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The First Born Burden[*]

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Abstract

Being the first born of a family entails inherent responsibilities. Sociologists, psychologists and economists have long argued that the first born's receive differentiated treatment within the household. This paper tests and quantifies the existence of a disproportionate workload over the oldest child in poor households: we call it *the first born burden*. We are concerned with the determinants of such work burden, and we analyze how access to basic infrastructure could release children from work. The empirical results for rural areas in Ghana confirm a systematic selection of first born's to work. Although access to infrastructure may not reallocate evenly the workload among siblings, it indeed relaxes the children's time constraints.

JEL classification: J22, D13, J1
Keywords: child labor, time allocation, birth order, infrastructure, water

1 Motivation

Parents wish the best to their children. Psychologists argue that the first born child of a family is especially endowed with more care than her following siblings. This is because the siblings are meant to share attention and resources from their very first day, unlike the first born. These would reflect into higher intellectual achievements and higher future success of first born's over higher birth-order siblings. We argue that being the first born child, however, entails particular responsibilities. The first born is often expected to carry on the family's name, traditions and reputation. Being the first born in a wealthy or in a poor family defines different nature of responsibilities. In a wealthy family, the first child is expected to fulfill longer run parents' aspirations on academic, personal and/or professional lives. Being the first born in a poor family entails more immediate responsibilities, such

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as caring for younger siblings, seeking for their education, complementing the parents earnings (sometimes being the breadwinner himself), and sharing responsibility for the family's financial debts and social duties.

From the parents' perspective, raising an additional kid is often an activity with diminishing marginal costs. This is specially true if the per capita investment in kids by their parents is anyways low. Nevertheless the cost exists, and household per capita income decreases with additional children in the family. During early ages, a child is often unable to contribute with an increase in the household income. Her productivity grows naturally with physical improvements over time (body size, strength, health) and it is boosted by human capital accumulation. In rural areas of the developing world, access to education is costly despite free basic education. In the mid 1990's, for instance, several Sub-Saharan African countries abolished primary school fees. Expenses for school supplies, uniforms, meals and transportation, however, remain under the parents' responsibility. Intense poverty, lack of job opportunity and high costs of education contribute to a high trade off between education and child work. The opportunity cost of education is magnified when parents see their households on poverty, and children may be called for some productive work contribution despite their still low productivity.

Poor household infrastructure often overloads women with household chores. An additional household member increases even more the total household work burden. Where time constraint of parents is binding, an additional household member may be needed to participate in the household production. In the intrahousehold labor division, there is empirical evidence that the additional member selected is often the first born child.[1] It is also noted a gender component on the household decision of workload allocation among children: Boys are usually assigned to follow the father's activity, while girls would be in charge of helping the mother with housework. This systematic selection also reflects a cultural component. In several developing countries, such as Ghana, children - especially girls - build their value as good future wives as much as they well learn the household chores since childhood. Children are appreciated as they learn from early ages how to perform non complex tasks at home, help the parents on the household activities including productive and traditional ones. If a child, especially girl, is unable to perform domestic work, she is regarded by family and communities as a 'lazy' or 'unhealthy' kid. Child work may therefore be enforced by social rules since early ages.

[1] To back up this reference, I refer to quotes from ordinary households in Benin and Ethiopia, documented in the video "The Call of Africa - Miraculous Water". There, households confidently explain why in their communities it so important to have their first-born's working on the family's profession instead of letting them attend school.

The primary economic impact of having a child to work is directly related to a deficient human capital accumulation (Psacharopoulos, 1997). It is scientifically demonstrated that the early ages of learning are the most productive and important for human development. No returns to work during childhood are able to compensate the future potential gains from education. The economic cost becomes even higher depending on the nature of the child work. Physically intense activities damage health, causing long term physical consequences and diminished future earnings. In a context of culturally supported child work, the only space for intervention is in the nature of the child activities. Assuring that children have access to school and to basic infrastructure may relax their time constraint and ease the nature the work burden.

It is important to distinguish two terms which are often referred to in the literature at different meanings. The UNICEF defines child labor as the productive work exploiting children's labor force at exceeding certain amounts of hours defined by age, and at unacceptable conditions such as slavery, hazardous activities, etc. Child work is often referred in the literature as any productive activity performed by a child, which does not affect negatively her health, development or accumulation of education. To our understanding it is, however, difficult to identify a child work which does not affect her stock of education. We understand that work and schooling are substitute activities on the time allocation perspective. In this paper we then adopt the terminology child work for any activity but education or leisure which is performed by a child and produces utility to the household.

This paper explores the existence of a *first born burden* in rural areas of Ghana. Using the Ghana Living Standard Survey (Round 4), we first analyze the the time allocation of children between paid and unpaid activities, testing the existence of a disproportionate burden on the first born child. Furthermore, we investigate the households' access to basic infrastructure and its role on releasing first born children from domestic chores of fetching water and collecting firewood, regarding the child's time use patterns.

The paper is organized as follows. Section 2 briefly reviews the literature on child work and its economic impacts. Section 3 presents a theoretical framework for the household decision regarding time allocation of household members between work activities and education. Data is presented in Section 4 and the empirical methods in Section 5, respectively. Section 6 reports the results divided in two parts: Subsection 6.1 tests the first born burden hypothesis by investigating the distribution of workload and the burden on the first born. Subsection 6.2 analyzes the effect of infrastructure on relaxing the children from work. oncluding remarks are offered in Section 7.

2 Child labor and birth order discrimination

Child achievements by birth order have long been studied in the psychology and sociology literatures. Authors argue for significant higher ability of first born's in test performance and IQ tests. They developed methods to evaluate both outcomes and resource allocations, following two hypotheses: better performance and IQ are associated to biological advantages of the first born, or household resources allocation benefit the earlier born (Chittenden et al., 1968; Rodgers, 2001; Rodgers et al.,2000; Downey, 2001).

In a positive effect perspective, the literature on birth-order has already focused on nutritional allocation and intellectual achievements of children depending on the birth order (Horton, 1988; Rodgers et al., 2000). Birdsall (1991) shows that in urban Colombia, in families where the mother does not work, the first and last-born children have an advantage in the allocation of parents time and resources compared to other order siblings. Although her analysis focuses an urban context and positive selectivity, it is important on supporting evidence that systematic child discrimination within the household in fact exists.

The economic development literature raised also a concurrent perspective: when households are forced by poverty or shocks to make extreme decisions, the earlier born's are the first children to be sacrificed. In the context of intra-household production, child labor is a function of selection by birth order, for several reasons. (Behrman and Taubman, 1986; Kessler, 1991).

Child work, therefore, comes in close relationship with birth order discrimination. In budget stressed households, when a child is selected among their siblings, this is often to perform responsibilities which comprise fully or partially some productive work. If the child's time constraint is binding, she is then required to rellocate time from leisure or school, with inevitable consequences on human capital accumulation and future expected earnings (Psacharopoulos, 1997; Emerson and Souza, 2008; Emerson and Souza, 2007). The adverse consequences of child labor, however, are mostly perceived in the long run.

Few studies have explored the existence of birth order selection on the work/education trade off. Emerson and Souza (2008) examine the negative effects of birth order on intra-household allocations in Brazil. They find that first born's are less likely to attend school, while later siblings are less likely to perform child labor. Using a probability model they show that first born's are less likely to attend school, while later siblings are less likely to perform child labor. Their study lacks however an investigation on what causes different intensities of child labor.

To best of our knowledge no studies have explored the relationship between infrastructure and child labor. Our paper is concerned with the existence of a systematic household selectivity regarding child labor, and the effect of access to infrastructure on releasing the first born from that work burden. Our study differs from the existing in three aspects: First, it targets specifically households in rural areas; second, it allows different sources of income constraint to shape the intra-household optimal decision on time allocation; finally, it analyzes the direct effect of basic infrastructure on the amount of hours spent by children in working activities.

In order to build our theoretical model and test it empirically, it is fundamental to set the scene: we analyze families in the context of rural in Ghana, where rational decisions are made in the short run and based on subsistence necessities. Despite traditional and cultural roles of children in the economic and social production of households, the government of Ghana is aware of overwhelmed work bear by some children. It has placed efforts on recognizing the problem of child labor and has ratified the Convention on the Rights of the Child in the 1990 World Summit for Children. In 1992, the Ghanaian government has launched a national program to discourage child labor. Child labor, however, is highly incident in Ghana, as we may see in the following pages.

3 The Home Production

Our household production model is based on a "time use portfolio". The household employs time for producing the goods consumed, following a Becker (1965) household production approach. The consumption of market purchased goods (c^m) is an increasing function of the time spent on paid activities (t^p). Agricultural goods consumption (c^a) requires time spent cultivating one own's plot, or someone else's usually for monetary return (t^p). The consumption of domestic goods (c^d) such as cooking, cleaning, washing clothes, etc. is increasing in the hours spent on housework production - which is usually an unpaid work (t^{un}). Water (c^w) and cooking fuel (c^f) consumption are increasing in the time spent on fetching those natural resources (t^w, t^f) in this rural communities setting. The aggregate household consumption (C_H) is given by the household's total productive time inputs, the ability of household members to transform time in consumption goods (X), and a vector of technology parameters (τ) available to the household, which makes this transformation more efficient. We assume there is no credit market and production and consumption occur within the same period, apart from investment in education, as will be discussed ahead.

$$\begin{aligned} C_H &= \sum_{i=1}^{n} c_i^m + c_i^d + c_i^a + c_i^w + c_i^f \\ &= \sum_{i=1}^{n} g_i(t^p, t^{un}, t^w, t^f, X; \tau) \end{aligned} \quad (1)$$

Each household member i is endowed with some amount T_i of time, which is the same across households and household members - 24 hours per day per individual. Time is optimally allocated into working activities (t_i^j) and free time (t_i^l), where the latter includes time for leisure and for learning (accumulation of human capital, or stock of education)[2].

$$T_i = \sum_j t_i^j + t_i^l \quad \forall j = p, un, w, f \quad (2)$$

We follow Edmonds (2006) in defining L as the sum of the returns to education across children in the household, interpreted as the present value of future consumption determined by the returns to hours of education (or learning) accumulated by the children. We consider that the stock of education of adults constant over time, and that learning (education) has decreasing marginal returns.

$$L = \sum_i^n R_i(t_i^l) \quad (3)$$

Household members differ in the wage commandment over a unit of time, i.e. the monetary compensation per time unit of labor. This is determined by individual characteristics (age, body size), social capabilities driven by traditional roles (gender, religion, ethnic group), and the accumulated stock of education. Education therefore enters the production function of each individual in two forms: contemporaneously, it decreases the time available to other activities - a substitution effect. On the other hand, the present value of education accumulated in previous periods augments the overall individual's productivity. Thus education enters the vector $X_i = (age, gender, religion, ethnicity, education)$ of individual characteristics affecting the wage commandment over the unit of time.

[2] We assume that all free time of a child represents some learning opportunity, more productive, of course, if the child attends school.

Poverty is characterized by the low ability of adult members to generate enough income able to provide all household members with consumption above the subsistence level (s). This inability appears either as a time constraint or as a capacity constraint. In time constrained households the wage commandment of adults despite full employment is rather low, and the monetary equivalent of all their time endowments is not enough to bring all household members to the subsistence consumption level. In capacity constrained households, adults are not fully employed in productive activities perhaps due to a lack of job opportunities or barriers to work, such as sickness, language, or simply lack of ability. In both cases, poverty is considered in a unidimensional, income approach, and households are classified as *poor* if: [3]

$$\frac{C_H}{n} < s \tag{4}$$

where n is the number of household members.

We assume the household is a unitary decision maker. It maximizes utility of all household members collectively. The utility maximization problem reveals the optimal distribution of labor (t_i^{j*}) to each individual, and the optimal time devoted to learning (or leisure, if one prefers) - t_i^{l*}. The household decision is constrained by the total time available to the household and the subsistence constraint.

$$\begin{aligned} max_{t_i^j, t_i^l} \quad & U_H(C_H, L) = u(t_i^j, t_i^l, X_i; \tau) \\ s.t. \quad & T_H = \sum_{i=1}^{n} t_i^j + t_i^l \\ & C_H \leq \sum_{i=1}^{n} g_i(t_i^j, X_i; \tau) \\ & C_H \geq ns \end{aligned} \tag{5}$$

where $j \in \{p, un, w, f\}$, $i = 1, ..., n$. H denotes the household aggregate.

Our model allows two possible equilibria depending on the nature of the household income constraint. The strongest assumption is that parents are altruistic and minimize the amount of labor allocated to their children, nevertheless keeping the household production (and consumption) at the subsistence level. The altruistic assumption leads to the first-best outcome: no child labor in non-poor households, child labor in poor households (just enough to bring the average consumption up to the subsistence level).

[3]We acknowledge the important growing literature on the multidimensional features of poverty and related literature on consumption smoothing by sharing. We adopt this limited income approach here for sake of a cleaner model.

The *non-poor household* equilibrium is trivial, straight from the altruistic assumption. The *poor household* equilibrium occur under two different settings: (i) time constrained poor households - child labor appears when households have exhausted all adult labor supply; (ii) capacity constrained households - child labor appears when adults are unable to increase earnings given their low productivity.[4] The next subsections derive the comparative statics for the *poor households*' equilibria, and the effect of infrastructure on the household's labor time allocation.

3.1 Child labor in time constrained households

In time constrained households, the labor force of adults is not enough to provide subsistence to all household members. From a household production perspective, child becomes a necessary additional labor force for the household survival (Baland and Robinson, 2000; Basu and Van, 1998; Grotaert and Patrinos, 1999). The equilibrium time allocation among the household members with positive child labor involves a trade off between the household's current consumption and a lower future expected consumption. This is because child labor competes with the current time devoted to learning, and thus one may expect a lower wage commandment of this child in the future, due to her lower stock of education. The equilibrium time allocation of household members calls for a positive amount of child labor when the marginal rate of substitution between consumption today and future household consumption is equal to the the child's present marginal rate of transformation between the time devoted to labor and the time devoted to learning.

$$\begin{aligned} MRS_{C_H,L} &= MRT_{t_i^j,t_i^l} \\ \frac{\partial U_H(t^j,t^l;\tau)/\partial C_H}{\partial U_H(t^j,t^l;\tau)/\partial L} &= \frac{\partial R(t_i^l)/\partial t_i^l}{\partial g_i(t^j,X;\tau)/\partial t_i^j} \end{aligned} \tag{6}$$

Our model also allows different returns to gender, age and education. Because household members have distinct characteristics, the marginal product of labor is also expected to vary across individuals. The amount of time spent on each activity will therefore depend on each individual's characteristics and wage commandment. In a household with more than one child, children are optimally selected for doing amounts of each type of work activities (domestic work, fetching water, fetching firewood, work for payment,

[4]We observe, however, that in developing countries, especially, children in non-poor households frequently perform some kind of work activity. This may occur when parents judge important that kids are introduced to work tasks as part of their education, hence increasing the utility of households. In our model this would be a 'weak equilibrium', in the sense that it requires our altruistic assumption to be relaxed or slightly modified.

learning) depending on their marginal rate of transformation.

The concept of the "first born burden" arises from the fact that the household optimal solution will often point out to a selection of the first born for bearing the highest workload among the children. This is because often the oldest child is able to command the highest wages among the siblings, given her higher age and (likely) higher accumulated stock of education. In addition, given decreasing marginal returns to education, it is expected that the marginal returns of the oldest children are lower than those of younger siblings. It must be then optimal for the household, ceteris paribus, to have the oldest child decreasing time allocated to education rather than the younger siblings, as the marginal rate of transformation between learning and labor is lower among the siblings.

This result is in line with Horowitz & Wang (2004) who show empirical links between child labor and birth order where families choose to send to the labor market first the children who could command higher wages. We note that the education effect can be offset by other individual characteristics of the child, such as gender and social norms, which may play higher role in the parents choice in certain cultural environments. For this reason we may want to control for several individual characteristics.

3.2 Child labor in capacity constrained households

In poor households with not fully employed adults, the equilibrium time allocation reveals always a positive amount of child labor. The utility of the household from increasing child work is larger than the utility of the household from increasing the adult's working hours. In such capacity constrained households increasing adult labor force may be very costly, when not impossible.

From Equation 6 we recall that, in equilibrium, $MRS_{C_H,L} = MRT_{t_i^j,t_i^l}$. The equilibrium child work in capacity constrained households solves for a positive child work when the the marginal rate of transformation of the child is greater or equal to the adult's marginal rate of transformation between labor and education. For example, suppose $MRT^a_{t_i^j,t_i^l} = MC^a_C/MC^a_L = 4/1$, i.e. the adult produces 4 units of consumption for each unit of education. Suppose the child's $MRT^c_{t_i^j,t_i^l} = MC^c_C/MC^c_L = 2/1$, i.e. one additional unit of education costs only the forgone production of 2 units of consumption good. In this case, the household maximizing utility would denote the child specialized in acquiring education while the adult would occupy itself in earning from labor. When education becomes relatively more expensive for the child than for the adult (the marginal rates of transformation are the same, and start reversing), then it would optimal for the household to allocate more of the child's time into productive work than that of the adult's. From the point when the marginal rates of transformation are the same and reverse, having the child a higher MRT, than it becomes more efficient to the household that the child will allocate more time to labor instead of the adult. The equilibrium time allocations are defined from:

$$\begin{aligned} MRT^{adult}_{t_i^j,t_i^l} &\leq MRT^{child}_{t_i^j,t_i^l} \\ \frac{\partial R(t^l_{adult})/\partial t^l_{adult}}{\partial g_{adult}(t^j,X;\tau)/\partial t^j_{adult}} &\leq \frac{\partial R(t^l_{child})/\partial t^l_{child}}{\partial g_{child}(t^j,X;\tau)/\partial t^j_{child}} \end{aligned} \tag{7}$$

Our simplification assumption in equation 3 that the adults' stock of education is constant over time implies that the left hand side on equation 7 is zero. Thus, in capacity-constrained poor households (with per capita income below the subsistence level) child labor will always occur because $\partial R(t^l_{child})/\partial t^l_{child} = 0$. Since the $MRS_{C_H,L}$ is constant for the household (does not vary across household members), the optimal time allocation of children among activities is determined by the marginal rate of substitution between current consumption and learning, respecting the subsistence constraint. This goes back to the solution as in the time-constrained poor household, as in Equation 6.

Let us relax the assumption of constant adult stock of education and allow adult household members to accumulate learning. Let us also assume that the capacity constrain is not binding, i.e. the marginal product of adults' time although small is slightly larger than zero. Assuming that marginal returns to education are non negative, the left hand side in equation 7 is greater than zero. The equilibrium with child labor appears when inequality in equation 7 holds.[5]. Another interpretation is: the optimal amount of child labor is given when the ratio of marginal product of time between adult and child is greater than the ratio of returns to education between adult and child:

$$\frac{\partial R(t^l_{adult})/\partial t^l_{adult}}{\partial R(t^l_{child})/\partial t^l_{child}} < \frac{\partial g_{adult}(t^j,X;\tau)/\partial t^j_{adult}}{\partial g_{child}(t^j,X;\tau)/\partial t^j_{child}} \tag{8}$$

Thus, the household's marginal rate of substitution between present consumption and future welfare is equal to the ratio of marginal products of the

[5]From the altruistic parent assumption, children will not work when equality holds for equation 7

adults and the children. Allowing differences in individual characteristics of children, the first born's are again most likely to perform a higher amount of work, as their MRT is more likely to equal that of the adults before than their his younger siblings'.

Emerson and Souza (2008) show empirically that "parents who were child laborers command lower wages and are more likely to demand their children work to supplement the family income". This confirms an inter generation transmission of the burden as predicted in our model. Children in capacity constrained households are more likely to perform child labor and sacrifice education accumulation, which leads to future lower wage commandment and perpetuation of the work burden toward their own children.

3.3 Child labor in the context of improved technology

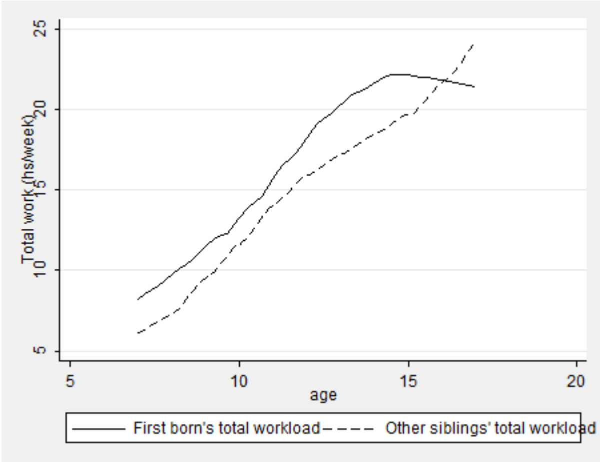
Access to basic infrastructure, such as piped water, improved cooking fuel, electricity, public lighting, roads, etc. contribute to transforming the household production function into more efficient. For instance, considerable less time is required to produce water or to prepare food when households do not need to fetch natural resources. Electricity enables productive activities to emerge, such as small businesses (e.g barber and hair saloons), and allow longer hours of business operations. It also allows longer hours for the household to do the domestic chores. If on one hand basic infrastructure may allow households to produce more by consuming fewer time, it also allows newer activities to take place, which will increase the possibility of longer hours of work. The ultimate effect of infrastructure on the optimal household time allocation is thus an empirical matter. In any case, we expect that the household marginal utility is increasing with access to technology, as the household production becomes more efficient.

$$\frac{\partial U_H(t^j, t^l; \tau)}{\partial \tau} \geq 0 \tag{9}$$

4 Data

The empirical analysis uses the Ghana Living Standards Survey (Round 4). This is a representative time use survey collected in Ghana during 1998/99. We focus the analysis in rural areas for two reasons. First, the trade off between home production and education is more evident in rural areas than in urban settings. Secondly, access to basic infrastructure varies significantly more within rural areas, what would allow us to better identify the effects of infrastructure on our outcome variables. The rural sample spans 190 rural communities in three main ecological zones: rural coastal, rural forest and

Figure 1: Birth order and work burden along the childhood



Note: Kernel-weighted local polynomial regression. GLSS4, sample children 7-17 years old.

rural savannah.

The sample consists of 3,799 households, where 5,456 children are aged 7-17 (30.7% of them are first-born's). The profile of child work reflects 84.2% of children doing some kind of work: 83.5% do unpaid, 7.88% are engaged in paid activities, 63.8% fetch water, and 31.2% fetch wood. Performing more than one activity is common among those children.

Table 4 shows some summary statistics of the data. The survey records for every household member above age 6 the amount of hours in the previous seven days spent on detailed activities. We classify unpaid work as the sum of hours spent on activities as fetching water, fetching wood, ironing clothes, sweeping, depositing garbage, cooking, shopping for the household, taking care of children, running errands, washing dishes, washing vehicles, and running other domestic chores. Paid work consists of the amount of hours spent on any productive activity with monetary return.

To investigate a disproportionate work burden on the first born child we use the sample consisting of children at schooling age (7 to 17 years old). By first born we consider the oldest child currently living in the household. A caveat of this definition is the lack of information in the dataset whether the oldest child living in the household is indeed the first born. This however does not harm our results, once our hypothesis is that the oldest child living within the household may be carrying out the heaviest work burden. On inspecting the data we observe, through a non parametric regression of total hours of work on age, that there is evidence that the first born carry on larger

Table 1: Summary Statistics

variable	mean	sd	min	max	unit
dependent variables					
hrs_unpaid	11.89	15.26	0	140	hrs/week
hrs_water	2.97	5.14	0	112	hrs/week
hrs_wood	1.05	2.91	0	112	hrs/week
hrs_paid	2.56	10.40	0	112	hrs/week
hrs_total	14.45	19.38	0	164	hrs/week
sh_hunpaid	0.39	0.34	0	1	proportion
sh_hwater	0.39	0.35	0	1	proportion
sh_hwood	0.32	0.36	0	1	proportion
sh_hpaid	0.16	0.31	0	1	proportion
sh_htotal	0.37	0.35	0	1	proportion
independent variables					
first born	0.24	0.43	0	1	dummy
female	0.48	0.50	0	1	dummy
fb*female	0.11	0.31	0	1	dummy
attending school	0.80	0.40	0	1	dummy
age	11.42	3.01	7	17	scalar
age^2	139.45	71.06	49	289	scalar
siblings	3.15	1.98	0	13	scalar
adult_women	1.29	0.79	0	7	scalar
adult_men	1.29	0.79	0	7	scalar
adult_elder	0.32	0.57	0	3	scalar
Ypc_x	18,055.58	41,399.10	0	1,537,097	scalar
elect comm	0.18	0.38	0	1	proportion
dist_water	0.37	0.52	0	3.50	kilometers
$dist\_water^2$	0.41	1.43	0	12.28	kilometers
dist_mkt	14.23	57.50	0	480	kilometers
dry season	0.47	0.50	0	1	dummy
region_Coastal	0.22	0.41	0	1	dummy
region_Forest	0.48	0.50	0	1	dummy
region_Savanah	0.30	0.46	0	1	dummy

Source: GLSS 4. Sample: children aged 7-17 years old.

workload than other siblings. The gap in workload between first born and non-first born's seems to decrease with age along the childhood. Figure 1 suggests that the first born burden is reverted at age 16. This result must be read with caution, however, as it is a kernel estimation, and 16 is close to the sample edge.

5 Empirical Strategy

We first test the existence of the *first born burden*, given by a disproportionate, systematic higher workload on the first born's. Then we explore the contribution of basic infrastructure to release the first born's from such workload. We analyze the impact of having access to different types of infrastructure at the household level, such as access to piped water and electricity, as well as a measures of market proximity given by the community geographical distance to the nearest market.

The reduced form regression model for the optimal time allocation between productive activities and the existence of the first born burden is estimated as:

$$y_i^j = \beta_0 + \gamma_1 fb_i + \gamma_2 fb_i * I_i + \beta_1 I_i + \beta_2 F_i + \beta_3 D_i + \beta_4 R_i + u_i \qquad (10)$$

where
y^j: child's hours of work,
for $j = \{unpaid, water, wood, paid, total\}$
fb: dummy first born
I: set of individual characteristics
F: set of infrastructure variables
D: set of household demographic controls
R: regional and seasonal controls

The reduced form model in Equation 11 analyzes the first born burden as from the perspective of intrahousehold allocation of work among siblings. The burden is determined by a disproportionate larger share of workload to the first born in relation to the share of workload of her siblings in the same household. We estimate the set of regressions described in Equation 11 using the sample of children, including first born dummy controls. As a robustness check and in order to further assesses the effect on infrastructure on the first born share of workload, we estimate Equation 11a using the subsample of first born's only ($b \in i = 1, ..., N$, b is first born child).

$$\begin{aligned} z_i^j &= \beta_0 + \gamma_1 fb_i + \gamma_2 fb_i * I_i + \beta_1 I_i + \beta_2 F_i + \beta_3 D_i + \beta_4 R_i + v_i && (11) \\ z_b^j &= \beta_0 + \beta_1 I_b + \beta_2 F_b + \beta_3 D_b + \beta_4 R_b + v_b && (11a) \end{aligned}$$

where
z^j: share of work relative to other children in the household, for $j = \{unpaid, water, wood, paid, total\}$
I: set of individual characteristics
F: set of infrastructure variables
D: set of household demographic controls

R: regional and seasonal controls

The dependent variables of hours of work are left-censored and thus use tobit method for estimating the models in Equation 10. For the dependent variable share of work in Equation 11a, we have censored values (from left and right) on the subsample of first born's only, but enough variation on the sample of all children. We therefore use tobit estimation method for estimating Equation 11a and standard OLS regression for Equation 11.

Our dependent variables are time-use related: the weekly hours spent in unpaid work, fetching water, fetching wood, doing paid work, and the total hours of work. Moreover, to investigate whether the first born have different responsibilities in the household production relative to their siblings, we use as dependent variable the share of hours of work relative to the total hours of children's work in the household.

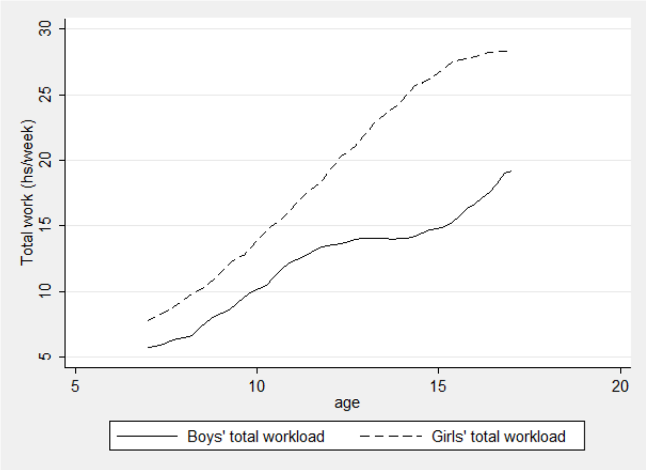
Our models control for several demographic characteristics of the households. We include the number of siblings and the adult members composition, as the "failure to control for family size may confound birth-order with family size effects" (Behrman and Taubman, 1986).

From a gender perspective, it is important to analyze gender gaps on children education and labor choices. The literature on birth order has long argued for the existence of children discrimination by gender. In addition, the specialization of work within households often leaves female household members responsible for the domestic work. Since the time spent on household chores is directly related to access to basic infrastructure, it is thus interesting to separate the effect by gender of the child. Moreover, our data suggests a sensitive difference in total hours of work between boys and girls across all ages in childhood, as seen in Figure 2.

We also control for the household size as it directly affects the amount of work in the production of household goods, and the income necessary to trespass poverty (or the subsistence income level). One may be curious whether is there a trade-off between the advantage of having several siblings regarding a lower probability of being selected for home production (against some other sibling with higher ability/productivity and thus higher commandment over wages), and a disadvantage given that larger households imply larger home production and thus higher work time demand. We test those hypotheses empirically.

Although other features of the household composition would be interesting to deeper explore, we may not spend too long on analyzing them. For a interesting findings and discussion, other authors have more carefully

Figure 2: Gender and work burden along the childhood



Note: Kernel-weighted local polynomial regression. GLSS4, sample children 7-17 years old.

analyzed the family size and the difference in characteristics between the first born and their siblings (see Becker & Lewis, 1973; Becker & Tomes, 1976; Hanushek, 1992). We are primarily interested in the existence of the first born burden and the role of infrastructure on alleviating the child work.

The infrastructure variables are key in our analysis. *Electricity* captures whether the household lives in a community where more than 50 percent of households have access to electricity. This is a dummy variable created from the average number of households in the community who uses electricity as the main source of lighting, excluding the response of the household itself. Descriptive statistics show that 18 percent of children in the sample live in communities where more than half of households 'have access' to electricity.

Distance to water is the average distance between the homestead and a water source of all households in a given community. It is constructed from individual household distances from the water source, averaged across household within a same communities (respecting the sample weights), and excluding the response of the household itself.

Distance to the market is measured as the distance from a given community to the closest periodic or daily market. It captures the accessibility to market for selling agricultural products, as well as the geographic distance to potential paid job opportunities. We also control for the season (dry or rainy) in which the households were interviewed, as the time spent collecting water and firewood may vary considerably depending on the season of the year. Regional controls for the three main ecological zones should capture local specific effects which would influence the households' time allocation and is common to households on those regions.

Finally, we use average per capita income in the community, excluding the household itself, to control for wealth status. Including the household per capita income for addressing the income effect could cause problems of reverse causality. For instance, would a child spend long hours doing unpaid work because she lives in a poor household, or is she poor because she spends several hours doing unpaid work? We therefore opted for using a community-built variable.

6 Results

6.1 Testing the first born hypothesis

Being the first born shows a positive and significant relation to the amount of hours dedicated to unpaid work, as depicted in Table 2. First born's on average spend 1 hour 7 minutes ($1.118 * 60 = 67.08 minutes$) more than non first born's in unpaid work per week, and about 24 minutes more collecting water. The effect of child work is more intense on girls in general. Girls spend 4 hours 8 minutes more than boys doing unpaid work, 46 minutes more collecting water, and 22 minutes more collecting firewood per week. Although girls on average do 1 hours 7 minutes less than boys of paid work, their total work burden is still higher than boys' by 3 hours 34 minutes per week. We find no additional effect on workload for being first born girls, as compared to being first born boys, as shown by the non statistically significant coefficient for the interaction term of female and first born.

A brief comment on other demographic characteristics. As expected the work burden increases with age, and seems to increase at a slightly decreasing rate as for the negative marginal effect in the squared age. Attending school significantly decreases the amount of hours children spend performing work, specially paid work, although no causality can be inferred. A child who attends school works on average about 12 hours less per week on paid activities than children who do not attend school. Interestingly, going to school seem not to affect the amount of time children will spend collecting water. We suspect that this is because water is a subsistence good with no close substitute and therefore it must be fetched independent of the household members' other activities.

In line with our theoretical model, a larger number of adult household members on average significantly decreases the child work on unpaid activities, water collection, wood collection and total work. It is curious to observe the different elasticities of child work for an additional female or

Table 2: Children's Determinants of Hours of Work

	hs unpaid	hs water	hs wood	hs paid	hs total
fb (d)	1.118**	0.415**	0.169	-0.634	0.885
	(0.47)	(0.16)	(0.11)	(0.60)	(0.59)
female (d)	4.134***	0.772***	0.363***	-1.123**	3.566***
	(0.33)	(0.11)	(0.07)	(0.47)	(0.40)
fb*female (d)	0.705	-0.232	-0.115	1.239	1.114
	(0.71)	(0.19)	(0.14)	(0.91)	(0.87)
age	3.816***	1.449***	0.825***	1.105*	3.590***
	(0.42)	(0.13)	(0.11)	(0.61)	(0.54)
age^2	-0.127***	-0.053***	-0.028***	-0.014	-0.102***
	(0.02)	(0.01)	(0.00)	(0.03)	(0.02)
school (d)	-0.932**	0.045	-0.159*	-11.981***	-6.783***
	(0.45)	(0.12)	(0.08)	(0.63)	(0.69)
siblings	0.001	-0.058**	0.048***	-0.194**	-0.086
	(0.08)	(0.02)	(0.02)	(0.09)	(0.09)
adult_w	-0.737***	-0.014	-0.209***	0.052	-0.705***
	(0.21)	(0.08)	(0.05)	(0.23)	(0.25)
adult_m	-0.484***	-0.130**	-0.030	0.251	-0.358*
	(0.17)	(0.05)	(0.04)	(0.21)	(0.21)
elect comm (d)	1.268***	0.216	-0.293***	-0.223	0.921**
	(0.36)	(0.14)	(0.09)	(0.64)	(0.42)
dist_H2O_comm	6.127***	1.787***	1.054***	5.182***	7.878***
	(0.69)	(0.22)	(0.18)	(0.78)	(0.89)
$dist\_H2O\_comm^2$	-2.062***	-0.586***	-0.356***	-1.093***	-2.261***
	(0.24)	(0.08)	(0.06)	(0.24)	(0.31)
dist_mkt	0.001	0.001	0.000	-0.001	0.003
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
regional controls	yes	yes	yes	yes	yes
left censored obs	709	1732	3410	4666	670
uncensored obs	4379	3356	1678	422	4418
F-test	35.88	16.85	5.97	35.32	40.06
Pseudo R2	.0239	.0217	.0325	.1714	.0280

Note: Mg effects reported, robust sd errors in parentheses,$^{*}p < 0.10$,$^{**}p < 0.05$,$^{***}p < 0.01$.
(d) for discrete change of dummy from 0 to 1. Ycapita and adult elders also included.

male adult in the household. One additional woman in the household decreases on average by 44 minutes a week the unpaid workload of a child.

On the infrastructure variables, living in a community where more than 50 percent of households have access to electricity increases by 1 hour 16 minutes the weekly child unpaid work, and decreases her time fetching firewood on average by 18 minutes. Regarding total work, having access to electricity denotes on average 55 more minutes ($0.921 * 60$ minutes) per week doing some kind of work than children in communities where electricity is scarcer.[6]

[6]We advise the reader to be careful on interpreting the electricity variable, once the survey questionnaire did not capture the extent of provision regarding reliability, hours of

Access to water is measured by the average distance in the community from a household to the closest water point. The results reveal that as the distance increases by one kilometer, children spend on average over six additional hours doing unpaid work per week. 1 hour 47 minutes is the extra amount of time fetching water per week for an additional kilometer of distance to the water point. The squared distance coefficient reveals that working time is increasing at a decreasing rate, probably due to some economies of scale on water collection. Not surprisingly, the time spent fetching wood also increases with the distance from the water source, suggesting that households live in a poorer natural resources environment. Interestingly, increasing distance from the water source increases also the time children spend doing paid work, by about 5 hours per week.

Table 3 confirms the existence of a work burden on the first born by showing a disproportionate higher share of workload on the first born's. Had not existed such first born burden, one could expect that a larger number of siblings would decrease the workload of the first born's, once the workload would be shred among a larger number of children in the household. The empirical results show, however, that even controlling for the number of siblings in the household, being the first born entails on average a 41.6 percentage points higher share of work than the siblings on unpaid work, 36.7 percentage points higher share of work on water collection, 41 percentage points higher share of work collecting wood, 55.7 percentage points higher share of paid work, and finally, 44.9 percentage points higher share of total work.

6.2 Does infrastructure play a role on releasing the first born?

Our results are not straight-forward concluding. The determinants of child work as in Tables 2 and 3 show that access to basic infrastructure are significantly related to a reduction in the overall time children work. Being closer to the water source decreases the amount of time spent on work activities, whereas access to electricity has a less undisputed result. Access to electricity is close related to the expansion of productive activities and, more importantly, an extension of the amount of productive hours per day. The second is likely the main reason explaining an increase in child work on domestic chores - unpaid work, accompanied by a significant decrease in hours of work for fetching firewood.

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provision without interruption, intensity of the power, power surge, etc.)

Table 3: Children's Determinants of Share of Work

	sh_hrs unpaid	sh_hrs water	sh_hrs wood	sh_hrs paid	sh_hrs total
fb	0.416***	0.367***	0.410***	0.557***	0.449***
	(0.02)	(0.02)	(0.03)	(0.05)	(0.02)
female	0.110***	0.067***	0.081***	-0.014	0.088***
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
fbfemale	0.036*	0.033	0.026	-0.049	0.038*
	(0.02)	(0.03)	(0.04)	(0.06)	(0.02)
agey	0.090***	0.142***	0.125***	-0.004	0.077***
	(0.01)	(0.02)	(0.02)	(0.02)	(0.01)
$agey^2$	-0.004***	-0.006***	-0.005***	0.001	-0.003***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
school	-0.014	0.008	-0.030*	-0.204***	-0.038***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)
siblings	-0.039***	-0.042***	-0.028***	-0.006*	-0.034***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
adult_w	-0.027***	-0.007	-0.027***	-0.017**	-0.024***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
adult_m	0.008	0.006	0.007	-0.014**	-0.010**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
elect comm	-0.014	-0.016	0.016	0.007	-0.012
	(0.01)	(0.02)	(0.02)	(0.02)	(0.01)
dist_H2O_comm	-0.017	-0.036	0.010	0.037	-0.017
	(0.02)	(0.03)	(0.03)	(0.03)	(0.02)
$dist\_H2O\_comm^2$	0.007	0.015	-0.003	-0.006	0.007
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
dist_mkt	0.000**	0.000	0.000	0.000	0.000**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
_cons	-0.092	-0.392***	-0.416***	0.294**	-0.007
	(0.08)	(0.09)	(0.12)	(0.12)	(0.08)
regional controls	yes	yes	yes	yes	yes
obs	3710	3345	2145	1123	3735
F-test	197.49	105.55	65.57	53.31	212.49
R2	.4950	.3965	.4012	.5763	.5258

Note: Mg effects reported, robust sd errors in parentheses,*$p < 0.10$,**$p < 0.05$,***$p < 0.01$.
(d) for discrete change of dummy from 0 to 1. Ycapita and adult elders also included.

For testing the effect of access to infrastructure on the specific workload of the first-born, we use a restricted sample of first born's only (see Table 4). On regressing the hours of work as in model 10, most coefficients are vanishing or insignificant[7] except for the distance to the water source, where one kilometer increase in distance increases the amount of time spent on work for the first born's at very small values. Table 4 uses the share of work among siblings as the dependent variable and shows that access to water or electricity in the community in general does not significantly influence the share of hours of workload that will be allocated to the first born's. More important variables affecting how workload is distributed among the

[7]We do not report the table results for it is uninteresting.

Table 4: First Born Effects - Determinants of Share of Work

	sh_hrs unpaid	sh_hrs water	sh_hrs wood	sh_hrs paid	sh_hrs total
female (d)	0.096***	0.075***	0.064***	-0.007	0.071***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
school (d)	0.004	0.016	-0.001	-0.114***	-0.034***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
siblings	-0.034***	-0.024***	-0.013***	-0.004	-0.034***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
adult_w	-0.010	-0.013	-0.025***	-0.028***	-0.010
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
adult_m	-0.031***	-0.028***	-0.032***	-0.044***	-0.029***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
adult_e	0.017*	0.019**	-0.005	-0.023**	0.014
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
elec comm (d)	-0.019	-0.016	0.003	0.013	-0.021*
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
dist_H2O_comm	-0.008	-0.019	0.000	-0.007	-0.027
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
dist_H2O_comm^2	0.004	0.008	0.003	-0.000	0.012
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
dist_mkt	0.000**	0.000***	0.000	0.000	0.000**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
regional controls	yes	yes	yes	yes	yes
demogr. controls	yes	yes	yes	yes	yes
left censored obs	133	327	238	77	94
uncensored obs	1105	699	341	194	1155
right censored obs	668	601	406	348	676
F-test	47.27	25.19	10.23	7.71	36.38
Pseudo R2	.2317	.2139	.1525	.1480	.2095

Note: Sample: first borns only. Mg effects reported, robust sd errors in parentheses,*$p < 0.10$, **$p < 0.05$,***$p < 0.01$.

household children are the additional number of siblings and adult males who significantly decrease the share of hours of work of first born's. Being a girl, however, implies an increasing burden between 6.4 to 9.6 percentage points depending on the work activity.

7 Policy Implications and Conclusion

There is strong evidence of a work bias against the first born. The empirical analysis of children's time use in rural Ghana confirms our theoretical predictions that a disproportionate work burden is placed on the first born. This is confirmed both from the analysis of number of hours of work, and also when estimating the determinants of the share of hours worked among the siblings in the household.

It is, nevertheless, hard to predict the impact of infrastructure on the time use of the first born only. In general, access to water and electricity significantly alleviates the work burden of children. No significant reduction on the work burden, however, was found specifically for the first born's.

The findings suggest that having access to infrastructure would release equally the burden of all children in the household, not causing necessarily an intra-household redistribution of work to release the first born. Households may need specific incentives to respond according to a policy objective of releasing the first born. The changes in time allocation given access to infrastructure seems not to be completely predictable. A package of complementary incentives seems to be necessary in order to redraw the household's optimal allocation of time between the economic activities and among the children.

After school programs with some kind of cash transfer or school feeding benefit may move the equilibrium time allocation toward the accumulation of higher stocks of education, as subsistence secured by such programs would release most children from work. Support for conditional cash transfers (CCTs) with regressive targeting according to birth order - the first child receiving a higher benefit than the additional children - may augment the opportunity cost of the first born child being out of school. In places where the first born burn is confirmed, there is strong indication that CCT programs may need to condition (or give a bonus) on having all household children in school, in order to guarantee that the burden would not be passed onto the younger siblings.

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A Appendix

The household maximizes utility with respect to the total time and the production constrains.

$$\begin{aligned} max_{t_i^j, t_i^l} \quad & U_H(C_H, L) = u(t_i^j, t_i^l, X_i; \tau) \quad (5) \\ s.t. \quad & T_H = \sum_{i=1}^{n} t_i^j + t_i^l \\ & C_H \leq \sum_{i=1}^{n} g_i(t_i^j, X_i; \tau) \\ & C_H \geq ns \end{aligned}$$

In equilibrium:

$$\begin{aligned} dU(C_H, L) &= \frac{\partial U}{\partial C} dC + \frac{\partial U}{\partial L} dL \\ \frac{dU}{dC} &= \frac{\partial U}{\partial C} + \frac{\partial U}{\partial L}\frac{dL}{dC} \\ 0 &= MU_C + MU_L \frac{dL}{dC} \\ \Rightarrow -\frac{dL}{dC} &= \frac{MU_C}{MU_L} \equiv MRS_{C,L} \end{aligned}$$

When the consumer chooses the time allocation that maximizes utility, the marginal rate of substitution equals the ratio of time requirement for the production of the goods (time labor for production of consumption goods and time invested on learning).

$$\begin{aligned} MRS_{t^j,L} &= \frac{MU_C}{MU_L} \\ \frac{MU_C}{t^j} &= \frac{MU_L}{t^l} \\ \frac{MU_C}{MU_L} &= \frac{t^j}{t^l} \qquad \text{(a)} \end{aligned}$$

The marginal rate of transformation is the rate at which the production of a unit of output in one activity can be transformed into output of another by reallocating the time devoted to the productions. In other words, the household member's marginal rate of transformation between production of goods and education is the opportunity cost of the production of one unit of goods in terms of forgone learning; how much of learning time must be given up in order to produce an additional good j for consumption. In equilibrium this time requirement ratio equals the ratio between marginal costs of consumption and learning.

$$\begin{aligned} MRT_{t_i^j, t_i^l} &= \frac{MC_C}{MC_L} \\ \frac{t^j}{t^l} &= \frac{MC_C}{MC_L} \qquad \text{(b)} \end{aligned}$$

The equilibrium time allocation is found when the indifference curve of the household is tangent to the household production frontier, determined by a time 'budget' line. In the equilibrium the slope of the marginal rate of substitution and marginal rate of transformation are the same. Thus, in equilibrium, the marginal rate of substitution equals the marginal rate of transformation between present consumption and the accumulation of stock of education.
$from(a)and(b)$:

$$\begin{aligned} MRS_{C,L} = \frac{MU_C}{MU_L} &= \frac{MC_C}{MC_L} = MRT_{t_i^j, t_i^l} \\ \Rightarrow MRS_{C_H,L} &= MRT_{t_i^j, t_i^l} \\ \frac{\partial U_H(t^j, t^l; \tau)/\partial C_H}{\partial U_H(t^j, t^l; \tau)/\partial L} &= \frac{\partial R(t_i^l)/\partial t_i^l}{\partial g_i(t^j, X; \tau)/\partial t_i^j} \end{aligned}$$

If this equality does not hold, the household could increase utility by decreasing the hours of work in the activity with the lower marginal utility per unit of time and increase time spent in another activity.