are more likely to work than to attend school while boys are more likely to attend school than to be involved in child labor. In this paper, we investigate the potential role of birth order in this specialization process. The underlying question we want to study is whether birth order may be a factor through which this discrimination between children arises, and if so, in favor of which child ?

The role of the birth order has been investigated in several studies. 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 conclusion. The fact - which has been largely pointed out by the psychological literature - that earlier born children have higher IQ's and cognitive abilities is one of them.¹ The economic implication of this fact is that parents may want to invest more resources in the education of the child with the greatest return to education. The hypothesis that birth order may affect parents' allocation choices also stems from the fact that first born children are favored for cultural factors (Horton, 1988) [10]. Because parents need security in old age, they will invest more in the education of the first born children because they will become economically independent first.

In recent theoretical and empirical contributions, this view is being challenged: later born children seem to be favored (more educated) than earlier born children. Ejrnaes & Pörtner (2004) [7] claim that this new conclusion can be reached once the endogeneity of fertility choices is properly taken into account. The theory they present to back up this result is based on a combination of uncertainty about the ability of the children to be born and the taste of parents for their offspring's human capital and their aversion for inequality between children. The intuition is the following: since the stopping rule (on the decision of having children) depends on the last child's potential return to education, last born children are more likely to be successful at school.

In this paper, we formalize the idea that birth order may indeed result in discriminating children at the expense of earlier borns when credit constraints force parents to send some of their children to work. To our knowledge, our model is

¹Zajonc (1976) ; Zajonc and Markus (1975)

the first one to take explicitly into account the order of birth and to show how it interacts with credit constraints. Papers by Emerson & Souza (2002) [8] and Edmonds (2006) [6] have studied this question both theoretically and empirically and reach the same conclusions as Ejrnaes & Pörtner (2004) [7]. These two papers study households behaviour in a static context where children potentially differ in innate ability and labor productivity. Implicitly, birth order is represented through these two characteristics. This modeling strategy generates general arbitrage conditions on the optimal allocation of schooling and child labor on the basis of innate ability and productivity, but fails to identify explicitly the role of birth order. For instance, it neither incorporates the fact that each child is born at different moments and becomes productive in different economic environments, nor shows how credit constraints play a role in this precise context.

The model we present takes explicitly into account the dynamics of the order of birth 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.² The importance of taking into account a dynamic perspective over the household is that it highlights a simple fact: different periods are characterized by different family sizes, and hence different pressures over resources, but also different potential labor forces, depending on how many children can be sent to work. The dynamic perspective is also important in the sense that the choice of discriminating one child in one period has repercussions over the next periods. The intuition behind our result is that there is a particular period where the tension over resources is stronger, that is when all children are born, but only the first borns are potentially productive.³ If the tension is too strong and there is a need for extra income sources, the first born children will be sent to work. Our 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. On the other hand, if a household faces credit constraints in the period where the tension over resources is the strongest, the first born child works more and receives less education than her younger sibling. The latter end up with higher level of human capital. We also show that bequests, which could be used as a way to compensate children with lower education levels, do not affect our result. The predictions of our model are thus somewhat different from both previous fields of literature since it underlines a fundamental distinction: household wealth affects the role of birth order. In "poor" households (that are credit-constrained), the elder children end up with a relatively lower level of human capital. On the other hand, "rich" households do not discriminate between their children on the basis of birth order, everybody has

²In some periods, some children are not productive while their elder siblings are. However, the papers we refer to are focusing on periods where all children are potential workers. In our model, in such periods, all children have the same productivity and return to education. Furthermore, in the last periods, the productivity of elder children becomes nil since they leave the household, while younger siblings are still productive. In other words, the productivity of children is globally the same over all periods.

³To see this, let us use a representative household in Cameroon. The average household has 5 children, with 2 years separating each of them. When the first born child is 8 years old, all five children are in the household, meaning that the tension on resources is at its maximum. It would take 2 more years to wait and send the second born to work, 4 years for the third born,...

the same final human capital level.

Regarding the empirical analysis of this paper, we check these predictions on the 2001 Cameroon Household Survey database. Once again, our strategy is to take into account a child's whole education background, rather than a short term information about whether he/she is working and/or registered at school on the year of the survey. The use of a dependant variable such as the educational z-score allows us to use a household fixed effect model. This approach allows us to control for unobservable characteristics of the parents such as the fact of being "pro-school", which have a strong impact on children's educational attainments.

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 definition of birth order and indicators of wealth.

The paper is organized as follows: 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. Estimation results and their interpretations follow in section 4. Section 5 concludes.

2 The model

2.1 The basic model

The household is composed of one parent and two children $i \in \{1, 2\}$.⁴ The parent lives for 4 periods $p = \{0, 1, 2, 3\}$ and there is no discounting of the future by any agent. Child $i = 1$ is born at period $p = 0$, child $i = 2$ at period $p = 1$. Each child i lives 3 periods $t \in \{0, 1, 2\}$ inside the household, then becomes an adult and quits. During her first period inside the household $t = 0$, a child is fully dependant: she can neither work nor go to school, but consumes k units of the numeraire good. During each of the next two periods $t \in \{1, 2\}$, she consumes the same amount k , and is endowed with one unit of time that parents decide to allocate between labor l_t^i and schooling $e_t^i = 1 - l_t^i$. Parents supply their own labor inelastically and parental labor has y efficiency units in each periods, while child labor productivity is constant and equal to 1. Child labor revenues contribute to household income. At the end of period $p = 3$, parents die and can leave bequests b^i to their children.

At the end of period $t = 3$, children become adults and work. Their earnings depend on the acquired level of human capital through the time spent at school e_1 and e_2 . The human capital technology is denoted $H(\cdot, \cdot) : [0; 1] \times [0; 1] \rightarrow \mathbb{R}^+$. We will make extensive use of the following notations: $H^i \equiv H(e_1, e_2)|_{(e_1^i, e_2^i)}$, $H_t \equiv \frac{\partial H(e_1, e_2)}{\partial e_t}$ and $H_t^i \equiv \frac{\partial H(e_1, e_2)}{\partial e_t}|_{(e_1^i, e_2^i)}$ for $i \in \{1, 2\}$ and $t \in \{1, 2\}$. Function $H(\cdot, \cdot)$ has the following properties. Children who spent all their childhood working have a single efficiency unit of labor as an adult. Marginal returns to both schooling times are strictly positive and strictly decreasing. Furthermore, we want it to

⁴In this simple version of the model, we consider the number of children as exogeneous. However in section ?, we specifically examine fertility decisions in the context of birth order.

have the appealing property that the marginal return to one period of education is increasing in the other. This last requirement supports the intuition that for instance the larger the investment in primary schooling, the larger the return to secondary schooling in terms of human capital accumulation. Finally, we assume that function $H(\cdot, \cdot)$ is globally concave. Formally:

$$\begin{aligned} H(0, 0) &= 1, \\ H_1 &> 0, H_2 > 0, \\ H_{11} &< 0, H_{22} < 0, \\ H_{21} &> 0, \\ H_{11}H_{22} - (H_{21})^2 &> 0. \end{aligned}$$

The consumption level of the numeraire good of child i when she becomes an adult depends on her human capital level H^i . Child i 's utility only depends on future consumption and is denoted $V(H^i)$.

Parental utility is denoted $\Pi(c_0, c_1, c_2, c_3, V(H^1), V(H^2))$ where c_p are parental consumption levels across periods $p = \{0, 1, 2, 3\}$. Π is assumed separable so that

$$\Pi(c_0, c_1, c_2, c_3, V^1, V^2) = U(c_0) + U(c_1) + U(c_2) + U(c_3) + \beta (V(H^1) + V(H^2)), \quad (1)$$

where both $U(\cdot)$ and $V(\cdot)$ are twice continuously differentiable, strictly increasing, strictly concave functions. From now on, we will make use of the following notations: $V^i \equiv V(H^i)$, $V' \equiv \frac{\partial V(H)}{\partial H}$ and $V^{i'} \equiv \frac{\partial V(H^i)}{\partial H}$. $\beta \in [0; 1]$ is a parameter measuring parental altruism towards children.

Apart from choosing their children's labor times l_t^i for all $i \in \{1, 2\}$ and $t \in \{1, 2\}$, parents decide whether to transfer income across periods through savings s_p for $p = \{0, 1, 2\}$. We assume that capital markets are imperfect, so that borrowing is impossible ($s_p \geq 0$). Parents therefore face the following budget constraints:

$$c_0 = y - k - s_0, \quad (2)$$

$$c_1 = y + l_1^1 - 2k + s_0 - s_1, \quad (3)$$

$$c_2 = y + l_2^1 + l_1^2 - 2k + s_1 - s_2, \quad (4)$$

$$c_3 = y + l_2^2 - k + s_2. \quad (5)$$

The first order conditions with respect to $l_1^1, l_2^1, l_1^2, l_2^2$ are respectively:

$$U'(c_1) = \beta V^{1'} H_1^1, \quad (6)$$

$$U'(c_2) = \beta V^{1'} H_2^1, \quad (7)$$

$$U'(c_2) = \beta V^{2'} H_1^2, \quad (8)$$

$$U'(c_3) = \beta V^{2'} H_2^2. \quad (9)$$

The first order conditions with respect to s_0, s_1, s_2 are respectively:

$$U'(c_0) = U'(c_1) \text{ and } s_0 > 0 \text{ or} \quad (10)$$

$$U'(c_0) > U'(c_1) \text{ and } s_0 = 0, \quad (11)$$

$$U'(c_1) = U'(c_2) \text{ and } s_1 > 0 \text{ or} \quad (12)$$

$$U'(c_1) > U'(c_2) \text{ and } s_1 = 0, \quad (13)$$

$$U'(c_2) = U'(c_3) \text{ and } s_2 > 0 \text{ or} \quad (14)$$

$$U'(c_2) > U'(c_3) \text{ and } s_2 = 0. \quad (15)$$

We assume that there exist interior optimum levels of child labour l_t^i for all $i \in \{1, 2\}$ and $t \in \{1, 2\}$.

Proposition 1 *If savings are interior, then birth order does not affect schooling and child labor decisions. Children receive the same level of human capital: $H(e_1^1, e_2^1) = H(e_1^2, e_2^2)$ with $e_1^1 = e_1^2$ and $e_2^1 = e_2^2$.*

Proof. We need to show that under the assumptions made on the human capital technology, equations (6) to (9), (12) and (14) imply that $(e_1^1, e_2^1) = (e_1^2, e_2^2)$.⁵

First note that since s_1 and s_2 are interior, (6), (7), (8) and (9) imply that $\frac{V^{1'}}{V^{2'}} H_1^1 = \frac{V^{1'}}{V^{2'}} H_2^1 = H_1^2 = H_2^2$.

$\frac{V^{1'}}{V^{2'}}$ may be smaller, equal to, or greater than 1. Let us study the different possible cases. If $\frac{V^{1'}}{V^{2'}} = 1$, $H_1^1 = H_2^1 = H_1^2 = H_2^2 = 1$. These equalities can be represented in the (e_1, e_2) space. The human capital technology is identical for both children. Hence showing that $H_1 = H_2 = k$, where k is a constant, admits a unique solution (e_1, e_2) is sufficient to prove that $H_1^1 = H_2^1 = H_1^2 = H_2^2 = 1$ implies $(e_1^1, e_2^1) = (e_1^2, e_2^2)$. Let us represent $H_1 = k$ and $H_2 = k$ in the (e_1, e_2) space. In this space, both these loci have positive slopes respectively equal to $-\frac{H_{11}}{H_{12}}$ and $-\frac{H_{21}}{H_{22}}$. The equation system $H_1 = H_2 = k$ has a unique solution if the loci respect the single crossing property in the (e_1, e_2) space. A sufficient condition for this property to be satisfied is that the slope of one locus is larger than the other's for all $e_1 \in [0; 1]$. This is true if and only if the assumption of global concavity of $H(\cdot, \cdot)$ holds: $H_{11}H_{22} - (H_{21})^2 > 0 \iff -\frac{H_{11}}{H_{12}} > -\frac{H_{21}}{H_{22}}$. An illustration of this argument is provided in Figure 1.

Let us now study the case in which $\frac{V^{1'}}{V^{2'}} > 1$. By strict concavity of $V(\cdot)$, H^1 is necessarily smaller than H^2 . $\frac{V^{1'}}{V^{2'}} > 1$ also implies by (6)-(9) that $H_1^1 < H_1^2$ and $H_2^1 < H_2^2$. By global concavity of $H(\cdot, \cdot)$, necessarily $e_1^1 > e_1^2$ and $e_2^1 > e_2^2$.⁶ These two inequalities imply that $H^1 > H^2$ and we have a contradiction. The converse reasoning can be applied to the case in which $\frac{V^{1'}}{V^{2'}} < 1$ and it also results in a contradiction. Hence, $\frac{V^{1'}}{V^{2'}}$ is necessarily equal to 1, which implies as shown above that $(e_1^1, e_2^1) = (e_1^2, e_2^2)$. ■

⁵Since the equilibrium level of s_0 does not affect this result, we do not need to mention anything about it in the proof.

⁶An illustration of this argument is provided in Figure 2.

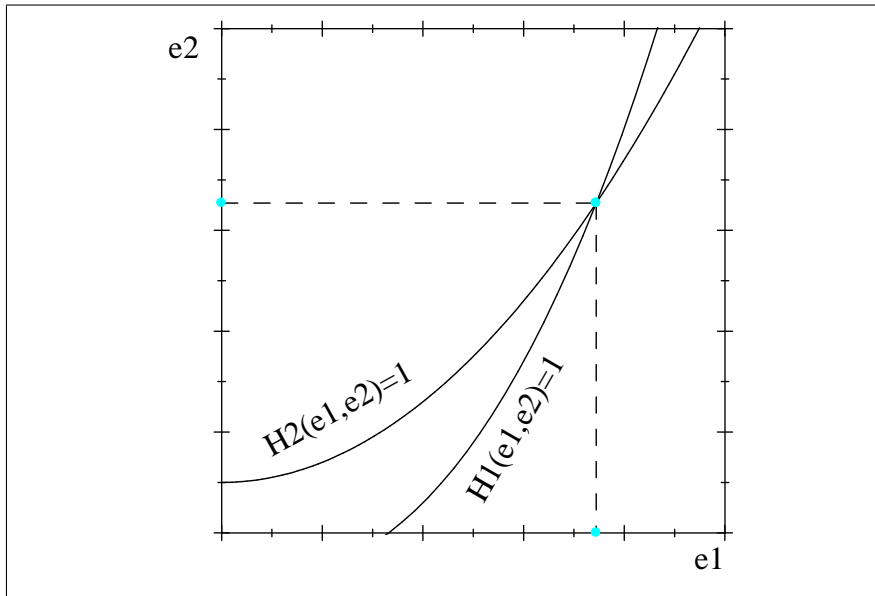


Figure 1: Education equilibrium when savings are interior.

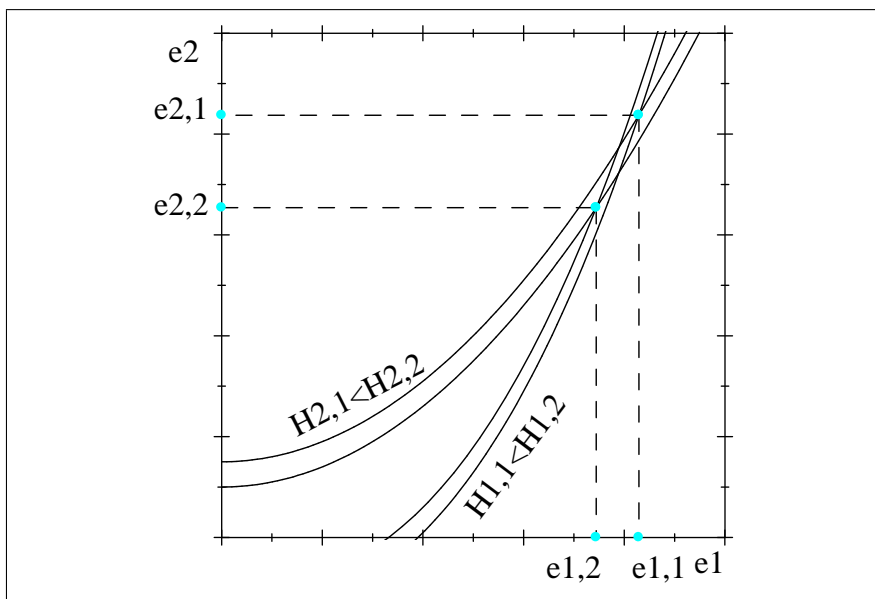


Figure 2

The intuition behind proposition 1 is that since parents are able to smooth consumption thanks to strictly positive savings, they do not need to discriminate between children. More precisely, they do not need to make some of them work more on the basis of the period during which they could bring resources to the household.

Let us now focus on the case in which the household would like to borrow but

since it faces liquidity constraints, savings are at a corner. This is particularly the case at period $p = 1$, in which the pressure over resources is important: two children consume but only one is able to bring resources to the household. In the next proposition, we will thus focus on the case where $s_1 = 0$. One can easily show that this result holds if instead s_2 is at a corner, or if both s_1 and s_2 are.

Proposition 2 *If savings are at a corner i.e. $s_1 = 0$, then birth order affects schooling and child labor decisions. The first born child's level of human capital is always smaller than the second's: $H(e_1^1, e_2^1) < H(e_1^2, e_2^2)$. The allocation of (e_1^1, e_2^1) and (e_1^2, e_2^2) is such that e_1^1 is always smaller than e_1^2 , but e_2^1 may be greater or smaller than e_2^2 .*

Proof. We need to show that under our set of assumptions, equations (6) to (9), (13) implies $H^1 < H^2$. One can easily show that the following reasoning can be applied to provide the same result with (15), and that combining both (13) and (15) reinforces the result.

From (13) and (6)-(9), $\frac{V^{1'}}{V^{2'}} H_1^1 > \frac{V^{1'}}{V^{2'}} H_2^1 = H_1^2 = H_2^2$. Once again, let us study separately the cases where $\frac{V^{1'}}{V^{2'}}$ is either greater than, equal to or smaller than 1.

If $\frac{V^{1'}}{V^{2'}} = 1$, $H_1^1 > H_2^1 = H_1^2 = H_2^2 = 1$. By global concavity of $H(\cdot, \cdot)$, necessarily $e_1^1 < e_1^2$ and $e_2^1 < e_2^2$. An illustration of this argument is provided in Figure 3. Since $e_1^1 < e_1^2$ and $e_2^1 < e_2^2$, $H^1 < H^2$.

Let us now study the case in which $\frac{V^{1'}}{V^{2'}} < 1$. By strict concavity of $V(\cdot)$, necessarily $H^1 > H^2$. $\frac{V^{1'}}{V^{2'}} < 1$ also implies by (6)-(9) that $H_1^1 > H_1^2$ and $H_2^1 > H_2^2$.⁷ By global concavity of $H(\cdot, \cdot)$, necessarily $e_1^1 < e_1^2$ and $e_2^1 < e_2^2$. These two inequalities imply that $H^1 < H^2$ and we have a contradiction.

Hence, either $\frac{V^{1'}}{V^{2'}} = 1$, which as we showed leads to $e_1^1 < e_1^2$, $e_2^1 < e_2^2$ and $H^1 < H^2$, or $\frac{V^{1'}}{V^{2'}} > 1$. In the latter case, strict concavity of $V(\cdot)$ implies that $H^1 < H^2$. Let us now look at the levels (e_1, e_2) that support this inequality, and show that $e_2^1 > e_2^2$ is possible.

If $\frac{V^{1'}}{V^{2'}} > 1$, from (6)-(9), it is sure that $H_2^1 < H_2^2$ but we can not infer anything about $H_1^1 \leq H_1^2$. However since $H^1 < H^2$, necessarily $H_1^1 > H_1^2$. Let us use again the graphical support in the (e_1, e_2) space. Let us fix (e_1^2, e_2^2) as the intersection between the loci defined by $H_1^2 = k$ and $H_2^2 = k'$. Let us also define the "iso human capital curve" of child 2 as $H(e_1, e_2) = H^2$. Since (e_1^1, e_2^1) is such that $H_2^1 < H_2^2$ and $H^1 < H^2$, $e_2^1 > e_2^2$ is possible.

■

⁷This case is the converse of the one illustrated in Figure 2.

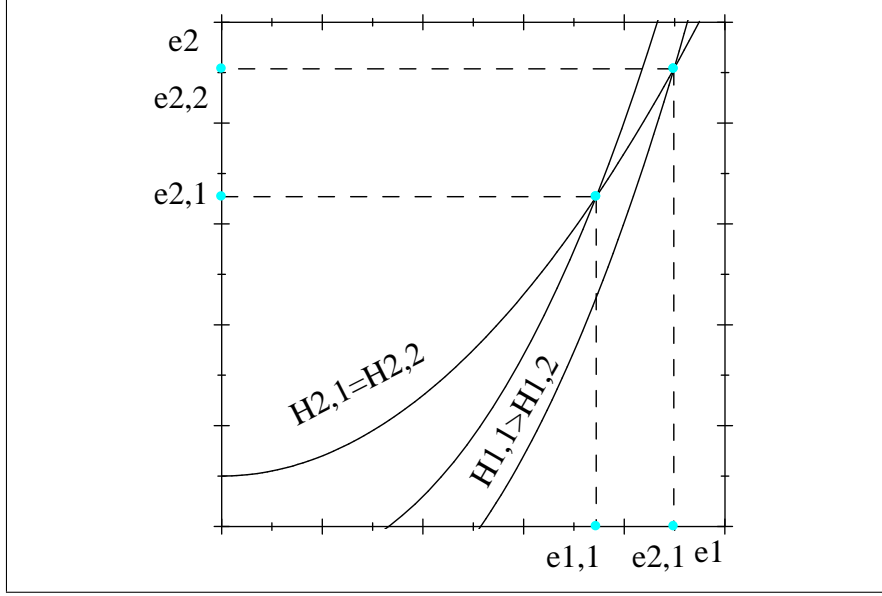


Figure 3

2.2 Extension: bequests

In this extension, we check the robustness of our result. We introduce the possibility that parents compensate children with different education levels through bequests $b^i \geq 0$ in their last period. As will be shown, the introduction of such compensatory measures does not affect our conclusions.

The consumption level of the numeraire good of child i when she becomes an adult is now denoted d^i . In the presence of bequests, $d^i = H^i + b^i$. Child i 's utility only depends on future consumption and is denoted $V(d^i)$. Notations do not vary: $V^i \equiv V(d^i)$, $V^1 \equiv \frac{\partial V(d^1)}{\partial d}$ and $V^{2'} \equiv \frac{\partial V(d^2)}{\partial d}$.

Parental utility is now denoted $\Pi(c_0, c_1, c_2, c_3, V(d^1), V(d^2))$.

Apart from choosing l_t^i for all $i \in \{1, 2\}$ and $t \in \{1, 2\}$ and s_p for $p = \{0, 1, 2\}$, parents decide in period $p = 3$ the levels of bequests they leave their children. The parental budget constraint in period 3 is now the following:

$$c_3 = y + l_2^2 - k + s_2 - b^1 - b^2.$$

The first order conditions with respect to b^1 and b^2 are respectively:

$$U'(c_3) = \beta V^{1'} \text{ and } b^1 > 0 \text{ or} \quad (16)$$

$$U'(c_3) > \beta V^{1'} \text{ and } b^1 = 0, \quad (17)$$

$$U'(c_3) = \beta V^{2'} \text{ and } b^2 > 0 \text{ or} \quad (18)$$

$$U'(c_3) > \beta V^{2'} \text{ and } b^2 = 0. \quad (19)$$

Proposition 3 *If savings are interior, then birth order does not affect schooling and child labor decisions. Children receive the same level of human capital: $H(e_1^1, e_2^1) = H(e_1^2, e_2^2)$ with $e_1^1 = e_1^2$ and $e_2^1 = e_2^2$. Bequests can be interior or at a corner, as long as they are the same for both children: $b^1 = b^2 \geq 0$.*

Proof. We need to show that under the assumptions made on the human capital technology, equations (6) to (9), (12) and (14) imply that $(e_1^1, e_2^1) = (e_1^2, e_2^2)$.⁸ First note that since s_1 and s_2 are interior, (6), (7), (8) and (9) imply that $\frac{V^{1'}}{V^{2'}} H_1^1 = \frac{V^{1'}}{V^{2'}} H_2^1 = H_1^2 = H_2^2$.

Depending on bequests levels, $\frac{V^{1'}}{V^{2'}}$ may be smaller, equal to, or greater than 1. Let us study the different possible cases depending on bequests.

If bequests are interior, then by (16) and (18), $\frac{V^{1'}}{V^{2'}} = 1$.⁹ Hence, $H_1^1 = H_2^1 = H_1^2 = H_2^2 = 1$. These equalities can be represented in the (e_1, e_2) space. The human capital technology is identical for both children. Hence showing that $H_1 = H_2 = k$, where k is a constant, admits a unique solution (e_1, e_2) is sufficient to prove that $H_1^1 = H_2^1 = H_1^2 = H_2^2 = 1$ implies $(e_1^1, e_2^1) = (e_1^2, e_2^2)$. Let us represent $H_1 = k$ and $H_2 = k$ in the (e_1, e_2) space. In this space, both these loci have positive slopes respectively equal to $-\frac{H_{11}}{H_{12}}$ and $-\frac{H_{21}}{H_{22}}$. The equation system $H_1 = H_2 = k$ has a unique solution if the loci respect the single crossing property in the (e_1, e_2) space. A sufficient condition for this property to be satisfied is that the slope of one locus is larger than the other's for all $e_1 \in [0; 1]$. This is true if and only if the assumption of global concavity of $H(\cdot, \cdot)$ holds: $H_{11}H_{22} - (H_{21})^2 > 0 \iff -\frac{H_{11}}{H_{12}} > -\frac{H_{21}}{H_{22}}$. An illustration of this argument is provided in Figure 1.

Let us now focus on the case in which at least one bequest is at a corner. Let us first consider the case where both bequests are at a corner. Note first that this implies that $d^i = H^i$. Also note that since $\frac{U'(c_3)}{\beta} > V^{1'}$ and $\frac{U'(c_3)}{\beta} > V^{2'}$, the first order conditions on bequests do not provide information to compare the values of $V^{1'}$ and $V^{2'}$. We have to study two cases: $\frac{V^{1'}}{V^{2'}} > 1$ and $\frac{V^{1'}}{V^{2'}} < 1$. The last case, $\frac{V^{1'}}{V^{2'}} = 1$ has been studied above.

Let us first study the case in which $\frac{V^{1'}}{V^{2'}} > 1$. By strict concavity of $V(\cdot)$, H^1 is necessarily smaller than H^2 . $\frac{V^{1'}}{V^{2'}} > 1$ also implies by (6)-(9) that $H_1^1 < H_1^2$ and $H_2^1 < H_2^2$. By global concavity of $H(\cdot, \cdot)$, necessarily $e_1^1 > e_1^2$ and $e_2^1 > e_2^2$.¹⁰ These two inequalities imply that $H^1 > H^2$ and we have a contradiction. The converse reasoning can be applied to the case in which $\frac{V^{1'}}{V^{2'}} < 1$ and it also results in a contradiction. Hence, when bequests are both at a corner, $\frac{V^{1'}}{V^{2'}}$ is necessarily equal to 1, which implies as proven above that $(e_1^1, e_2^1) = (e_1^2, e_2^2)$.

Let us finish by showing that the cases where one bequest is interior and the other is at a corner do not occur at the optimum. Let us consider that $b^1 > 0$ and $b^2 = 0$. This implies that $\beta V^{1'} = U'(c_3) > \beta V^{2'}$. By strict concavity of $V(\cdot)$,

⁸Since the equilibrium level of s_0 does not affect this result, we do not need to mention anything about it in the proof.

⁹Even though the point we want to make is neither linked to bequests nor to efficiency of child labor, note that as in Baland and Robinson (2000), child labor is efficient when both savings and bequests are interior. This is due to the fact that the marginal return to education in every period for every child is equal to 1, which is by definition equal to the marginal productivity of child labor.

¹⁰An illustration of this argument is provided in Figure 2.

$H^1 + b^1 < H^2$ As a consequence, $H^1 < H^2$. $\frac{V^{1'}}{V^{2'}} > 1$ also implies by (6)-(9) that $H_1^1 < H_1^2$ and $H_2^1 < H_2^2$. By global concavity of $H(\cdot, \cdot)$, necessarily $e_1^1 > e_1^2$ and $e_2^1 > e_2^2$. These two inequalities imply that $H^1 > H^2$ and we have a contradiction. The converse reasoning can be applied to the case in which $b^1 = 0$ and $b^2 > 0$ and it also results in a contradiction. ■

The reason why bequests do not play a role in this mechanism is that their role is to compensate children if they had to receive different levels of human capital. Since no discrimination takes place because of interior savings, there is no need to compensate one child. Hence it does not make any difference if bequests are available or not at parents' death.

Proposition 4 *If savings are at a corner i.e. $s_1 = 0$, then birth order affects schooling and child labor decisions. The first born child's level of human capital is always smaller than the second's: $H(e_1^1, e_2^1) < H(e_1^2, e_2^2)$. However, the allocation of (e_1^1, e_2^1) and (e_1^2, e_2^2) depends on bequests. If bequests are interior, the first born child is less educated in both periods: $e_1^1 < e_1^2$ and $e_2^1 < e_2^2$. If the bequest to the second born child is at a corner, then the first born child might receive more education in the second period than her sibling: $e_1^1 < e_1^2$ and $e_2^1 > e_2^2$.*

Proof. We need to show that under our set of assumptions, equations (6) to (9), (13) implies $H^1 < H^2$. One can easily show that the following reasoning can be applied to provide the same result with (15), and that combining both (13) and (15) reinforces the result.

From (13) and (6)-(9), $\frac{V^{1'}}{V^{2'}} H_1^1 > \frac{V^{1'}}{V^{2'}} H_2^1 = H_1^2 = H_2^2$. Once again, let us study separately the case of interior and corner bequests.

If bequests are interior, then by (16) and (18), $\frac{V^{1'}}{V^{2'}} = 1$. Hence, $H_1^1 > H_2^1 = H_1^2 = H_2^2 = 1$. By global concavity of $H(\cdot, \cdot)$, necessarily $e_1^1 < e_1^2$ and $e_2^1 < e_2^2$. An illustration of this argument is provided in Figure 3. Since $e_1^1 < e_1^2$ and $e_2^1 < e_2^2$, $H^1 < H^2$.

Let us now focus on the case in which bequests are at a corner. As shown in proof of proposition 1, we have to study two cases: $\frac{V^{1'}}{V^{2'}} > 1$ and $\frac{V^{1'}}{V^{2'}} < 1$. The last case, $\frac{V^{1'}}{V^{2'}} = 1$ has been studied above.

Let us first study the case in which $\frac{V^{1'}}{V^{2'}} < 1$. By strict concavity of $V(\cdot)$, necessarily $H^1 > H^2$. $\frac{V^{1'}}{V^{2'}} < 1$ also implies by (6)-(9) that $H_1^1 > H_1^2$ and $H_2^1 > H_2^2$.¹¹ By global concavity of $H(\cdot, \cdot)$, necessarily $e_1^1 < e_1^2$ and $e_2^1 < e_2^2$. These two inequalities imply that $H^1 < H^2$ and we have a contradiction.

Hence, either $\frac{V^{1'}}{V^{2'}} = 1$, which as we showed leads to $e_1^1 < e_1^2$, $e_2^1 < e_2^2$ and $H^1 < H^2$, or $\frac{V^{1'}}{V^{2'}} > 1$. By strict concavity of $V(\cdot)$, $H^1 < H^2$. Let us now look at the levels (e_1, e_2) that support this inequality, and show that $e_2^1 > e_2^2$ is possible.

If $\frac{V^{1'}}{V^{2'}} > 1$, from (6)-(9), it is sure that $H_2^1 < H_2^2$ but we can not infer anything about $H_1^1 \leq H_1^2$. However since $H^1 < H^2$, necessarily $H_1^1 > H_1^2$. Let us use again the graphical support in the (e_1, e_2) space. Let us fix (e_1^2, e_2^2) as the intersection between the loci defined by $H_1^2 = k$ and $H_2^2 = k'$. Let us also define the "iso human capital curve" of child 2 as $H(e_1, e_2) = H^2$. Since (e_1^1, e_2^1) is such that $H_2^1 < H_2^2$ and $H^1 < H^2$, $e_2^1 > e_2^2$ is possible.

¹¹This case is the converse of the one illustrated in Figure 2.

Let us show that the case where the first child does not receive any bequest while the second one does is not optimal. If $b^1 = 0$ and $b^2 > 0$, $\beta V^{1'} < U'(c_3) = \beta V^{2'}$. By strict concavity of $V(\cdot)$, $H^1 > H^2 + b^2$. As a consequence, $H^1 > H^2$. $\frac{V^{1'}}{V^{2'}} < 1$ also implies by (6)-(9) that $H_1^1 > H_1^2$ and $H_2^1 > H_2^2$. By global concavity of $H(\cdot, \cdot)$, necessarily $e_1^1 < e_1^2$ and $e_2^1 < e_2^2$. These two inequalities imply that $H^1 < H^2$ and we have a contradiction.

Finally, let us show that the case where the first child receives a strictly positive bequest while the second one does not yields the same type of outcome as the. If $b^1 > 0$ and $b^2 = 0$, $\beta V^{1'} = U'(c_3) > \beta V^{2'}$. By strict concavity of $V(\cdot)$, $H^1 + b^1 < H^2$. As a consequence, $H^1 < H^2$. Note that this case is similar to the one where both bequests are at a corner and $\frac{V^{1'}}{V^{2'}} > 1$. Hence the end of the proof is identical to the one of this latter case. ■

3 The data and the empirical model

3.1 The data

We use data from the second Survey on Cameroonian Households (SCH) conducted in 2001. It includes an extensive household questionnaire. The survey was part of the "Poverty data improvement" component of a partnership project for growth and poverty reduction established between Cameroon and the World Bank. It consists of nearly 11,000 urban and rural households drawn to form a representative sample of the whole country.

The survey gathers information over about 57,000 individuals. We focus on those who are aged between 6 and 18 years old and are living in household where the eldest child is 18. This subsample consists of 6,452 individuals from about 2,560 households.

It is important to recognize that because the data used here is based on a household survey, it may not take into account the fact that some children may no longer live with their parents. 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, while the national median is around 2.5¹². This suggests that the information we use to construct our birth order measures is reasonably cleaned of measurement errors due to the phenomenon of migrating children. 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 on a subsample where households did not face migratory flows over the last 5 years.

We use three different measures of the order of birth. The first one is the absolute birth order (Horton, 1988) [?]. The value for the absolute birth order of the firstborn child is one, that of the second-child is 2 and so forth. Most of the variation in this measure is due to larger families. The second measure is the relative birth order (Behrman, 1988) [2]. 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

¹²From the Demographic and Health Survey of 2004.

number of children.¹³ The relative birth order for a given child can be interpreted as the share of elder siblings he/she has in the household.

The third measure of birth order is a set of dummy variables. We use a set of dummy variables: one for the firstborn, one for the second-born and a third one for the third-born. We use only three dummy variables because the birth order of only 13% of children in the sample is higher or equal to 4.

Most children below 18 are at school. They are still in the process of accumulating human capital and we do not know what would be their final educational attainment in the future. Hence the current level of education is not a suitable indicator of the human capital of these children. The dependant variable in our regression will instead be a standardized education level ("z-score"). This standardized education score of a child is defined as

$$z - score = \frac{EL - M(EL|age)}{IQI(EL|age)},$$

where EL is the current education level (measured by the number of completed years of education) of this child, $M(EL|age)$ is the median educational level of children of the same age in the sample and $IQI(EL|age)$ is the interquartile interval of the education levels of children of that age. The z-score expresses the divergence of the education level of a child from the median education level of children of his age, standardized by a spread measure.¹⁴

The main prediction of Section 2 is that in poor households, firstborn children have reached a smaller education level compared to later-borns, while this discrimination does not occur in wealthier households. For the reasons mentioned above, we will make use of the educational z-score to test this prediction. Table 3.1 gives a first indicator backing the latter up. It presents the average z-scores of children from poor and non-poor households by birth order.¹⁵¹⁶ It indicates that on average, in poor families, being among the earlier born children seems to strongly deteriorate their education level (relative to the median of their age), while fourth borns and later borns do not seem to suffer this comparison anymore. 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 families appear to have significantly the same education

¹³This definition is more interesting because it is not sensitive to the number of children, which may be an issue as long as the latter is considered endogenous. Birth order, or sibling composition, is the realization of parent's fertility decision and is likely to be correlated with unobserved characteristics of the households. Indeed parents decisions on fertility, education and child labor are simultaneously determined through a dynamic structure (Cigno & Rosati (2000), Baland & Robinson (2000)). In particular, Ejrnaes & Pörtner (2004) study the impact of birth order on schooling focusing on the endogeneity of fertility choices.

¹⁴A more common definition of the Z-score is the diversion of the variable of interest from its conditional mean, standardized by its conditional standard error. The reason why we use this alternative definition is linked to the problem of extreme values, which is potentially present for the variable of interest in our sample. Both the median and the interquartile interval are less sensitive to this problem than respectively the mean and the standard error.

¹⁵A household is considered as "poor" if it is living below the country's poverty line.

¹⁶This table 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 .

level as their median.

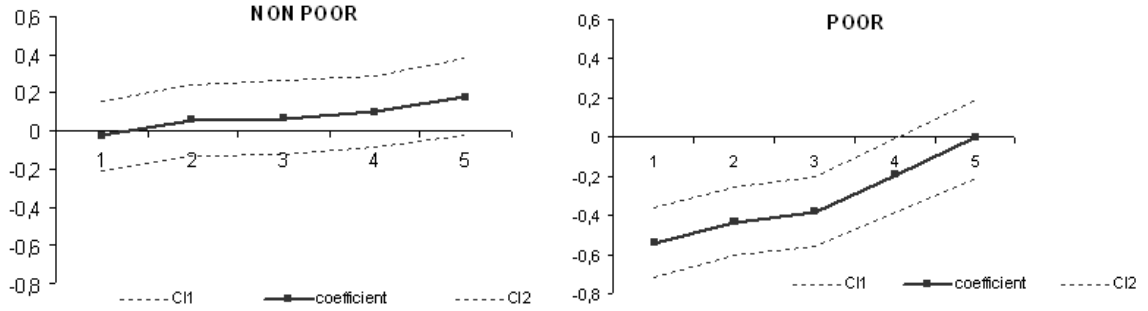


Table 1: Average educational z-scores by household wealth and absolute birth order.

To conclude this subsection, some relevant descriptive statistics of our sample are displayed in table 2.¹⁷

Variable	Mean	Std. Dev.	Min.	Max.	N
Absolute Birth Order	2.1	1.2	1	8	6452
Relative Birth Order	0.33	0.34	0	1	6452
Age	10.71	3.47	6	18	6452
Gender (Male=1)	0.51				6452
Education (years)	3.31	2.9	0	14	6452
Grade retention (years)	2.39	2.48	-8	13	6452
Z-score	0.02	0.75	-2	4.5	6452
Firstborn (firstborn=1)	0.4				6452
Second born (Second born=1)	0.3				6452
Third born (Third born=1)	0.17				6452
Number of juniors	2.3	1.66	0	12	6452
Household characteristics					
Number of children	3.77	1.62	2	13	2560
Expenditures p. cap. (100,000 CFA)	3.03	4.73	0.18	171.05	2560
Est. Exp. p. cap. (100,000 CFA)	3.62	2.84	-6.55	14.78	2546
Wealth (POOR=1)	0.35				2560

Table 2: descriptive statistics

As can be noticed on the first line of table 2, 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

¹⁷The 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.

first and second born children (respectively 0.4 and 0.3): earlier born children are over-represented in the 6-18 interval. In the latter, the average age is 10.7, with a standard deviation of around 3.5. This suggests that the oldest children in the sample are under-represented, which might cause some worries about the fact that some older children may have already left the household. This concern, which has already been addressed in the previous subsection, will be taken care of in a robustness check in which we use a subsample where households did not face migratory flows over the last 5 years.. The number of completed years of education is comprised between 0 and 14, with an average of 3.3 and a standard deviation of 2.9. The grade retention variable is a number of years that represents the difference between the education level a child should have reached given his age and the effective level he has reached. One can interpret this in the following way: on average, children in the sample have failed 2.4 years of education. The number of juniors also encompasses the siblings below 6 years of age, with an average of 2.3. The largest household comprises 13 children, the average 3.8. The data on expenditures per capita (in 100 000 CFA) is built by gathering all the household's annual expenditures (housing, food, health care,...) and dividing it by the number of people living inside it. Due to the usual endogeneity of household income, we use the estimated expenditures per capita.¹⁸ Table 2 also provides the descriptive statistics of the fitted values of this first stage regression. Finally, on the basis on the poverty line criterion, our sample is composed of 35% of poor households.

3.2 The empirical model

The specification is based on the following fixed effect model:

$$E_{i,j} = BO_{i,j}\alpha + BO_{i,j}HW_{i,j}\beta + C_{i,j}\gamma + \mu_j + \varepsilon_{i,j},$$

where $E_{i,j}$ is the education level of child i in household j , $BO_{i,j}$ is his birth order, HW_j is household j 's wealth and $C_{i,j}$ are control variables. As already mentioned, we will make use of the education z-score as our measure of the education level. Birth order will be alternatively represented by means of the 3 measures mentioned above: absolute, relative birth order, and dummies for the first, second and third born. We also use alternative measures of wealth: estimated expenditures per capita, value of land owned, housing expenditures,.... The control variables we use are the child's age, gender and number of younger siblings.

Note that since μ_j is a household-specific fixed effect, the model takes account of household heterogeneity. Since the estimation technique is based on the deviations of all variables from their household means, all household-invariant variables C_j , such as parental education and professional activity, living area,... would be wiped out in the regression. This is however not an issue here since we are only interested in the estimation of the birth order effect.

The tests we need to run to check our model's predictions are the following:

¹⁸We regress actual values on a large set of instruments, including parental activities, asset ownership, parental education, regional dummies,...

1. In "poor" households (that are credit-constrained), the elder children end up with a relatively lower level of human capital.^{19,20}

$$H_0 : \alpha > 0 \quad H_A : \alpha = 0$$

2. "Rich" households do not discriminate between their children on the basis of birth order, everybody has the same human capital level. This implies first that the interaction effect between birth order and household wealth has an opposite sign.

$$H_0 : \beta < 0 \quad H_A : \beta = 0$$

4 Empirical results

We studied the role of the order of birth on children's educational attainments at a given age. We present here the most important results, based on regressions using the three distinct birth order measures we discussed. In each of them, we are able to confirm the predictions of our theoretical model. The regression results are displayed in table 3 and 4.

	Zscore		Zscore
Absolute BO	0,105 (3,50)***	Rel BO	0,399 (2,98)***
Abs. BO * HW	-0,085 (6,55)***	Rel BO * HW	-0,195 (3,85)***
Gender (Male=1)	0,111 (2,96)***		0,045 (1,73)*
Age	-0,057 (8,16)***		-0,036 (6,53)***
Constant	0,743 (6,52)***		0,402 (5,37)***
‡ Observations	6412		6412
‡ Households	2546		2546

Table 3: Regressions with the absolute and relative BO.

Before commenting on the regressions with the absolute and relative birth order measures represented in table 3, note that the household wealth variable has been treated so that HW equals zero for the poorest household. By so doing, one can interpret the partial effect of the birth order variable as its effect on the poorest household. Let us now turn to the interpretation of the result.

Firstly, the coefficient on birth order is significantly positive. This means that at a given age, the later a child is born in a poor household, the better will be his education level (relative to the median level of children of the same age). Secondly, the coefficient on the interaction term between birth order and household wealth is negative. This means that the total effect of birth order decreases with the

¹⁹Note that we treated our data on household wealth so that the value of HW is zero for the poorest household.

²⁰Also note that birth order variable has to be interpreted in the same spirit as the absolute or relative birth order measure: the larger, the later the child is born compared to his siblings.

household's wealth. Since HW equals 4.2 for the richest household, one can easily see that for a sufficiently rich household, being among the earlier born children no longer implies a poorer education level. It may even imply a relatively better education level. Also note that boys have a relatively higher education level than girls.

Let us now turn to table 4, in which we used the birth order dummies.

	Zscore
Firstborn (firstborn=1)	-0,342**
Second born (Second born=1)	-0,278**
Third born (Third born=1)	-0,004
Firstborn * Wealth	0,221***
Second born * Wealth	0,17***
Firstborn * Gender	0,135**
Second born * Gender	0,098*
Third born * Gender	0,013
Number of junior siblings	0,029
Gender (Male=1)	-0,068
Age	-0,058***
Constant	0,511***
Observations	6412
Number of households	2546
Table 4: Regression with the BO dummies.	

At a given age, first and second born children in poor household appear to have a significantly lower level of education. This effect disappears for sufficiently high household wealth levels. Note that in this regression, we also used an interaction term between birth order and gender. This teaches us that the gender bias appears to be significant only for the first and second born, and disappears for later born children.

5 Concluding remarks

References

- [1] P. H. BASU, K. & VAN. The economics of child labor. *The American Economic Review* **88** (3), 412–427 (1998).
- [2] J. R. BEHRMAN. Nutrition, health, birth order and seasonality : Intra-household allocation among children in rural india. *Journal of Development Economics* **28**(1), 43–62 (February 1988).
- [3] J. R. BEHRMAN AND P. TAUBMAN. Birth order, schooling, and earnings. *Journal of Labor Economics* **4**(3), S121–45 (July 1986).
- [4] S. CANAGARAJAH AND H. COULOMBE. Child labor and schooling in ghana. (1844) (Nov. 1997).
- [5] R. F. CIGNO A. Why do indian children work, and is it bad for them? *IZA DP* **115** (2000).
- [6] E. EDMONDS. Understanding sibling differences in child labor. *Forthcoming in Journal of Population Economics* **4** (2006).
- [7] M. EJRNÆS AND C. C. PÖRTNER. Birth order and the intrahousehold allocation of time and education. *The review of Economics and Statistics* **86**(4), 1008–1019. (2004).
- [8] P. M. EMERSON AND A. P. SOUZA. Birth order, child labor and school attendance in brazil. (0212) (May 2002).
- [9] M. FAFCHAMPS AND J. WAHBA. Child labour, urban proximity, and household composition. *Journal of Development Economics* **79** (2), 374–397 (2006).
- [10] S. HORTON. Birth order and child nutritional status: Evidence from the philippines. *Economic Development and Cultural Change* **36**(2), 341–54 (January 1988).
- [11] D. LEVISON, K. S. MOE, AND F. MARIE KNAUL. Youth education and work in mexico. *World Development* **29**(1), 167–188 (January 2001).