Birth Order and Educational Attainment: Evidence from Lesotho

Ramaele Moshoeshoe*

Very preliminary. Please do not cite.

Abstract

This paper examines the effect of birth order on educational attainment in Lesotho. Using family fixed effects models, I find robust negative birth order effects on educational attainment, which in sharp contrast with the evidence from many other developing countries such as Ecuador and Kenya, but consistent with the evidence from developed countries. I further find that these birth order effects are pronounced in large families, and families with first-born girls, which suggests presence of girls' education bias. Turning to potential pathways of these effects, I find that they are not propagated through family wealth, but mainly through birth-spacing. These results are robust to different sample restrictions.

JEL Classification: D13, I21, J1, O12

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*Correspondence: School of Economics, University of Cape Town, Private Bag X3, Rondebosch 7701, Cape Town, RSA. e-mail: rmoshoeshoe@gmail.com

1 Introduction

Over the past two decades, increasing education levels in the developing world, particularly sub-Saharan Africa, has been of paramount importance. Morduch (2000) argues that an effective policy for achieving this goal depends on a better understanding of the nature of schooling decisions in these countries. According to Leibowitz (1974), Cunha, Heckman, Lochner and Masterov (2006), and Cunha and Heckman (2009), differences in child outcomes emerge from an early age, due in part to the amount of human capital (cognitive and non-cognitive skills) acquired before age six. The different environments chosen and created by families help create these differences in child outcomes. Moreover, much of schooling decisions, which affect later life outcomes, take place within the family. Hence, it is important to understand specific family factors responsible for these differences in child outcomes.

One of the family environment factors, birth order (that is, a child's order of birth), is a recurrent theme in the economics and psychology literatures. Even though any particular child's order of birth is biologically determined, parents can actively or passively choose to create different home environments for children of different birth orders, which will then affect their cognitive and non-cognitive skills' development. The available evidence on birth order effects on educational attainment shows a consistent divide between the developing world and the developed world: there tend to be negative birth order effects in developed countries, while there is evidence of positive birth order effects from developing countries (De Haan, Plug and Rosero, 2014). Therefore, birth order effects on child outcomes are context-specific, as it relates to countries' levels of development.

However, within less developed countries there are heterogeneities in terms of social norms that shape parental preferences towards children of different birth orders, which may lead to different birth order effects (see Jayachandran and Kuziemko, 2011). Thus, the evidence of positive birth order effects found in some developing countries may not be generalised to other developing countries with different contexts. More importantly, the underlying causal mechanisms through which birth order affects educational attainment are still unsettled, and also appear to be context-specific.

In this paper, I examine the effect of birth order on children's educational attainment in Lesotho. I use the 2006 census data for children aged six to twelve years to estimate birth order effects on educational attainment. To deal with potential endogeneity of birth order resulting from its correlation with family size and other unobserved family factors, I use family fixed effects models.

Apart from this paper being the first to estimate birth order effects on human capital development in Lesotho, it adds to the literature in three other ways. Firstly, I use different measures of educational attainment, instead of one as is common in the literature. I estimate birth order effects on a short-run measure of education (that is, enrolment), and two long-run measures of education (that is, completed years of education, and *schooling progression* or age-adjusted schooling). It is interesting to not only know the birth order effects on short-term outcomes, but also its effects on long-term educational outcomes. Moreover, the fact that these measures have different strengths and weaknesses, as detailed below, means that estimating birth order effects on all of them will also allow one to check the robustness of the birth order results. Secondly, I examine two possible sources of heterogeneity in birth order effects: differences due to families of different sizes, and gender bias (that is, gender of the first-born). Lastly, I investigate whether family wealth and child-spacing can explain the observed birth order effects.

Different from the available evidence based on many developing countries data, I find large and significant negative birth order effect on child educational attainment. I also find strong evidence that this negative birth order effect is transmitted through birth-spacing, and not family wealth, contrary to earlier evidence from other developing countries (for example, Ecuador and some sub-Saharan countries) which shows that wealth is the underlying causal mechanism behind the positive, not negative, birth order effect on attainment (De Haan *et al.*, 2014; Tenikue and Verheyden, 2010). Surprisingly, my results affirm the negative birth order effects found in developed countries (for example, Norway and the United States) (Black, Devereux and Salvanes, 2005; De Haan, 2010). The difference with the latter evidence is that, in the United States, for example, De Haan (2010) finds that family wealth, and not birth-spacing, explains the negative birth order effect. Therefore, I tentatively conclude that these findings are consistent with the *confluence* model's predictions, even though I cannot rule out the hypothesis that first-borns do better because of being brought up under tougher parental disciplinary rules than their younger siblings.

The paper proceeds as follows. Section 2 gives the context of Lesotho. Section 3 details the related literature. Section 4 describes the data and gives descriptive analysis. Section 5 discusses the empirical strategy: the fixed effects model of birth order effects. Section 6 presents the main birth order effect results, and the heterogeneities of birth order effect by family size and family gender preferences. Section 7 examines the pathways through which this birth order effect is transmitted. Section 8 concludes the paper.

2 The context

Lesotho is a small landlocked, lower middle income sub-Saharan African country with an estimated population of 2 million. Like many other developing countries, unemployment, poverty and income inequality are major concerns. The proportion of people living below the national poverty line is 56.6 percent, and there is a great divide between the rich and the poor with an estimated Gini coefficient of 0.52 (Bureau of Statistics, 2006).

During the South African apartheid era, Lesotho served as a labour reserve for the South African mining sector. This situation helped create a culture of labour migration, particularly among prime-age men. Although the number of Basotho men currently working in the South African mines has drastically declined over the last twenty years, being a migrant miner is still regarded as the best employment avenue by many prime-age men. For example, according to the

2008 Labour Force Survey (2008 LFS), about 14 percent of individuals in the prime-age (25-54 years old) group were living outside the country (Bureau of Statistics, 2008), compared to about 0.7 percent, 1.1 percent, and 3.5 percent for those aged 5-9 years, 10-14 years, and 15-19 years, in that order. In the absence of adult males, young boys (mainly in rural areas) have to look after their families' livestock. According to the 2008 LFS, of all children aged 6-14 years, 2.9 percent are working, with girls making up only 0.3 percentage points of child labour force participation. Many of these children work as herd boys and do not attend school.

The FPE programme has been introduced to encourage these children to enrol and acquire basic education, which comprises seven years of primary education and three years of secondary education. Even though secondary education is still not free, there are programmes, which include scholarships for orphaned children and book rental schemes to reduce costs of textbooks, that are meant to assist disadvantaged children. Nonetheless, enrolment drops drastically when children transition from primary to secondary school.

3 Birth Order: Theory and Evidence

In this section, I review the literature on birth order effects on child outcomes. There are several theories that attempt to explain the birth order effects on human capital development of children: some theories predict negative birth order effects, while others predict positive birth order effects. I first review the theories that predict the negative birth order effects and the evidence consistent with this prediction. I then review the theories that predict positive birth order effects, and discuss the evidence consistent with this prediction.

Birth order has been an active research theme in psychology literature where researchers are interested in its effects on individuals' intelligence. The confluence model, which predicts negative birth order effects on a child's intelligence level, is the operating theory in psychology literature. (Zajonc, 1976). According to this model, the intellectual performance of a child depends on his/her intellectual environment, which is a function of the average of the absolute intellectual levels (or age levels) of the child and his/her family members. For example, the first-born child enters a high intellectual environment with two adult parents. The second-born child enters a relatively lower intellectual environment because of the presence of her first-born sibling in the family, and the intellectual environment for the third-born is much lower. The model, therefore, predicts a negative relation between birth order and educational attainment.

Child-spacing (or birth spacing) can either perpetuate or attenuate the negative birth order effects. Parents can stimulate their offspring's intellectual ability through talking and playing with them. Thus, a large gap between siblings increases parent-child interaction, all else equal, and this can translate into better outcomes for the earlier-born sibling. The longer birth interval can further perpetuate the negative birth order effects through the tutoring effect (Sulloway, 2007). According to this tutoring hypothesis, first-borns develop more intellectual abilities, through organisation and expression of thoughts, as they teach their younger siblings, while the last-borns have no one to teach.

However, using American data, Baydar, Greek and Brooks-Gunn (1997) find that the birth of a sibling results in changes in the family environment (e.g. changes in maternal labour participation and family income), a decline in maternal interactions with the older child, especially when the birth-space is short, and that mothers adopt controlling parenting styles toward the older sibling. They discover that these changes result in negative verbal development of the older child. So, a short birth interval between siblings is harmful to cognitive and non-cognitive development of the earlier-born child. Therefore, the mediating effects of birth-spacing are ambiguous *a priori*.

There is also the hypothesis that birth order effects have biological or prenatal origins. According to this hypothesis, later-borns face higher prenatal environmental risks because levels of maternal antibody increase with birth order (Gualtieri and Hicks, 1985). It, therefore, predicts a negative relation between birth order and child development. The evidence, however, seems to refute this hypothesis. Kristensen and Bjerkedal (2007) use Norwegian data to show that the negative birth order effect on intelligence depends on the child's social rank within the family, and not her birth order *per se*. For instance, second-born children who have deceased first-born siblings, and hence brought up as 'first-borns', have equally high levels of intelligence as biological first-borns.

Most economic theories of intra-household resource allocation emphasise the resource dilution hypothesis as the mechanism behind negative birth order effects on human capital development. The first-born child becomes the only-child of the family, hence she enjoys a higher stock of parental resources (including time and financial resources) than the later-born siblings who have to share parental resources with all other earlier born siblings. According to Cunha *et al.* (2006), early child investments are the most productive, and they increase the productivity of later investments. Therefore, the theory predicts that first-borns will have higher intellectual ability than their later-born siblings because of high investment enjoyed during the sensitive formative years. This first-born advantage gets larger the longer the birth space.

Hao, Hotz and Jin (2008), however, posit that the negative birth order effects arise endogenously due to the strategic interaction between parents and their offspring. Parents impose more stringent disciplinary measures on their first-born children in response to their bad behaviour and/or poor school performance in order to establish a reputation of toughness and deter similar behaviour amongst their later-born children. This increased attention on the first-born leads to better outcomes for the first-born relative to the later-borns. Using data from the National Longitudinal Survey of Youth, Hotz and Pantano (2013) find robust evidence that children's school performance declines with birth order, as does the toughness of their parents' disciplinary actions.

Black *et al.* (2005) use family fixed-effects models to tease out birth order effects on child outcomes from a large administrative data of Norwegians aged 16-74. They find large and statistically significant negative birth order effects on children's education and their later life outcomes, such as earnings and teenage childbearing. They then posit that their findings are consistent with the optimal fertility stopping model where parents stop having children if the last one has low endowments. It is, however, hard to divorce these findings from the predictions of models by Zajonc (1976), Cunha *et al.* (2006), and Hao *et al.* (2008).

De Haan (2010) uses the Wisconsin Longitudinal Study data to estimate birth order effects. To purge any potential endogeneity of birth order due to its correlation with family size and/or any other family size related factors, she estimates birth order effects separately for families with different number of children. Like Black *et al.* (2005), she finds strong negative birth order effects on completed years of education, evidently due to high parental financial transfers to earlier-borns, and not due to the average age gap between successive children posited by the confluence model. Härkönen (2014) also finds similar evidence in West Germany using family fixed-effects models, and propounds that the dilution of parental time is a plausible mechanism behind these effects. Likewise,Price (2008) finds evidence supporting the parental time dilution hypothesis using the American Time Use Survey data. He finds that parents spent significantly more quality time with their first-born children than with later-born children.

The evidence on birth order effects discussed thus far is consistent with the negative birth order effects on human capital development predicted by the confluence model, the resource-dilution, and strategic parenting hypotheses. This evidence is exclusively from the developed world. The evidence from developing countries, in contrast, reveals positive birth order effects.

How could birth order positively affect human capital development? The resource dilution hypothesis provides a different mechanism through which this could happen. Horowitz and Wang (2004) develop a model of intra-household allocation of resources (that is, time of children) across labour market and education activities when children are different in their human capital accumulation abilities.[1] As the sibship size increases, per capita familial resources decline. Therefore, according to this model, poor families supply too much labour of (that is, provide too little education to) the child with human capital accumulation comparative advantage (that is, the first-born) resulting in 'reverse specialisation'. That is, increased pressure on familial resources may force a poor family to send the first-born child out to work to compensate familial resources and finance education of her younger siblings. This will have a negative impact on human capital accumulation of the first-born child and a positive effect on attainment of the younger siblings. Tenikue and Verheyden (2010)'s model, which explicitly models child heterogeneity in terms of birth order, gives similar predictions to those of Horowitz and Wang's model.

Relatedly, Lafortune and Lee (2014) examine birth order and gender bias effects on human capital accumulation within a model that combines convex returns to education and credit constraints. In this model, higher birth order children are favoured for schooling in credit-constraint families. Additionally, the model predicts that if there are higher opportunity costs of educating boys compared to girls, for instance, having male siblings will lead to higher education for girls.

[1] Children are different either due to their innate abilities, gender, birth order or environmental factors.

An implicit prediction of this model is that a first-born male will have lower schooling relative to his later-born siblings, and much more so if he is the only son in the family. Lafortune and Lee (2014) use data from the United States, South Korea and Mexico to test the theory's predictions. They find that birth order is positively related with a child's schooling in low income families, but in high income families, the first-born gets more education. Moreover, they find that in South Korea, where boys are preferred over girls, having more younger female siblings benefits the boys.

Much of the evidence from developing countries consistently supports the theoretical prediction that birth order positively affects schooling. Applying the family fixed-effects estimation strategy on data from the Philippines, Ejrnæs and Pörtner (2004) find positive birth order effects on completed years of schooling, and that these effects are more pronounced in low-educated (or low-income) families. Tenikue and Verheyden (2010) also use family fixed effects strategy on data from 12 sub-Saharan African countries[2]. They find positive (negative) birth order effects on educational attainment, measured by completed years of education during the survey period, of children aged six to 18 years in poor (rich) families.

Tenikue and Verheyden (2010)'s results, however, are potentially confounded by measurement error in birth order. As the authors rightly acknowledged, there is a high likelihood that the observed 18 year-old child in the household is not the first-born but actually a second-born, if the first-born has moved out of the household and hence not observed. I show in the data analysis section below that this is a real threat in this study. In addition, Tenikue and Verheyden (2010) estimate family fixed effects models, but do not deal with the problem of increased correlation between child age and birth order within the family, which may also bias their results. I later on deal with this problem by including age fixed effects following Jayachandran and Kuziemko (2011) and De Haan *et al.* (2014). Finally, as pointed out by De Haan *et al.* (2014), Tenikue and Verheyden's finding that birth order effects are transmitted by wealth may be confounded with age effects, for example, because they do not estimate a fully interacted model.

De Haan *et al.* (2014) use Ecuadorian survey data on infants (the less than six year old children) and adolescents (the 12-18 year olds) to estimate long term effects of birth order on human capital development. They find positive and persistent birth order effects on achievement; that is, first-born children lag behind in educational achievement from infancy to adolescence, evidently due to mothers spending less quality time with first-borns, and breastfeeding them for a shorter period than later-born children. They also find that first-born adolescents are more likely be involved in child labour than their younger siblings. Furthermore, they find that the positive birth order effects on human capital development are larger in poor and low-educated families, but are negative in rich and high-educated families. This is consistent with Tenikue and Verheyden (2010)'s and Lafortune and Lee (2014)'s findings.

To sum up, the confluence model, the resource dilution hypothesis, and the strategic-parenting

[2] These countries are Benin, Burkina Faso, Cameroon, Ghana, Kenya, Mali, Niger, Senegal, Tanzania, Uganda, Zambia, and Zimbabwe.

hypothesis predict negative birth order effects on child outcomes. According to the confluence model, these birth order effects are wholly mediated by birth spacing, which may intensify or reverse them owing to the tutoring effect that kicks-in as sibship size increases. Empirical evidence from developed countries, namely the United States, Norway, and German, is largely consistent with the negative birth order effects predicted by these theories. On the contrary, available evidence from developing countries, namely the Philippines and Ecuador, reveals positive birth order effects on human capital development. This latter evidence is largely consistent with a different resource dilution hypothesis mechanism; in resource-poor families, an increase in sibship size reduces per capita resources, and may force the family to sacrifice schooling of the first-born child by sending the child to work to compensate familial resources.

Even though the evidence from developing countries largely supports the positive birth order effects and the family resource dilution hypothesis, it may not be generalised to other developing countries with different contexts. For instance, the context in all the countries included in Tenikue and Verheyden's study is different from that in Lesotho in two important ways. First, anecdotally, Lesotho has female (not male) bias in education. Second, the fertility rate (that is, average family size as used here) in Lesotho is about 3.3 births per woman, much lower than any of the countries in Tenikue and Verheyden (2010). Therefore, to the extent that birth order effects differ by family size, and that birth-spacing transmits birth order effects, we might expect to find different birth order effects in Lesotho.

4 Data and Descriptive Statistics

I use data from the Lesotho Population and Housing Census (the Census, hereafter) which was collected on the 19$^{\text{th}}$ April 2006. This data contains information on household (or family)[3] socio-economic background, employment status, school enrolment, highest level of education completed, family relations, and demographic characteristics of all family members. For each family, information is collected about all members, those present during the census and those temporarily absent, including their relation to the household head. As per the Census, the population of Lesotho is 1,868,526.

For purposes of this paper, I assume that all children identified as household head's children are his biological children. The majority of household heads are men, about 76 percent. I use information on family members' relations with the household head, irrespective of the gender of the household head, and age (in years at last birthday) to construct the absolute birth order measure: Birth order equals 1 for the first born, 2 for the second-born, et cetera.

To get to the working sample, I sequentially impose the following restrictions. Firstly, I restrict the sample to all children of the household head aged between 6 and 18 years. This is to ensure that

[3]In this paper, I use family and household interchangeably.

all primary and secondary school-going children are included. Following Tenikue and Verheyden (2010) and De Haan (2010), I further reduce the sample to households where the eldest child is at most 18 years old, and where there are a minimum of two and a maximum of five children. The second restriction, that families should have at least two children, is a technical requirement for studying birth order effects. Because the total fertility rate in Lesotho is 3.3 children per woman, limiting the sample size to households with a maximum of five children increases the chances that all children observed within the household are the biological children of the household head. In addition, by including families with up to five children increases chances that households with completed family sizes are included[4]. It also ensures that we have enough observations in each family size cell. This restriction, however, does not have implications to the estimations later on given that the fertility rate is exactly 3.3 in the final sample. Finally, I drop all families with multiple births[5] (for instance, twins) because of the ambiguities of assigning birth order in such instances.

If there are some household head's biological children who have moved out of the household, this will introduce measurement error in the birth order measure. The incidence of this happening for those aged below 18 appears to be low. For instance, I find that only about 0.08 percent and 0.15 percent of children aged 6-18 years old are listed as household heads or spouses and household head's sons/daughters-in-law, respectively. These are children that must have moved out of their biological families. However, there is a real concern that many of those aged above 18 years may have moved out of their biological families. Figure A.1 shows that the proportion of those living outside their biological families (that is, young household heads and young sons- or daughters-in-law) increases just after age 18. Therefore, to deal with this problem, I restrict the analytical sample to include only children of primary-school-going age; that is, all 6-12 year olds. The advantages of this sample restriction are that (1) it is less likely that a 12-year old has an elder sibling who is outside the family, hence making the 12-year old a 'social first-born', and (2) all 6-12 year-old children are potential beneficiaries of the FPE programme, making it easy to isolate birth order effects from FPE effects. The down-side, however, is that one cannot look at birth order effects on child labour participation on human capital development. These restrictions together reduce the working sample to 77,730 children living in 46,973 families.

Educational attainment is measured in three ways. The first measure is enrolment where a child aged between 6 and 12 years is considered enrolled if her parent reports that the child is enrolled. This is a short-run measure of education, but it has the advantage of being easy to calculate and interpret. The second measure is the number of completed years of education at the time of the census. The strength of this measure is that it is a long-term measure of education that is easy to read and interpret. Its limitation, however, lies in the fact that it is right-censored

[4]According to the 2009 Demographic Health Survey data, 95 percent of all women of productive age, 15-49, with five living children do not want to have any more children (SIF, 2011).

[5]The Census data does not come with birth date information, but only age in years at last birthday, even though the questionnaire also has a birth date question.

because many children are still in school and their final attainment will most likely differ from the currently reported. The third measure is schooling progression (or relative grade attainment or age-adjusted schooling), which is a long-term measure of education that is good in an environment where there is high grade repetition and high school entry delays. Schooling progression is defined as completed years of schooling divided by potential years of schooling, which are the total number of schooling years a child would have accumulated had she completed a year of schooling by age 7 and continued to add one more in each subsequent year (Mani, Hoddinott and Strauss, 2013).[6] The downside of schooling progression is that for any two children of different ages (say, 7 and 10 years old) with zero completed years of education, one cannot tell which one of the two is more disadvantaged than the other as they will both have zero schooling progression. Additionally, it is only defined for children aged 7 and older.

To get the completed years of education variable from the data, I use the highest level of education completed as is reported for the first seven grades, and then add one year for each of the three years of secondary, and two years of high school grades completed. Therefore, individuals who have completed high school must have 12 years of education, while those with graduate and post-graduate degrees have 16 and 18 years of education, respectively.[7] I then convert other qualifications into completed years of schooling as follows. *Non formal education* is converted to two years of schooling, *Diploma/Vocational training after primary* to 8 years, *Diploma/Vocational training after secondary* to 11 years of schooling, and *Diploma/Vocational training after high school* to 14 years of schooling.

One of the key control variables of interest is household wealth. The Census does not have household income or expenditure but does have information on household ownership of durable goods[8], land (that is, the number of fields), and livestock (for instance, number of cattle, sheep, horses, chicken, et cetera.). In such situations, the best available option widely applied in the literature is the use of wealth or asset indices constructed using the principal components analysis (PCA). Under the PCA, the variables are first standardized (that is, they are demeaned and divided by their standard deviations), and then the asset/wealth index is constructed as the first principal component of the correlation matrix. The main problem with this *centered* PCA index is that it tends to give negative scores to assets that are owned only in rural areas, such as having cattle, and hence exaggerate the rural-urban divide (Wittenberg and Leibbrandt, 2015). As Wittenberg and Leibbrandt (2015) argue, it gives us information about wealth and the degree of 'urbanness' in the data.

Given this, Wittenberg and Leibbrandt (2015) advocate for the use of the procedure proposed by Banerjee (2010) to construct an *uncentered* PCA asset index. Under this procedure, we first divide the variables (assets) by their respective means to form a matrix $\boldsymbol{A}$, and then create the asset

[6] In this study, schooling progression equals $education/(age-6)$, where education is completed years of education.

[7] This information is only relevant for the older siblings in the household.

[8] These are radio, TV, telephone, cellular phone, refrigerator, bed/mattress, car, scotch cart, computer, and internet.

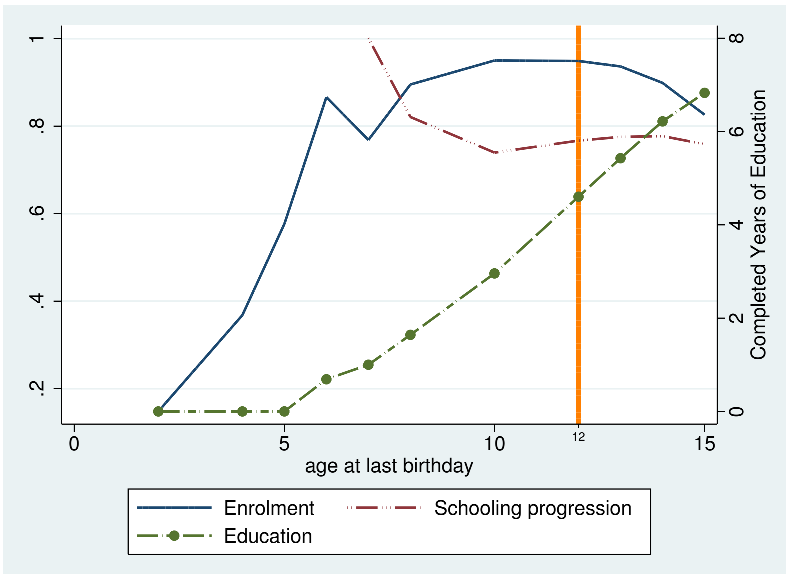
Table 1: Summary Statistics

Variables	Number of children	Mean	Overall Std.Dev.	Between Family Std.Dev	Within Family Std.Dev
Outcome variables					
Enrolment	77730	0.911	0.285	0.231	0.172
Education	77471	2.512	1.720	1.403	1.144
Schooling progression	67124	0.807	0.406	0.357	0.206
Child characteristics					
First-Born	77730	0.204	0.403	0.228	0.326
Second-Born	77730	0.481	0.500	0.350	0.403
Third-Born	77730	0.249	0.433	0.350	0.306
Fourth-Born	77730	0.061	0.239	0.165	0.173
Fifth-Born	77730	0.005	0.073	0.041	0.056
Male	77730	0.506	0.500	0.418	0.314
Age	77730	9.110	1.992	1.443	1.515
Family characteristics					
Household head education	73996	5.168	3.920	3.969	0
Rural	77730	0.764	0.425	0.434	0
Children	77730	3.287	0.973	0.951	0
Wealth Index	77730	0.964	29.977	30.686	0
Number of families	46973				

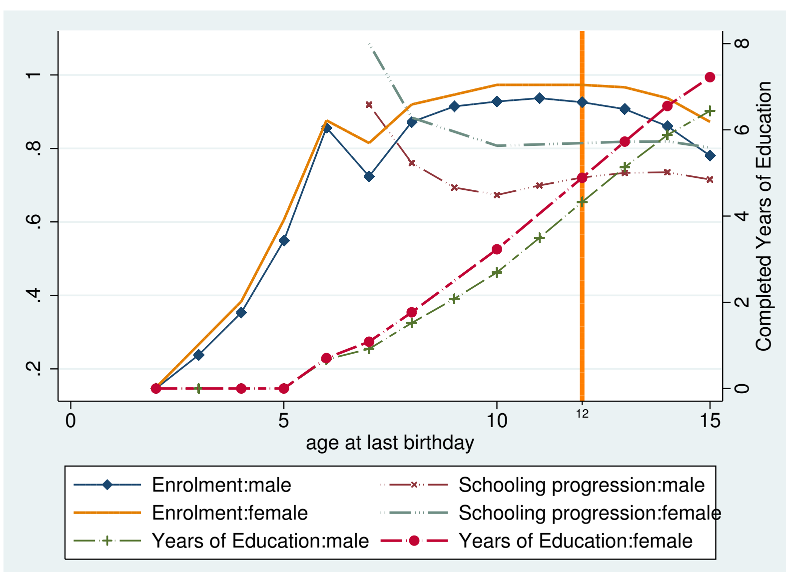
Source: Own calculations from 2006 Census. *Notes*: The sample is all children aged 6-12 from families with 2-5 children, and where the oldest observed child is at most 18 years. Education is completed years of education during the census period, Schooling progression equals $education/(age-6)$, and Enrolment is a equals 1 if a child is reported to be enrolled by the parent. The sample size is smaller for schooling progression because, for children aged 6, the measure is unidentified. I use the uncentered PCA (see Banerjee, 2010 and Wittenberg and Leibbrandt, 2015) to calculate the wealth index from household ownership of durable goods (e.g. TV, radio, etc.), land (i.e. number of fields), and livestock (e.g. number of cattle, sheep, horses, etc.). I use Martin Wittenberg's Stata code to calculate this index.

Figure 1: Educational Attainment, Age and Gender

(a) Educational Attainment by Age



(b) Educational Attainment by Age and Gender



Source: Own calculations from 2006 Census. *Notes*: The sample is all children aged 6-15 from families with 2-5 children, and where the oldest observed child is at most 18 years.

index as the first principal component of the non-negative square matrix $A'A$ (see Banerjee, 2010 and Wittenberg and Leibbrandt, 2015). Unlike the wealth index constructed using the ordinary PCA procedure, the uncentered PCA index is not only externally consistent in that it is a good proxy for household income and expenditure, but it is also internally consistent (Wittenberg and Leibbrandt, 2015)[9]. It, however, has the limitation that it pays more attention (that is, it gives large scores) to rare assets in the binary variable cases. Despite the differences, these indices (*the centered* PCA and *uncentered* PCA indices) are highly correlated in practice. I, therefore, construct the wealth index using the uncentered PCA procedure, and also create wealth quintiles from this index.

Table 1 presents the descriptive statistics of the outcome and control variables. We can see that about 91 percent of 6-12 year old children are enrolled, and their average completed years of education is 2.5. The average schooling progression (or relative grade attainment) is 0.81, which implies that children accumulate an average of 0.81 grades per year of schooling. The table also shows that there is more between-family variation than within-family variation in educational attainment. For example, the between- and within-family standard deviations in enrolment are 0.231 and 0.172, respectively.

Consistent with the 3.3 average children per family, there are more second-born children, about 48 percent, and relatively fewer first- and third-borns who, respectively, make up 20 percent and 25 percent. The share of fourth-borns is 6 percent, and the fifth-borns are least represented, making up only about 0.5 percent. The sample is equally split between males and females, and the average age is 9.1. In all these variables, unlike in educational attainment outcomes, there is almost as much within-family variation as there is between-family variation. The average household head's education is 5.3, and about 76 percent of children live in rural areas.

Figure 1 shows the relationship between educational outcomes and age. Figure 1 presents the overall picture, while Figure 1 shows the relationship by gender. We can see from Figure 1 that enrolment has an inverted U-shape relationship with age: it first increases with age up to 90 percent at age 10, and then starts to decline. Schooling progression first drops from about 1 grade per year of schooling at age 7 to a low of 0.75 at age 10. It then steadies just below 0.8 grades per year of schooling. On the other hand, completed years of education have a strong positive relationship with age; they strongly increase with age from age 6. Figure 1 reveals that, across all three measures of educational attainment, girls outperform boys. Therefore, in order to tease out the association between birth order and educational outcomes, one needs to control for age, among other potential confounding factors. I turn to this next.

[9] An internally consistent asset index ranks individuals with more of anything good (in this case assets) higher than individuals with less. Therefore, by satisfying these criteria, the uncentered PCA wealth index ranges from zero upwards, i.e. it is never negative, and can be used to calculate asset inequality.

5 Empirical Model

To estimate the effect of birth order on educational attainment, I follow De Haan *et al.* (2014) and estimate a family fixed effects model to address the endogeneity between birth order and observed and unobserved family specific fixed effects, including family size. The model is specified as

$$y_{if} = \alpha + \beta_2 \cdot Second_{if} + \beta_3 \cdot Third_{if} + \beta_4 \cdot Fourth_{if} + \beta_5 \cdot Fifth_{if} + X_{if}\theta + \lambda_f + \varepsilon_{if} \quad (1)$$

where y_{if} is the outcome of child i in family f; $Second$, $Third$, $Fourth$, and $Fifth$ are dummies for second, third, fourth, and fifth-born children, respectively; X_{if} is a vector of controls, including dummies for age and gender of the child, family wealth and birth order interaction dummies, and λ_f are family fixed effects. I add age dummies (that is, age fixed effects or birth cohort effects) to address the fact that the correlation between age and birth order within a family is high, which could bias the results. Controlling for birth cohort effects also addresses the fact that later-borns may face different educational opportunities compared to first-borns, either due to changes parental tastes for education or otherwise. In the OLS specification, X_{if} also includes location, household head's education, number of children in the family (or family size) as dummies. The estimation results allow for any arbitrary correlation within the family.

6 Results

In this section, I first present the paper's main results on birth order effects on educational attainment. Thereafter, I discuss the heterogeneities in birth order effects by family size and gender, and then discuss some sensitivity checks to the main results.

6.1 Birth order effects on educational attainment

Table 2 presents the estimated effects of birth order on educational attainment (that is, enrolment, completed years of education, and schooling progression) of 6-12 year old children. For each outcome, the table reports estimates for two different estimation strategies: the OLS estimates are reported in columns 1, 3, and 5; and the family fixed effects model estimates are reported in columns 2, 4, and 6. All specifications include dummies for child age, to control for cohort effects and sample selection bias[10], child gender, location, and location interacted with gender. In the OLS regressions, I also include household head's years of education, and a full set of dummies for

[10]Since educational attainment is only observed for children from families with at least two children aged between 6 and 12 years old, sample selection bias could arise. Controlling for age dummies makes the estimates consistent because, conditional on family fixed effects, whether or not we observe the child's outcome is wholly determined by her age at the time of the census (see De Haan *et al.*, 2014).

the number of children in the family (four in all), which control for the correlation between birth order and family size.

Looking at the OLS estimates in columns 1, 3, and 5 of the table, they reveal a significant positive relation between birth order and educational attainment. For example, relative to the first-born, an average second-born child has 0.05 more years of education, and accumulates 0.01 more years of education per year of schooling. We also see that educational attainment is negatively associated with family size, and this is consistent with previous findings by Black *et al.* (2005), De Haan (2010), De Haan *et al.* (2014), and Ponczek and Souza (2012). However, these results cannot be given any causal interpretation because of the possible bias due omitted unobserved family factors. In fact, we have seen in Table 1 that there is more between-family variation than within-family variation in all educational attainment measures. Therefore, the positive OLS birth order coefficients could be due to differences in educational attainment across families, not necessarily due to differential investments on children of different orders of birth within families.

In order to isolate the effect of birth order on educational attainment, I turn to family fixed effects specifications presented in columns 2, 4, and 6, respectively, for enrolment, completed years of education, and schooling progression. We immediately see that the estimates for educational attainment show a reverse birth order pattern from that produced by the OLS regression estimates, and that the fixed effects estimates are much larger, in absolute values, than the OLS estimates. This suggests that OLS estimates are potentially upward biased.

Looking at enrolment results in column 2 of the table, I find that higher birth order children are less likely to be enrolled compared to their first-born sibling, and this effect increases, in absolute values, with birth order. For example, relative to the first-born, a second-born has 6 percentage points less probability of enrolment, while the fifth-born is 30 percentage points less likely to be enrolled. This effect is sizeable. Relative to the average enrolment rate of 91 percent in the sample, this means that being a fifth-born reduces the enrolment probability by 33 percent ($= 30/90$) or 0.77 standard deviations ($= 0.30 \times (0.073/0.285)$).

Column 4 of Table 2 shows that a second-born completes 0.11 less years of education compared to her elder sibling. The later-born's disadvantage increases to 0.33 fewer years of education for the fifth-born. Similarly, there is a strong negative birth order effect on schooling progression (or relative grade attainment) in column 6, and the absolute effect is increasing with birth order. For example, relative to the first-born, a second-born child accumulates 0.13 less years of education (or grades) per year of schooling, while the fifth-born accumulates 0.63 fewer years of education for each year of schooling. This implies that first-borns progress much faster in school than their younger siblings, either due to early school entry or less grade repetition.

Overall, these results are in stark contrast with the previous evidence from other developing countries, including sub-Saharan Africa, showing strong positive birth order effects (De Haan *et al.*, 2014; Ejrnæs and Pörtner, 2004; Tenikue and Verheyden, 2010). The positive birth order effects have been interpreted as partial evidence for the financial resource dilution hypothesis. In other

Table 2: The Effect of Birth Order on Educational Attainment

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Enrolment		Education		Schooling progression	
	OLS	FE	OLS	FE	OLS	FE
Second-Born	0.00304	-0.0580***	0.0458***	-0.114***	0.0122***	-0.130***
	(0.00218)	(0.00620)	(0.0111)	(0.0207)	(0.00217)	(0.0105)
Third-Born	0.00402	-0.131***	0.0954***	-0.182***	0.0209***	-0.264***
	(0.00325)	(0.0121)	(0.0140)	(0.0398)	(0.00328)	(0.0205)
Fourth-Born	-0.0115*	-0.221***	0.133***	-0.255***	0.00826	-0.424***
	(0.00638)	(0.0184)	(0.0197)	(0.0595)	(0.00636)	(0.0312)
Fifth-Born	-0.0248	-0.303***	0.192***	-0.332***	-0.00488	-0.626***
	(0.0204)	(0.0311)	(0.0429)	(0.0919)	(0.0210)	(0.0554)
Three children	-0.00430		-0.0452***		-0.0113***	
	(0.00269)		(0.0111)		(0.00298)	
Four children	-0.0140***		-0.123***		-0.0270***	
	(0.00333)		(0.0131)		(0.00345)	
Five children	-0.0326***		-0.245***		-0.0552***	
	(0.00464)		(0.0175)		(0.00453)	
Constant	0.859***	0.997***	0.647***	1.103***	0.682***	1.292***
	(0.00531)	(0.0216)	(0.0192)	(0.0828)	(0.00657)	(0.0373)
Observations	73,996	73,996	73,758	73,758	73,758	63,917
R-squared	0.075	0.099	0.656	0.775	0.116	0.118
Number of Families		44,732		44,672		43,316

Notes: The sample is all children aged 6-12 from families with 2-5 children, and where the oldest observed child is at most 18 years. All regressions include household head's education, dummies for age (in years), and gender of the child, and location, location interacted with gender, and household head's education. Enrolment is a dummy which equals 1 if a child is reported as enrolled. Education is completed years of schooling. Schooling progression equals $education/(age-6)$. Standard errors (in parentheses) are clustered at the family level. ***significant at 1 percent, **significant at 5 percent, *significant at 10 percent.

words, it implies that liquidity constraints force families to invest less on earlier born children in spite of their comparative advantage in human capital accumulation (De Haan *et al.*, 2014; Horowitz and Wang, 2004; Tenikue and Verheyden, 2010). These results surprisingly affirm evidence from the developed world, and this is the first indication that they are less likely to be explained by the liquidity effect hypothesis (Black *et al.*, 2005; De Haan, 2010).

This evidence is consistent with the predictions of the confluence and 'strategic' parenting models of Zajonc (1976) and Hao *et al.* (2008). The first-borns not only have higher enrolment rates, but they also progress faster in school than their younger siblings, potentially due to the high quality investments they must have enjoyed while young (Cunha *et al.*, 2006; Heckman and Mosso, 2014). These childhood investments could have come in the form of high family intellectual environment, teaching younger siblings, breastfeeding longer than the younger siblings, and/or stricter parenting that instils much better discipline. It is important, therefore, to investigate some of these possible mechanisms through which these birth order effects are being propagated. But, before doing that, I first look at the differential effects of birth order according to family size and child gender.

6.2 Heterogeneities in birth order effects: family size and gender

Birth order effects may be different due to different family environments, for instance, different family sizes and differences in family gender preferences (Jayachandran and Kuziemko, 2011; Lafortune and Lee, 2014; Zajonc, 1976). Here I specifically test two hypotheses. First, if the confluence model is a good candidate model for explaining the observed birth order effects, then we should expect to see more pronounced birth order effects in large families because, all else equal, younger children are born in a low intellectual environment, and have to compete for limited parental time with their elder siblings. Second, the first-borns develop more skills as they teach their younger siblings. However, as families grow larger, birth order effects might get smaller (in absolute terms) or even dissipate for the middle-born children as the tutoring effect kicks in. That is, middle-born children may develop skills through teaching their younger siblings, thereby reducing the knowledge gap between them and the first-born.

According to Jayachandran and Kuziemko (2011), if parents prefer sons to daughters, girls will be weaned faster than boys so that parents can try again for a son, and once a boy is born, they nurse him for a longer time to reduce their fecundity (see also Zajonc, 1976). To wit, parents may passively invest differently on children of different birth orders based on their gender preferences. It follows then that the second hypothesis I test is that, if parents prefer girls' education over that of boys, then the negative birth order effects will be stronger for first-born girls than first-born boys. That is, these negative effects will be attenuated (or even reverse signs) in first-born boy families. I follow De Haan *et al.* (2014) in studying these two possible sources of heterogeneity in birth order effects.

6.2.1 Birth order effects by family size

I first explore the birth order effects by family size. Table 3 presents family fixed effects estimation results for families with two, three, four, and five children, in that order. The three columns present results for educational attainment outcomes: enrolment, years of education, and schooling progression, in that order. By and large, these results are consistent with the main findings: birth order negatively affects educational attainment, and the absolute effect intensifies with birth order.

In line with De Haan *et al.* (2014), I find that birth order effects are different for different family sizes. Looking at schooling progression results in column 3, for example, we can see that a second-born child in a two-child family accumulates 0.09 fewer years of education for each year of schooling relative to her first-born sibling, while a second-born in a four-child family accumulates twice as much less years of education per year of schooling as her counterpart in a two-child family: she accumulates 0.17 fewer years of education for each year of schooling than her first-born sibling. The second-born disadvantage relative the first-born drops to 0.14 grades per year of schooling in a five-child family. A similar pattern is observed for enrolment. The second-born in a two-child family is 4 percentage points less likely to enrol compared to the first-born, while her counterparts in four- and five-child families are, respectively, 9 and 5 percentage points less likely to enrol relative to the first-born. There is no such clear birth order effects pattern in the case of completed years of education.

To formally test for the equality of the coefficients, I estimate three fully interacted fixed effects models where every variable, not just birth order, is interacted with family size. This is equivalent to jointly estimating panels 1-4 of Table 3 for each outcome variable. The results are reported in Table A.1. The interactions between birth order and family size are statistically significant for enrolment and schooling progression, which implies that birth order effects on enrolment and schooling progression get larger (in absolute values) as the sibship size increases, but not on completed years of education. The pattern is more robust for schooling progression where all birth order interactions with family size are negative and statistically significant at 5 percent level. Furthermore, these effects seem not to dissipate as the family size increases.

6.2.2 Birth order effects by gender

I now turn to the heterogeneity in birth order effects by gender of the child. To disentangle birth order effects purely driven by gender biases from those due to sibling sex composition, I compare birth order effects for families of first-born sons versus those for families of first-born daughters (De Haan *et al.*, 2014). This is a relevant margin to examine because, if parents do have strong preferences for girls, a favourable treatment for girls should give us stronger birth order effects among families with first-born girls. Put differently, the first-born boys will have less or no advantage over their younger siblings.

Table 4 presents family fixed effects birth order estimates for two separate samples of, respect-

Table 3: Birth Order Effect on Education Attainment and Child labour, Fixed Effects by Family Size

VARIABLES	(1) Enrolment	(2) Education	(3) Schooling progression
	Two-child families		
Second-Born	-0.0411***	-0.102**	-0.0912***
	(0.0125)	(0.0446)	(0.0244)
Observations	17,812	17,771	15,507
	Three-child families		
Second-Born	-0.0467***	-0.111***	-0.109***
	(0.00985)	(0.0340)	(0.0175)
Third-Born	-0.101***	-0.312***	-0.220***
	(0.0198)	(0.0671)	(0.0349)
Observations	26,882	26,803	23,237
	Four-child families		
Second-Born	-0.0869***	-0.0900**	-0.170***
	(0.0118)	(0.0378)	(0.0191)
Third-Born	-0.162***	-0.285***	-0.326***
	(0.0221)	(0.0708)	(0.0367)
Fourth-Born	-0.243***	-0.577***	-0.516***
	(0.0332)	(0.106)	(0.0551)
Observations	19,570	19,494	16,799
	Five-child families		
Second-Born	-0.0493**	-0.0733	-0.142***
	(0.0194)	(0.0641)	(0.0267)
Third-Born	-0.132***	-0.221**	-0.293***
	(0.0329)	(0.102)	(0.0485)
Fourth-Born	-0.224***	-0.461***	-0.445***
	(0.0478)	(0.147)	(0.0713)
Fifth-Born	-0.286***	-0.734***	-0.633***
	(0.0643)	(0.194)	(0.0992)
Observations	9,732	9,690	8,374

Notes: The sample is all children aged 6-12 from families with 2-5 children, and where the oldest observed child is at most 18 years. All regressions include household head's education, dummies for age (in years), and gender of the child, and location, location interacted with gender, and household head's education. Enrolment is a dummy which equals 1 if a child is reported as enrolled. Education is completed years of schooling. Schooling progression equals $education/(age-6)$. Standard errors (in parentheses) are clustered at the family level. ***significant at 1 percent, **significant at 5 percent, *significant at 10 percent.

Table 4: The Effect of Birth Order on Educational Attainment and Child labour, Fixed Effects by Gender of the First-Born

VARIABLES	First-Born is a Boy			First-Born is a Girl		
	(1)	(2)	(3)	(4)	(5)	(6)
	Enrolment	Education	Schooling progression	Enrolment	Education	Schooling progression
Second-Born	-0.0612***	-0.0220	-0.138***	-0.0616***	-0.196***	-0.119***
	(0.00948)	(0.0315)	(0.0157)	(0.00878)	(0.0287)	(0.0150)
Third-Born	-0.123***	-0.0655	-0.257***	-0.143***	-0.293***	-0.266***
	(0.0181)	(0.0596)	(0.0302)	(0.0167)	(0.0534)	(0.0285)
Fourth-Born	-0.207***	-0.117	-0.400***	-0.237***	-0.390***	-0.440***
	(0.0275)	(0.0889)	(0.0461)	(0.0250)	(0.0796)	(0.0426)
Fifth-Born	-0.278***	-0.164	-0.575***	-0.331***	-0.507***	-0.667***
	(0.0457)	(0.138)	(0.0834)	(0.0428)	(0.122)	(0.0741)
Observations	36,605	36,475	31,675	37,391	37,283	32,242
R^2	0.089	0.753	0.135	0.110	0.795	0.104

Notes: The sample is all children aged 6-12 from families with 2-5 children, and where the oldest observed child is at most 18 years. All regressions include household head's education, dummies for age (in years), and gender of the child, and location, location interacted with gender, and household head's education. Enrolment is a dummy which equals 1 if a child is reported as enrolled. Education is completed years of schooling. Schooling progression equals $education/(age-6)$. Standard errors (in parentheses) are clustered at the family level. ***significant at 1 percent, **significant at 5 percent, *significant at 10 percent.

ively, families with first-born boys (in columns 1 to 3), and families with first-born girls (in columns 4 to 6). There are huge differences in birth order effects across these families, and these results are largely consistent with the girl-bias hypothesis. While birth order effects on completed years of education for families with first-born girls are strongly negative, and consistent with the main results, there are no significant birth order effects on completed years of education in families with first-born boys. We can further see that birth order effects on enrolment and schooling progression in first-born-girl families are slightly larger, in absolute values, than in first-born-boy families, especially for fifth-borns relative to the first-born. Taking the fifth-borns in first-born-boy families, for example, we can see that, compared to the first-born, they are 28 percentage points less likely to be enrolled, and they accumulate 0.6 fewer grades per year of schooling, while their counterparts in first-born-girl families are 33 percentage less likely to enrol, and accumulate 0.7 fewer grades for each year of schooling.

I formally test for the equality of birth order effects between first-born-boy and first-born-girl families by estimating fully interacted models, where every variable is interacted with a dummy for first-born-girl families. The results are presented in Table A.2. The results show that there are statistically significant differences in birth order effects on completed years of education between first-born-boy and first-born-girl families, but not on enrolment and schooling progression. For example, a second-born in a first-born-girl family has 0.193 less years of education than his/her elder sister, which is 0.18 years lower than what his/her counterpart in a first-born-boy family gets. This implies that later-borns are more disadvantaged, in terms of completed years of education, if they have a first-born sister than when they have a first-born brother.

To sum up, the evidence presented in this subsection shows that birth order effects on educational attainment are larger, in absolute terms, in larger families, and they appear not to evaporate with the increase in family size. Moreover, birth order effects are larger in first-born-girl families, and this is consistent with the hypothesis that parents prefer to educate girls more than boys. The fact that first-borns' advantage increases with sibship size could possible be due to: (1) the dilution of familial resources as the family size increases, (2) the lower intellectual environment, relative to the first-born, that later-borns are born into, or (3) the strict disciplinary environment that the first-born are brought up with. In the following section, I narrow down on the potential transmission mechanisms of these birth order effects. I begin with checking the sensitivity of the main results.

6.3 Sensitivity checks

In this subsection, I present sensitivity checks of the main birth order results to different sample restrictions made to reduce measurement error in the birth order measure. The sample restrictions imposed in Section 4 are: (1) that families should have at least two children, with the eldest aged at most 18 years old, and (2) that families should have a maximum of five children. I further

Table 5: The Effect of Birth Order on Educational Attainment: 6-18 year-old children sample

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Enrolment		Education		Schooling progression	
	OLS	FE	OLS	FE	OLS	FE
Second-Born	0.00420**	-0.0106***	0.0275***	-0.0408**	0.0111***	-0.0464***
	(0.00194)	(0.00365)	(0.0103)	(0.0173)	(0.00182)	(0.00390)
Third-Born	0.00883***	-0.0219***	0.107***	-0.0184	0.0183***	-0.0939***
	(0.00303)	(0.00687)	(0.0138)	(0.0323)	(0.00377)	(0.00719)
Fourth-Born	-0.00131	-0.0455***	0.199***	0.0579	-0.00705	-0.163***
	(0.00609)	(0.0107)	(0.0203)	(0.0484)	(0.00943)	(0.0122)
Fifth-Born	-0.00983	-0.0749***	0.301***	0.118	-0.0578	-0.245***
	(0.0201)	(0.0234)	(0.0468)	(0.0889)	(0.0404)	(0.0394)
Three children	-0.00516**		-0.0347***		-0.00895***	
	(0.00247)		(0.0129)		(0.00262)	
Four children	-0.0146***		-0.119***		-0.0289***	
	(0.00298)		(0.0152)		(0.00301)	
Five children	-0.0413***		-0.311***		-0.0564***	
	(0.00414)		(0.0212)		(0.00389)	
Constant	0.858***	0.907***	0.623***	1.007***	0.992***	1.148***
	(0.00506)	(0.0149)	(0.0208)	(0.0737)	(0.00799)	(0.0166)
Observations	123,603	123,603	123,304	123,304	113,463	113,463
R^2	0.153	0.170	0.740	0.768	0.147	0.113
Number of Families		49,484		49,460		49,458

Notes: The sample is all children aged 6 to 18 years old from families with 2-5 children, and where the oldest observed is at most 18 years. All regressions include household head's education, dummies for age (in years), correcting for cohort effects, and gender of the child, and dummies for location, and location interacted with child's gender. Enrolment is a dummy which equals 1 if a child reported as enrolled. Education is completed years of schooling. Schooling progression equals $education/(age-6)$. Standard errors (in parentheses) are clustered at the family level. ***significant at 1 percent, **significant at 5 percent, *significant at 10 percent.

restricted the analytical sample to children aged 6-12 years, which could introduce sample selection bias because educational attainment is only observed for some but not all children in families with 6-18 year old children. I first relax these restrictions and compare the results with the main results which are based on stricter sample selection criteria. Relaxing these restrictions increases the sample size as well as the measurement error.

Table 5 presents fixed-effects model results based on a much bigger sample of 6-18 year-old children from families where the eldest child is at most 18 years old. Since the oldest child observed in the family may not necessarily be the eldest child, there is high measurement error in the birth order measure. As we can see from the table, the birth order effects on educational attainment are still negative, and are very similar to the results reported in Table 2, in spite of the increased measurement error in the birth order measure. However, the birth order effects in this sample appear to be underestimated (that is, biased towards zero).

The possibility that the observed oldest child in the household might not be the eldest living child of the household forced one to restrict the analytical sample to 6-12 year old children. Thus, the results may suffer from sample selection bias, even though controlling for age fixed effects is an attempt to address this problem, as mention in footnote 10.

Table 6: Birth Order Effects on Educational Achievement: Young Mothers Families

VARIABLES	(1) Enrolment	(2) Education	(3) Schooling progression
Second-Born	-0.0241***	-0.0475**	-0.0667***
	(0.00524)	(0.0239)	(0.00652)
Third-Born	-0.0599***	-0.0444	-0.141***
	(0.0102)	(0.0451)	(0.0125)
Fourth-Born	-0.112***	0.0351	-0.225***
	(0.0173)	(0.0702)	(0.0241)
Fifth-Born	-0.118***	0.167	-0.265***
	(0.0443)	(0.156)	(0.0781)
Constant	0.922***	1.001***	1.158***
	(0.0177)	(0.0843)	(0.0219)
Observations	56,750	56,586	50,311
R^2	0.113	0.789	0.113

Notes: Fixed-effects regression results. The sample is all children aged 6 to 18 years old from families of young mothers (i.e. women aged 35 years or less and are household heads or household head spouses) with 2-5 children, and where the oldest observed is at most 18 years old. All regressions include household head's education, dummies for age (in years), correcting for cohort effects, and gender of the child, and dummies for location, and location interacted with child's gender. Enrolment is a dummy which equals 1 if a child reported as enrolled. Estimates are from fully interacted fixed effects models where all birth order dummies and controls variables are interacted with the wealth index. Education is completed years of schooling. Schooling progression equals $education/(age - 6)$. Standard errors (in parentheses) are clustered at the family level. ***significant at 1 percent, **significant at 5 percent, *significant at 10 percent.

To formally check the robustness of the results against this potential sample selection bias, I estimate birth order effects using a sample of families of 'young mothers'. I define 'young mothers' as all women aged 35 years and below, and are either household heads or household head spouses. These are mothers who are less likely to have children older than 18 years, which allows one to estimate birth order effects on a sample of 6-18 year olds with little measurement error.

According to the 2009 Lesotho Demographic Health Survey report (SIF, 2011), Lesotho's overall fertility rate has been on the decline since the 1970s, but that of women aged 15-19 years has been on the rise over the same period. Between 2004 and 2009, the proportion of 15-19 year old women who have ever given birth to more than one child increased from 0.8 percent to 1.5 percent. This implies that in the 1980s, when most of our young mothers were teenagers, giving birth to at least two children as a teenager was a rarity. If we assume that a woman gave birth for the first time at age 17, her eldest child, if alive, must be 18 years old in 2006. Therefore, restricting the sample to families of mothers aged at most 35 years essentially ensures that there are no over-eighteen year old siblings omitted in the sample, and hence provides the most accurate birth order measure among the 6-18 year olds, although at a cost of a relatively small sample size.

Table 6 presents fixed effects model results using a sample of young mothers' families with at least two children aged between 6 and 18 years old, where the eldest is at most aged 18. We can see from the table that birth order effects on educational attainment and child labour participation are negative. However, it appears that the birth order effects on educational attainment in this table are almost half, in absolute values, the main effects reported in Table 2, but larger than those reported in Table 5. Notwithstanding these differences, it appears that, by and large, the results presented in Tables 5 and 6 are qualitatively the same as the main birth order effects findings. Therefore, I conclude that the main results are not very sensitive to the imposed sample selection criteria.

7 Potential pathways of negative birth order effects

In this section I investigate two mechanisms through which birth order effects can be propagated: the liquidity effect (or wealth) channel, and the birth-spacing (or child-spacing) channel. The decision to look at these two potential transmission mechanisms is purely based on data availability. I begin with the wealth channel and then turn to the child-spacing channel.

7.1 Family wealth

According to the liquidity effect hypothesis, as the household gets larger, per capita household resources get depleted, and this may force the household to send the first born to the labour market to relax the household's budget constraint (Tenikue and Verheyden, 2010). This hypothesis predicts positive birth order results, contrary to the evidence presented in this paper thus far.

Table 7 discloses the fixed effects birth order results, with wealth index interactions. Following De Haan *et al.* (2014), I estimate fully interacted fixed effects models where birth order dummies and included control variables are interacted with the wealth index. We can see from the table that birth order effects are largely consistent with the earlier findings: birth order negatively affects educational attainment. More importantly, these results do not support the hypothesis that the observed birth order effects are transmitted through wealth. All the wealth-index–birth-order interactions are insignificant, and the coefficients are approximately equal to zero. Moreover, comparing the birth order results from this table with the main birth order results reported in Table 2, we can see that the magnitudes are almost the same. Therefore, based on these results, there is no evidence to support the hypothesis that the observed birth order effects are propagated by wealth.

7.2 Child-spacing

I now turn my attention to the birth- or child-spacing channel. According to the confluence model, birth order effects on human capital development are wholly transmitted by the birth interval between successive siblings (Zajonc, 1976).

For the analysis that follows, I define birth-spacing as the actual age gap between two successive

Table 7: Fixed Effects Estimates of Birth Order, Interacted with Wealth Index

VARIABLES	(1)	(2)	(3)
	Enrolment	Education	Schooling progression
Second-Born	-0.0578***	-0.114***	-0.130***
	(0.00620)	(0.0207)	(0.0105)
Third-Born	-0.130***	-0.181***	-0.263***
	(0.0121)	(0.0398)	(0.0205)
Fourth-Born	-0.220***	-0.255***	-0.423***
	(0.0184)	(0.0595)	(0.0312)
Fifth-Born	-0.304***	-0.334***	-0.628***
	(0.0312)	(0.0921)	(0.0559)
Second-Born×wealth_index	4.57e-05	-0.000282	0.000638
	(0.000411)	(0.00119)	(0.000886)
Third-Born×wealth_index	0.000287	-0.000774	0.00109
	(0.000874)	(0.00227)	(0.00207)
Fourth-Born×wealth_index	-9.11e-05	-0.000671	0.00148
	(0.00129)	(0.00330)	(0.00286)
Fifth-Born×wealth_index	0.00109	-6.28e-05	0.00284
	(0.00180)	(0.00470)	(0.00440)
Constant	0.962***	1.121***	1.237***
	(0.0273)	(0.114)	(0.0449)
Observations	73,996	73,758	63,917
R-squared	0.099	0.776	0.118

Notes: The sample is all children aged 6-12 from families with 2-5 children, and where the oldest observed child is at most 18 years. All regressions include household head's education, dummies for age (in years), and gender of the child, and location, location interacted with gender, and household head's education. Enrolment is a dummy which equals 1 if a child is reported as enrolled. Education is completed years of schooling. Schooling progression equals $education/(age - 6)$. Standard errors (in parentheses) are clustered at the family level. ***significant at 1 percent, **significant at 5 percent, *significant at 10 percent.

siblings within a family. For example, the age between the first- and second-born is given by the difference between their respective ages. Because the first-born follows no one, the age gap for this child is undefined.

The regression results for birth order, child-spacing, and their interaction (with family fixed effects) are presented in Table 8. As in the case of wealth effects above, these results are from fully interacted models where all variables, not just birth order, are interacted with birth-space. Looking at these results, we can see that birth order effects on enrolment, completed years of education, and schooling progression are still negative, as in the main results. In addition, the magnitudes of the coefficients are slightly larger than those reported in the main results, Table 2, particularly the fifth-borns' disadvantage in completed years of education relative to first-born where the difference is largest, about 0.1 years.

More interestingly, birth order interactions with child-spacing are negative and statistically significant in the completed years of education regression. This indicates that child-spacing amplifies the negative birth order effects on completed years of education. For example, increasing the age gap between the third- and fourth-born by one year reduces the fourth-born's completed years of education by 0.24 (that is, $-0.230 - 0.00848$) years relative to the first born.

These results are consistent with models that emphasise the importance of early quality investments (in the form of high intellectual enrolment and/or strict parenting which instils discipline) enjoyed by the first-born children as the driving force behind birth order effects. Without better data, however, it is difficult to pin down which mechanism, whether the intellectual environment or the strict parenting, birth-spacing actually captures in this context.

8 Conclusion

In this paper, I examine the effect of birth order on educational attainment in Lesotho using the 2006 Census data for children aged 6 to 12 years. Applying family fixed effects models, I find robust negative birth order effects on all measures of educational attainment (enrolment, completed years of education, and schooling progression). These results are in stark contrast with previous evidence from developing countries, but much in line with that from the developed world, and hence strongly challenge the idea that birth order effects in developing countries are largely due to wealth constraints.

I also investigate heterogeneities in birth order effects due to family size and family gender bias, and find that birth order effects are more pronounced in large families. I take this as part evidence for the confluence model predictions. Furthermore, there is strong evidence that girls' education is favoured over that of boys.

Turning to the potential pathways through which these birth order effects operate, there is evidence that they are mainly transmitted through the average age gap between two close siblings. I find no support for the hypothesis that birth order effects are propagated through family wealth

Table 8: Effect of the child-spacing, birth order and their interaction on educational development and child labour, with Fixed Effects

VARIABLES	(1) Enrolment	(2) Education	(3) Schooling progression
Second-Born	-0.0596***	-0.116***	-0.132***
	(0.00623)	(0.0209)	(0.0105)
Third-Born	-0.126***	-0.177***	-0.263***
	(0.0121)	(0.0397)	(0.0204)
Fourth-Born	-0.214***	-0.230***	-0.423***
	(0.0187)	(0.0601)	(0.0314)
Fifth-Born	-0.311***	-0.405***	-0.654***
	(0.0350)	(0.104)	(0.0619)
Second-Born×Birth-Space	-0.000792	-0.00649	-0.00285
	(0.00144)	(0.00412)	(0.00308)
Third-Born×Birth-Space	-0.00118	-0.00716*	-0.00305
	(0.00145)	(0.00412)	(0.00308)
Fourth-Born×Birth-Space	-0.00104	-0.00848**	-0.00299
	(0.00150)	(0.00421)	(0.00314)
Fifth-Born–Birth-Space (omitted)	0	0	0
	(0)	(0)	(0)
Constant	0.994***	1.183***	1.298***
	(0.0220)	(0.0842)	(0.0380)
Observations	77,730	77,471	67,124
R-squared	0.098	0.776	0.121

Notes: The sample is all children aged 6-12 from families with 2-5 children, and where the oldest observed child is at most 18 years. All regressions include household head's education, dummies for age (in years), and gender of the child, and location, location interacted with gender, and household head's education. Enrolment is a dummy which equals 1 if a child is reported as enrolled. Education is completed years of schooling. Schooling progression equals $education/(age-6)$. Birth-space is the actual age gap between successive siblings. Standard errors (in parentheses) are clustered at the family level. ***significant at 1 percent, **significant at 5 percent, *significant at 10 percent.

as previously found in other developing countries. Taken together, the evidence presented here largely supports the notion that it is early quality investments enjoyed by earlier-born children that gives them a comparative advantage over their siblings in human capital accumulation. More research is, however, needed to test many other potential pathways that could strengthen this explanation. For example, do pre- and post-natal parental investments on children vary with birth order?, If so, how? Answering these questions could help narrow down the main transmission mechanisms of these birth order effects.

In order to attenuate these birth order effects and increase educational attainment of later-borns, it is essential that the government designs policies that will improve school participation of later-borns, especially boys and those from larger families. Without speculating on the general equilibrium effects, one such policy intervention could be the introduction of conditional cash transfers to larger families, particularly those with first-born boys.

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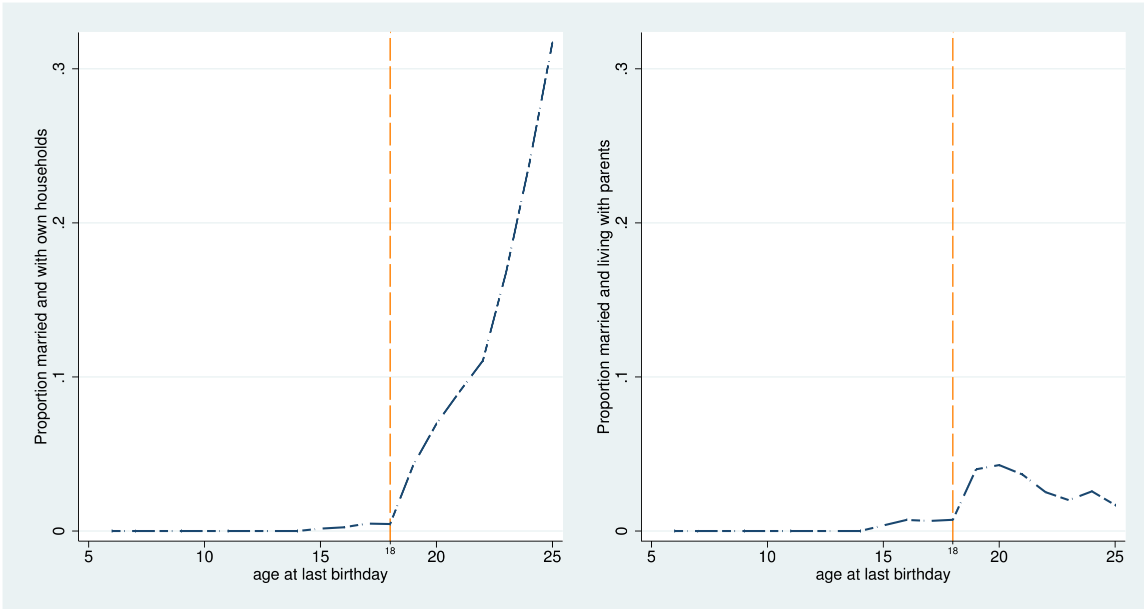
A Appendix

Figure A.1: Proportion of children out of their biological families



Source: Own calculations from 2006 Census. *Notes*: The left panel of the figure shows the proportion of 6-25 year olds who are household heads or spouses by age, while the right panel shows the proportion of 6-25 year olds who are sons/daughters-in-law in a household by age.

Table A.1: Birth Order Effect on Education Attainment, Fixed Effects by Family Size: Fully interacted models

VARIABLES	(1) Enrolment	(2) Education	(3) Schooling progression
Second-Born	-0.0296	-0.157**	-0.0464
	(0.0219)	(0.0743)	(0.0377)
Third-Born	-0.0505	-0.355**	-0.0654
	(0.0442)	(0.147)	(0.0768)
Fourth-Born	-0.00475	-0.639**	-0.149
	(0.0824)	(0.260)	(0.142)
Fifth-Born (omitted)	-	-	-
Second-Born×Family Size	-0.00839	0.0194	-0.0238**
	(0.00650)	(0.0216)	(0.0106)
Third-Born×Family Size	-0.0202	0.0249	-0.0538**
	(0.0126)	(0.0408)	(0.0210)
Fourth-Born×Family Size	-0.0482**	0.0291	-0.0731**
	(0.0214)	(0.0673)	(0.0360)
Fifth-Born×Family Size	-0.0628***	-0.159***	-0.145***
	(0.00963)	(0.0293)	(0.0160)
Constant	0.996***	1.191***	1.301***
	(0.0214)	(0.0850)	(0.0383)
Observations	77,730	77,471	67,124
R^2	0.099	0.778	0.121
Number of Families	46,973	46,905	45,500

Notes: The sample is all children aged 6-12 from families with 2-5 children, and where the oldest observed child is at most 18 years. All regressions include household head's education, dummies for age (in years), and gender of the child, and location, location interacted with gender, and household head's education. Enrolment is a dummy which equals 1 if a child is reported as enrolled. Education is completed years of schooling. Schooling progression equals $education/(age-6)$. Standard errors (in parentheses) are clustered at the family level. ***significant at 1 percent, **significant at 5 percent, *significant at 10 percent.

Table A.2: The Effect of Birth Order on Educational Attainment, Fixed Effects by Gender of the First-Born: Fully Interacted model

VARIABLES	(1) Enrolment	(2) Education	(3) Schooling progression
Second-Born	-0.0602***	-0.0130	-0.138***
	(0.00923)	(0.0306)	(0.0153)
Third-Born	-0.122***	-0.0522	-0.257***
	(0.0176)	(0.0580)	(0.0294)
Fourth-Born	-0.206***	-0.0995	-0.403***
	(0.0267)	(0.0864)	(0.0451)
Fifth-Born	-0.285***	-0.137	-0.584***
	(0.0445)	(0.134)	(0.0815)
Second-Born ×FirstBorn_Girl	-0.00156	-0.180***	0.0179
	(0.0126)	(0.0415)	(0.0211)
Third-Born×FirstBorn_Girl	-0.0193	-0.239***	-0.00575
	(0.0239)	(0.0780)	(0.0405)
Fourth-Born×FirstBorn_Girl	-0.0248	-0.283**	-0.0303
	(0.0361)	(0.116)	(0.0614)
Fifth-Born×FirstBorn_Girl	-0.0326	-0.367**	-0.0657
	(0.0606)	(0.179)	(0.109)
Constant	1.001***	1.056***	1.295***
	(0.0216)	(0.0819)	(0.0373)
Observations	77,730	77,471	67,124
R-squared	0.098	0.776	0.122
Number of num_id	46,973	46,905	45,500

Notes: The sample is all children aged 6-12 from families with 2-5 children, and where the oldest observed child is at most 18 years. All regressions include household head's education, dummies for age (in years), and gender of the child, and location, location interacted with gender, and household head's education. Enrolment is a dummy which equals 1 if a child is reported as enrolled. Education is completed years of schooling. Schooling progression equals $education/(age-6)$. Estimates are from fully interacted fixed effects models where all birth order dummies and controls variables are interacted with First-Born-Girl dummy. Standard errors (in parentheses) are clustered at the family level. ***significant at 1 percent, **significant at 5 percent, *significant at 10 percent.