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Abstract

Using panel data from Madagascar, we study how birth order influences the transition into adulthood. We find that earlier borns drop school at a younger age, attain less schooling, and thus have lower cognitive skills than later borns. They also start working out of the family firm earlier and girls marry younger. The precocious transition of the firstborn is likely to finance younger siblings' education. These mechanisms are stronger in rural areas, where the liquidity constraints are stronger. Results are robust to different specifications commonly used in the birth order literature and are not sensitive to the presence of fostered children in the household.

Keywords

Birth order; educational attainment; age at marriage; transition into adulthood; liquidity constraint.

JEL Codes

D1; I2; J1.

1 Introduction

By chance we are born first, second, third or last. The order of birth is purely random. Yet it can be decisive in explaining why we are more or less educated, rich, why we have one job or another, why we get married at a certain age. Parents, more or less consciously, invest differently in their children depending on their birth order, and this indirectly influences key outcomes in their adult life. This is especially true in contexts where resources are scarce and where the competition between siblings is therefore high.

The role of birth order on lifelong outcomes has been widely studied in developed countries. Literature has shown that firstborns perform better than their younger siblings in most aspects of life. They have higher cognitive and non-cognitive skills, are more educated and healthier and have better jobs (Black, 2017). Different dynamics could be in place in developing countries because of the tightest budget constraints of the households (Tenikue and Verheyden, 2010), but also because of cultural and legal factors. The pervasive role of the extended family in children rearing (Cox and Fafchamps, 2007), the extensive use of fostering practices (Marazyan, 2015), differences in gender preferences, as well as specific formal or informal inheritance and succession rules, could conduct to a different relationship between order of birth and child development in poor countries. Indeed, in those contexts, when the effects of the order of birth have been explored, this has yielded to mixed results, with some authors finding similar results as for developed countries on educational achievement and cognition (Moshoeshoe, 2019; Schwefer, 2018; Calimeris and Peters, 2017), while others pointing at positive effects of birth order (Eirnæs and Pörtner, 2004; Emerson and Souza, 2008; De Haan et al., 2014; Botzet et al., 2020).

In this paper, we explore the effects of birth order on schooling outcomes and cognition development in Madagascar, an extremely poor country. We also study how birth order shapes transitions into adulthood i.e., age at entry on the labour market and age at marriage.

To shed light on these issues, we use detailed data from a survey that tracked a cohort of individuals when they were around 14 years old (in 2004) and then when they were around 22 years old (in 2012). The second wave of the survey was explicitly designed to capture the transition from adolescence to young adulthood. Therefore, we have detailed information on school, work and marriage history for those individuals. Their cognitive (and non-cognitive) skills were also assessed both in 2004 and in 2012.

Using a between-family model with sibship size fixed effects, we find that earlier borns transit earlier into adulthood. First (and second) borns drop out from school relatively early as compared to their later born siblings. Because of that, they have lower education levels and cognitive skills. Firstborns also work outside the family firm for the first time at younger

ages than later borns. Hence they can provide the household with an extra income that can be invested into third and later borns' education. The positive effects of birth order on education and age at entry in the labor market are particularly strong for children whose oldest sibling is a male. While birth order seems to be particularly important for females when it comes to marriage: we find that firstborns females marry at a younger age than their sisters. We are not able to establish whether this also occurs for firstborn males.

We do not find any direct effect of birth order on cognitive (and non cognitive) skills, suggesting that birth order does not influence the amount and the quality of parental resources received in early childhood. We speculate that in the Malagasy context the quality time parents spend with children is relatively less important because children develop their cognitive (and non cognitive) skills through interactions with the members of the extended family (see the concept of *fihavanana* in [Ottino \(1998\)](#)) rather than with the members of their nuclear family only.

The heterogeneity analysis by area of residence allows us to observe that our results are mostly driven by individuals living in rural areas. They could thus be explained with the way parents manage the legacy of their land. When parents share their land endowment between their children, the size of the plots reduces. In order to limit this, some parents could prefer to transmit the physical capital to earlier borns, and to compensate the latest ones transmitting them more human capital, i.e. sending them to school longer.

Our results are robust to the utilisation of different measures of birth order, either social or biological. Taking into account all children living with the cohort member at age 14, we still find that oldest children in the household are the ones who dropout from school and start working outside the household the youngest. It means that older non-biological children living in the household take over biological firstborns workload which allow them to complete higher school attainment. However, even if they have oldest 'social' siblings in the households, biological firstborns still marry the youngest.

Finally, thanks to the detailed information on cohort members' siblings collected in 2012, we are able to verify the robustness of our findings on schooling and age at marriage using a within-family model, which is considered the best methodology to take into account all family characteristics that could bias the results ([Black, 2017](#)).

Our work contributes to the literature on birth order's effects on a diversity of outcomes that are related to the transition into adulthood. In particular we contribute to shed light on the effects of birth order on (i) education and cognition, on (ii) entry in the labor market and (iii) marriage timing. We do this in a developing country, for which these research questions have been less explored.

Parental time investment has been shown to have a strong effect on the formation of

cognitive (and non-cognitive) skills, especially at early stages of life (Hsin, 2007; Cunha and Heckman, 2008; Carneiro and Rodrigues, 2009; Cunha et al., 2010; Lehmann et al., 2018; Attanasio et al., 2020). Literature shows that the time spent by parents with earlier and later-borns varies across countries. In the US, later-borns spend less quality time with their mother. They are less cognitively stimulated by her than earlier borns (Monfardini and See, 2016; Lehmann et al., 2018). Coherently with that, studies focused on developed countries, show that later-borns have lower cognitive abilities than their older siblings (see for example Black et al. (2005) for Sweden and Barclay (2015) for Norway). For developing countries, conversely, there is no consensus on the effect of birth order on cognitive skills. In Ecuador, De Haan et al. (2014) find that later born children receive more cognitive stimulation by their mothers, are breastfed longer and this translates in higher cognitive tests. On the other hand, in Indonesia, Calimeris and Peters (2017) find that second and third born perform worse than firstborns on cognitive skills for children aged between 7 and 14.

The effect of birth order on cognitive skills is related to the effect of birth order on education. It is generally admitted that in developed economies, later-borns have a lower educational attainment than their older siblings (e.g., Booth and Kee (2009) for Great Britain and Black et al. (2005) for Norway).¹ In developing economies, results are more mixed. Some authors find a negative effect of birth order on educational outcomes, as in developed countries (Schwefer, 2018; Moshoeshoe, 2019). Others find a completely opposite effect: later-borns are more educated than earlier borns (Lee et al., 1994; Eirnæs and Pörtner, 2004; Emerson and Souza, 2008; De Haan et al., 2014; Botzet et al., 2020). In Madagascar, we find a positive effect of the order of birth on schooling duration and education level, and we also show a positive effect on cognitive skills that passes through schooling.²

Research has widely demonstrated that in countries where child work is widespread (i.e. Nepal (Edmonds, 2006), Brazil (Emerson and Souza, 2008), Guatemala (Dammert, 2010), Ethiopia (Alvi and Dendir, 2011; Haile and Haile, 2012) and Ecuador (De Haan et al., 2014)), firstborns are more likely to work than their younger siblings at time t and they also work longer hours. This is rationale because wages increase with the age of child workers (Freije and Lopez-Calva, 2001). However, as far as we know, only Bertoni and Brunello (2016) estimated the effect of birth order on the age at entry on the labor market, in European countries.³ This remains an open question for developing countries. We show that (male) firstborns living in rural areas are sent to work outside the family firm at younger ages than their later born siblings; we suppose that in the Malagasy poor context, parents send the

¹See Botzet et al. (2020) for a literature review of findings in developed countries).

²In additional results, presented in Annex A.5, we show that birth order does not affect non-cognitive skills development in the Malagasy context.

³They found that firstborns start to work 0.7 year later than later-borns. It is mostly due to their longer education.

earlier born child to work to provide more resources to the whole sibship and this occurs at the detriment of their education.

The effect of birth order on the time of marriage was explored by the seminal paper of [Vogl \(2013\)](#), who shows that in South Asian countries, where arranged marriages are prevalent and dowry is customary, girls marry earlier when they have young sisters. [Vogl \(2013\)](#) claims that parents rush earlier-borns' marriage - choosing a less educated and skilled husband - to have a lower dowry to pay and more time to accumulate following dowries to ultimately marry all their younger daughters.⁴ This could also be valid for a context where dowry is not customary, because female's value on the marriage market declines with age ([Wahhaj, 2018](#)): when parents have more daughters to marry, they could feel some pressure to rush the marriage of the oldest ones because they have other marriages to arrange in a short period of time, before their daughters become too old to find a spouse.⁵ In Madagascar, where bride price transfers are small or symbolic⁶, we show that having older sisters is associated with a delay in marriage. This is coherent with the results of [Pesando and Abufhele \(2019\)](#), who find that the probability of child marriage decreases with the number of older sisters in Ethiopia, India and Vietnam. Moreover, if siblings differ in their education outcomes according to their order of birth, they could also differ in terms of marriage timing: siblings with higher education levels are likely to marry later. In this case, the order of birth could also affect the risk of marriage of males. This is what we find for Madagascar, when we use a within family model.

Our paper also contributes to the literature on interactions between co-resident children in developing countries ([Akresh and Edmonds, 2011](#); [Marazyan, 2015](#); [Schwefer, 2018](#); [Hedges et al., 2019](#)). In contexts where child fostering is common, the presence of co-resident children can aggravate the rivalry for households' resources. On the other hand, hosted children can be used as worker substitutes to biological children providing them with more time to devote to schooling.⁷ Therefore, age order among co-resident children can give different results than birth order among biological siblings ([Akresh and Edmonds, 2011](#)). When using a measure of social birth order which considers as sibling every child residing in the household when the cohort member was 14, we find similar results as the ones we obtain with biological birth

⁴This is observed for all socio-economic status: the effect is even stronger for girls whose fathers' education level is above the median.

⁵In many societies, sisters get married in the order of birth because an out-of-order marriage is perceived as a bad signal about the quality (i.e. virginity or agency) of the eldest daughter and reduce her chances to be ever married ([Vogl, 2013](#))

⁶ATLAS from the Institute of Social Anthropology, University of Zurich

⁷In Tanzania, [Hedges et al. \(2019\)](#) show that girls living with more older girls (either their biological sisters or not) are more likely to be enrolled in school and can devote more time to leisure and less time to chores. [Marazyan \(2015\)](#) finds similar results in Senegal where girls who were aged six to nine when a fostered girl arrived in their household are more likely to be enrolled in school.

order. This suggests that, in Madagascar, birth order effects are social rather than biological, in line with the important role of the extended family in child development (Ottino, 1998). However, this is not true for the girl's age at marriage, for which it is the rank between biological siblings that matters.

The rest of the paper structures as follows: Section 2 describes the context and the data used in our study, Section 3 presents the methodology, while the main results and the robustness checks are presented in Section 4 and 5 respectively. The last Section concludes. Additional results on non cognitive skills are presented in Annex A.5.

2 Context and data description

2.1 Context

Madagascar is one of the poorest countries in the world. In 2019, 74.3% of Malagasy people lived below the international poverty line of \$1.90 while the regional Sub-Saharan average was 41%. Poverty is mainly concentrated in rural areas⁸ and in the Southeastern regions (Kubot et al., 2015). Poverty leads children to transit very early into adulthood in Madagascar where educational outcomes are low while child work and child marriage are highly prevalent.

According to the last Multiple Indicators Cluster Survey (MICS), in 2018, a fifth of children aged 6-10 and a third of children aged 11-14 were not in school. Repetition rate is very high and few children who enter primary school remain until the last grade. While in Sub-Saharan Africa, only 7.8% of primary school students were repeating their previous grade in 2018, they were 26% in Madagascar. The situation is even worse than in 2012 as 20.5% of primary school students were repeating their previous grade this year.⁹ High rates of repetition lead to low rates of persistence to the last grade of primary school. In 2018, only 31.6% of students who have been enrolled in first grade of primary school eventually reached the last grade (56.2% for the Sub-Saharan Africa region). Again, this indicator was lower in 2019 than in 2012 when 38% of students enrolled in first grade of primary school eventually reached last grade.¹⁰ Low rates of persistence to last grade of primary translate into low gross secondary enrollment rates. In 2019, gross secondary enrollment rate was only 34.6% (3.4 percentage points lower than in 2012) against 43.3% in Sub-Saharan Africa.¹¹

⁸Recently, the Covid-19 crisis had stronger detrimental effect on households income in urban areas where 20% of the Malagasy population live. In rural areas, resilient agricultural productivity helped to reduce the impact (Stocker et al., 2020).

⁹Repeaters, primary

¹⁰Persistence to last grade of primary

¹¹School enrollment, secondary, gross

Besides poor educational outcomes, the country suffers from low level of learning. Learning of students in final year of primary school has been assessed four times between 1998 and 2019 with the *Programme d'Analyse des Systèmes Educatifs de la Confemem (PASEC)*.¹² The two first evaluations took place in 1998 and in 2005. At that time, the country scored high in math but very low in French (PASEC, 2005). The two last evaluations took place in 2015 and in 2019. This time, Madagascar performed worse than the assessed countries' average either in math or in Malagasy (PASEC, 2015, 2020).¹³

According to PASEC (2020), Madagascar poor performances in learning are partly due to a lack of time devoted to study and reading. 97.1% of students assessed in 2019 take part in domestic chores and 74.1% to on-farm activities. According to the last MICS survey, girls are more involved than boys in domestic chores: 88% of girls aged 5-11 and 93.3% of girls aged 15-17 are involved in domestic chores, while the percentages for boys are 82.1% and 86.9% respectively. On the other hand, 38.3% of boys aged 5 to 11 and 72% of boys aged 15 to 17 work on-farm or off-farm against 33.4% and 61.3% of girls (INSTAT and UNICEF, 2019). Child work is thus highly prevalent in Madagascar.

On average, girls perform better than boys in terms of learning and schooling. They repeat less, are more likely to complete primary school and to be enrolled in lower secondary school. However, they face higher risk to be married before their 18th birthday. According to the last MICS survey, 40,3% of women aged 20-24 were married before age 18 for 11,8% of men. Child marriage is more prevalent in rural areas where 44,1% of women aged 20-24 were married before age 18 for 29,1% in urban areas (12,9% in rural areas and 8,5% in urban areas for men) (INSTAT and UNICEF, 2019). Once married, the bride usually moves in with her husband kin. Bride price transfers are small or symbolic.¹⁴

Household size has not changed much in the past fifteen years. In 2003-2004, there were 4.6 person per household on average (INSTAT and ORC Macro, 2005), against 4.2 persons in 2018. Child fostering is less common in Madagascar than in the rest of Sub Saharan Africa (Eloundou-Enyegue and Kandiwa, 2007). It was estimated at about 13,5 per cent in 2008-2009, according to the Enquete Demographique et de Sante (Delaunay et al., 2013).

Households are mostly nuclear (63.4%) but a quarter of them (25.3%) are extended. Nuclear households are more prevalent in rural areas (65,8% of households) than in urban areas (54,3% of households) (INSTAT, 2019). Regardless of the administrative classification, traditionally the role of the extended family is extremely important in Madagascar. The work

¹²PASEC is a tool developed by the CONFEMEN, an association of Ministries of Education from 44 French-speaking countries. PASEC assesses the performances of education systems by evaluating reading and math abilities of students in second and sixth year of primary school in member states. [PASEC website](#)

¹³As the instruction language is Malagasy, in 2019, the language test assessed Malagasy abilities instead of French ones.

¹⁴ATLAS from the Institute of Social Anthropology, University of Zurich

of the anthropologist [Ottino \(1998\)](#) illustrates how individuals tend to live in hamlets, in groups of twenty to forty individuals, that are most of the time related by blood or marriage. People living in the same hamlet trust each other: the traditional concept of "*fihavanana*" is established between people who, reside together. The *fihavanana* "allows some people, whether they are related or not by family ties, to act as parents act" (page 11, author's translation) [Ottino \(1998\)](#) depicts different types of parenting (by identity, by ownership and by affinity/alliance) precisely to prove that biological ties with parents are not necessarily the strongest one.

Households' size and composition are important for our research question as the effect of birth order on transition into adulthood could depends on who was living with the individual when she was a child.

Practices concerning inheritance are officially regulated by a national law of 1968 ¹⁵, that establishes that every legally recognized child is entitled to a part of the inheritance in absence of a will, but parents can totally disinherit one of their children or all of them if they want to ([PAULE and Professionnel, 2015](#)). The law thus gives a lot of freedom to parents. This reflects in the heterogeneity of practices across regions and ethnicities. Differences exist in particular with respect to the gender and birth order discrimination in heritage. In some regions, land is divided among the sons of the fathers at his death. In some others, the eldest son is the only heir. Often daughters are excluded from inheritance ([Lanto, 2007](#)). But this is not always true: in the Hauts Plateaux area, for example, girls enjoy the same rights on the land ([Randriamamonjy, 2007](#)), while in the South-Est they need to revert the land to their families once they leave the village to marry. These practices are coherent with the tradition that sees the sons administering the family property, with their father, in the general interest of all the members and with the aim of guaranteeing an inheritance for future generations. The eldest son is particularly important because he is the one who assumes decision-making power over land and property as well as other responsibilities in place of the father. He is also the only member of the sibship that is accepted into the group of elders. For all these reasons, firstborns deserve the obedience and the respect of his/her siblings ([Pronk and Evers, 2007](#); [Crenn, 2013](#)).

2.2 Data description

To analyze the effect of birth order on transition into adulthood in Madagascar, we use data from the 2004 Madagascar Study on Academic Progress and Academic Performance (EPSPAM) and from its follow-up, the 2012 Madagascar Youth Transition Survey. The 2004 EPSPAM survey was based on the sample of children enrolled in 2nd grade who were

¹⁵Loi n. 68-012, July 4th 1968

surveyed by PASEC in 1998.

In 2004, 48 clusters were randomly selected from the original 120 PASEC clusters. Additional (25) "small"¹⁶ schools' communities were also sampled from the Ministry of Education database after stratifying on provinces. Small schools were added to the sample because PASEC schools in rural areas were larger than average rural schools. In each PASEC's cluster, 15 households with PASEC children surveyed in 1998 were resurveyed in 2004. As PASEC sample was school-based, only children enrolled in school in 1998 were part of the sample. To avoid selectivity bias and to include in the sample children who already had dropped form school at time they were supposed to attend their 2nd grade, 15 additional non-PASEC households containing children of the same cohort (i.e. born between 1988 and 1992) were randomly selected within each cluster and added to the 2004 sample.¹⁷ Although the sample was cohort-based, all household members were interviewed.

This sampling frame was designed in order to assure the national representativeness of the survey. Unfortunately, we are unable to compare our survey data with population data that refer to the 2004 - 2012 time period, since no population census had been conducted in Madagascar from 1993 to 2018. 2012 survey was designed to track all cohort members interviewed in 2004, even if they moved to another locality. Around 1750 cohort members from the 2004 EPSPAM survey - representing 89% of the 2004 sample - were revisited, giving an extremely low attrition rate if comparing to other surveys from Sub-Sahara Africa. However, as shown in Table A1, attrition seems to be correlated to the order of birth: earlier borns are more likely not to be interviewed in 2012. This is probably due to the fact that a larger proportion of firstborns leave the household of origin earlier, and, because of tracking difficulties, this automatically determines an higher attrition for this group, even in presence of a non systematic correlation between individual characteristics and attrition.¹⁸

The 2012 Madagascar Youth Transition Survey was designed to specifically capture the transition from adolescence to young adulthood of the individuals who were part of the PASEC cohort. Detailed questions on education, employment, health, marriage and migration were asked to the members of this cohort, who were around 22 years old in 2012. In our main analysis, we only use the sample of the cohort members to explore the effect of birth order on our outcomes of interest.

Measures of birth order Given the structure of our data, we can compute different measures of birth order. Birth order can be build (i) using 2004 information on all the biological siblings

¹⁶A public primary school was considered as small when it had fewer students than the national median of about 140 students.

¹⁷See [Glick et al. \(2011\)](#) for a more detailed description of the sampling method.

¹⁸We also compared other individual and household characteristics (i.e. gender, education, cognitive skills, place of residence, parents' characteristics, ...) of cohort members re-interviewed in 2012 with the ones of attrited cohort members, and we did not observe significant differences among the two groups.

of the cohort members who lived (or not) with them in 2004, when she was around 14; (ii) using 2004 information on all the children who lived with the member of the cohort at that time, regardless of whether they were siblings or not (social birth order); or (iii) using the 2012 siblings' module, that gives basic information on all cohort members' siblings still alive at that time. We prefer using 2004 data in order to measure birth order because some of the cohort members' siblings may have died between 2004 and 2012. As shown by [Lehmann et al. \(2018\)](#), the effects of birth order on cognition, education and employment outcomes depends on life circumstances during childhood. Thus, it is the order of birth in childhood that matters for most of the outcomes we explore in the paper, in particular for the education and learning-related outcomes.¹⁹

Sample selection The construction of the birth order variable from the 2004 survey relies on the identification of parents in the household. We consider as biological siblings individuals who declare the same mother or the same father. Parents are also asked to give basic information concerning their children, younger than 30, who do not live in the household. As fostered and adopted children do not live with their biological parents, we are not able to identify their siblings properly. We drop the 42 adopted or fostered children from our estimation sample.

Since we prefer running all models on the same estimation sample, we also drop all cohort members who have a missing value in one of the main outcomes we explore. For instance, 177 cohort members did not take the tests measuring their cognitive skills, they are thus removed from the sample.²⁰

Finally, in order to correctly estimate the effects of birth order on our outcomes of interest, we need to use a number of covariates that concern parents of the cohort members, for which we have lower quality data as they were not the principal target of the survey. For instance, the information on mother's age is missing for 290 individuals, but this variable is important to include in the model because later borns have older mothers (see [Table A2](#)). We are thus obliged to drop from our sample individuals with missing information on key covariates.

We end up with an estimation sample of 1,107 individuals (53% of females), interviewed both in 2004 and in 2012 and having at most 11 siblings and 4.4 siblings on average. Almost 30% of them is firstborn (28.6%) and one quarter second born (24.75%). [Table 1](#) describes the main characteristics of the cohort members by order of birth.²¹ By construction, the average

¹⁹Concerning the time of entry in the labor market and in the marriage market, we would like to observe the birth order at the time the decision is taken, but we are unfortunately unable to do so.

²⁰Our results are robust when we use the largest possible sample of cohort members for each outcome of interest.

²¹The characteristics of the sixth and following born are very similar to the ones of the fifth borns. This is why we decided to group them in a sole category. 124 cohort members are sixth borns or more (from 65 sixth born cohort members to 1 eleventh born).

age is the same across birth order because all individuals belong to the same cohort. The share of female remains also stable across birth orders, suggesting that son preference is not strong in the Malagasy society.

Outcomes and control variables On average cohort members dropped school at age 17 and attained 8.4 grades of schooling. 84 per cent of them completed primary school while 52 per cent completed lower secondary school. We can observe small (though non-significant) differences in the education related outcomes in favour of later borns (i.e. fifth and following children).

In both EPSPAM 2004 and the 2012 Madagascar Youth Transition Survey, cognitive skills are appraised by oral and written French and Math assessments administered at home. Tests were designed by specialists from the Ministry of Education to compare cognitive skills among a heterogeneous population. Each cohort member took the same test, regardless of her educational level. The survey provides z-scores separately for Math and French, as well as a combined Math and French z-score, that we use in our analysis.²² Table 1 shows that later borns have lower cognitive abilities in 2004, but higher ones in 2012, with respect to those with a lower birth order.

84.13 per cent of cohort members already engaged in some form of work²³, while only 54.74 per cent of them already work outside the family firm. Those who already work outside the family firm started at around 18 years old. 33.97 per cent of cohort members were married or in cohabitation (43.41% of females and 23.11% of males). Average age at marriage for those who are already married is 18.5 years (18 for females and 19 for males). No clear trend appears in Table 1 with respect to the relationship between the order of birth and the time of entry in the labor market or the time of marriage.

The variables used as covariates are described in Table A2.

As noted by Black et al. (2018) these simple descriptive statistics can be misleading as they compare individuals who do not necessarily have the same family background. Table A2 shows that later-borns belong to larger sibships and have older mothers than firstborns. These characteristics could also influence our outcomes of interest. We present in next section the empirical strategy we adopt to identify the effect of birth order on the outcomes we described.

²²We also performed our analysis on separate Math and French scores but do not find any meaningful difference with the analysis on the combined score.

²³We consider as work any income or non-income generating activity that is not domestic work.

Table 1: Descriptive statistics cohort members characteristics by birth order

	Birth order measured with the 2004 wave survey					Total
	First borns	Second borns	Third borns	Fourth borns	Fifth borns or more	
Age in 2012	22,04	22,02	21,99	21,94	21,84	21,97
Female	0,55	0,53	0,55	0,54	0,49	0,53
Urban household (2004)	0,23	0,19	0,21	0,24	0,26	0,23
School attainment	8,35	8,28	8,34	8,22	8,55	8,36
Highest education level	3,79	3,76	3,78	3,72	3,95	3,80
Cognitive skills (2012)	-0,02	-0,03	-0,02	0,12	0,10	0,02
Out of school	84,38	82,73	76,53	83,92	80,79	81,81
Ever worked	82,75	87,85	79,69	87,05	83,78	84,13
Ever married	37,50	32,93	31,98	32,64	33,19	33,97
Observations	288	249	197	144	229	1,107
Cognitive skills (2004)	0,12 (182)	0,07 (160)	0,11 (118)	0,01 (78)	0,05 (135)	0,08 (673)
Age at school dropout	16,81 (231)	16,68 (201)	16,57 (141)	16,71 (112)	16,94 (175)	16,75 (860)
Age at first work	14,03 (235)	13,97 (217)	13,92 (153)	13,73 (121)	14,30 (186)	14,01 (912)
Ever worked outside the family firm	59,24 (238)	51,39 (216)	57,05 (156)	50,41 (121)	53,76 (186)	54,74 (917)
Age at first work outside the family firm	17,54 (140)	18,09 (110)	17,55 (88)	18,03 (60)	17,43 (99)	17,70 (497)
Age at first marriage	18,76 (108)	18,44 (82)	18,05 (63)	18,21 (47)	18,88 (76)	18,53 (376)

Notes: All variables are constructed using the 2012 *Madagascar Young Adult Transitions Survey* except birth order, the dummy indicating if the individual used to live in a urban area and cognitive skills measured in the 2004 *Madagascar Study on Academic Progress and Academic Performance*. We have a measure of 2004 cognitive skills only for 673 cohort members. We have information on age at school dropout, age at first work, age at first work outside the family firm and age at first marriage for cohort members who already dropped out from school, worked or get married. The number of observations is indicated in parentheses in the lower panel of the table. Age in 2012, age at school dropout, age at first work, age at first work outside the family firm and age at marriage are measured in years. "Female" is a dummy variable equal to 1 if the individual is a female. School attainment measures the last grade completed by the cohort member. Highest education level indicates the highest level completed by the cohort member. Cognitive skills in 2012 and in 2003 are displayed as a z-score.

3 Empirical strategy

Ideally, to assess the effect of birth order, researchers need information about the outcomes of interest for several members of the sibship in a sufficiently large sample of families. In this case, researchers can use a family fixed effect model, also called within-family model, which takes into account all family characteristics that could bias the effect of birth order.

Unfortunately, data allowing to use family fixed effect models are quite rare. When using family fixed effect models is impossible, researchers use between-family models instead. Between family models compare firstborns to later borns coming from different families controlling for family background characteristics that could bias the effect of birth order. Important controls are sibship size, mother's age, mother's age at first birth and socio-economic conditions (Black et al., 2018).

In our case, the majority of our outcomes are measured for cohort members only, so that we can not use family effect models. Therefore, in the core part of the analysis, we rely on

between family models with sibship size fixed effects. Nevertheless, in the 2012 wave of the survey, we have information on age at marriage and highest school level for all cohort members' siblings that are still alive. We are thus able to use a within-family model to assess the robustness of our results on age at marriage and school attainment.²⁴

We analyse the effect of birth order on several outcomes. We use different estimation strategies according to the nature of each outcome. We use linear regression to estimate the effect of the order of birth on the cognitive skills, that are measured through a test score. An ordered probit model is used to analyse the effect on highest education level attained by the individuals, while hazard models are used to study birth order effects on age at school dropout, age at entry on the labor market and age at marriage. All models are described below.

We estimate the birth order effects, β_n , using linear regressions absorbing sibship size fixed effects for cognitive skills²⁵. Formally, we estimate the following between family model with sibship size fixed effects for individual i in sibship j :

$$Y_{ij} = \alpha + \sum_{n=1}^5 \beta_n \mathbf{Birth_order}_{ij} + \kappa' \mathbf{X}_{ij} + \lambda' \mathbf{S}_{ij} + \epsilon_{ij} \quad (1)$$

where Y_{ij} is the outcome of individual i in sibship j . The vector $\mathbf{Birth_order}_{ij}$ denotes the birth order of individual i thanks to 5 birth order dummies, with the omitted category being firstborn child. Thus, coefficients on the birth-order dummies are interpreted relative to the firstborn child.

\mathbf{X}_{ij} is a vector of individual's background variables, including gender, age, ethnicity, mother's age, mother's age at first birth, parent's activity (wage worker, own account worker, family worker or housewife), parent's education (no education, primary completed or college completed), place of residence (urban or rural), household's wealth in 2004²⁶. As age

²⁴Black et al. (2018) propose a third way to estimate the effect of birth order : family type fixed effect models. Black et al. (2018) assume that same size families with children born on the exact same year are sufficiently similar to be used as fixed-effects. They actually show that their results are comparable when using within-family or family-type fixed-effect specifications. We tried to use family-type fixed-effects model as well but it was still too data demanding given the size of our sample and the common large sibship sizes in Madagascar. Results are available from the authors upon request.

²⁵We employ the same model when we use, as a robustness check, the highest grade attained in school as the dependent variable

²⁶Household wealth in 2004 is measured by an index built from housing conditions and belongings, total surface harvested by the household in 2004 and an index measuring household's proximity to infrastructures (health centers, banks, post offices, schools, transportation, food markets, electricity and water). Control variables are described in Table A2. We use household wealth in 2004 as control because this is less likely to be influenced by the resources from child work

difference between siblings can interfere with the effect of birth order (Moshoeshoe, 2019), we add a measure of the average age difference among sibship j in our control variables. Sibship size fixed effects are added as a vector of dummies indicating size of sibship j for individual i : S_{ij} . Sibship size is one of the most important control as it addresses the fact that later-born children belong to larger sibships (Table 3) and that sibship size might affect our outcomes of interest (Eirnaes and Pörtner, 2004; Black et al., 2005; Booth and Kee, 2009; De Haan, 2010; Lafortune and Lee, 2014).²⁷ ϵ_{ij} indicates the stochastic component.

When we are interested in observing gender heterogeneity in the effect of birth order on Y_{ij} , we add an interaction term between birth order and a dummy equal to 1 when the cohort member is a female. When we explore the heterogeneities with respect to locality of residence, we interact birth order with a dummy indicating whether the household is living in a rural area or not.

The variable measuring highest education level is defined as a series of ordered discrete choices. It takes values from 0 (when the individual has never been to school) up to 7 (when she has some college education). Therefore, to estimate the birth order effects, β_n , on the highest completed level of individual i , we rely on an ordered probit model, as it is common in the economics literature after the seminal article of Lillard and King (1984). More specifically, we model individual i from sibship j who has attained c levels of schooling; that is, $L_{ij} = c$, if $\mu_c < L_{ij}^* < \mu_{c+1}$, where L_{ij}^* is the latent continuous variable that generates the observed L_{ij} and μ_c and μ_{c+1} are the cutoff points to be estimated. The latent variable L_{ij}^* is described as follows:

$$L_{ij}^* = \alpha + \sum_{n=1}^5 \beta_n^L \mathbf{Birth_order}_{ij} + \kappa^{L'} \mathbf{X}_{ij} + \lambda^{L'} \mathbf{S}_{ij} + \epsilon_{ij}^L \quad (2)$$

where vectors $\mathbf{Birth_order}_{ij}$, \mathbf{X}_{ij} and \mathbf{S}_{ij} are the same as in equation (1).

Our data allow us to use a within-family model to estimate the effects of birth order on the highest level of education. In this case, household- and community-level covariates are no longer necessary, because of the introduction of the household fixed effects. We only control for age and gender of individual i and add a sibship j fixed effect.

When we estimate the ordered probit model within families, we might incur in the incidental parameters problem that might occur when using fixed effects in a non-linear model

²⁷Average age difference among sibship and sibship size vary with the birth order measure we are using (i.e. biological or social birth order)

(Greene et al., 2002). We would prefer using a linear probability model, but we only have information on the highest education level attained by all siblings of cohort members, not on their highest grade. In order to run a linear model using the information on the highest education level, we calculated, for each school level, the mean grade attained by cohort members. Then, we constructed a new variable to measure school attainment, called 'average grade for level', whose values are the average grades attained for each education level. For instance, individuals whose highest level is 'primary school not completed' left school after third grade on average. The variable 'average grade for level' thus takes value 3 in this case while the highest level variable is coded 1. This variable is built both for cohort members and for their siblings and allows us to use a linear model to analyse the effect of the order of birth on school attainment even for individuals for which we do not have information on their highest grade completed. We run a linear regression on this variable and we compare the results with the ones obtained with the ordered probit on the actual highest level of education. This allows us to measure how biased are our results when using household fixed effects in a non-linear model.

Among cohort members, 18.19% are still in school, 15.87% have never worked and 66.03% are still single. We do not know how old they will be when they will leave school, have their first job or get married. As our data are right-censored, we cannot rely on linear regressions when estimating the effect of birth order on age at school dropout, age at marriage and age at first work. Therefore, we use time-to-event analysis to estimate the effect of birth order on the hazard functions of school dropout, marriage and first work. Hazard functions give the probability that an event occurs at age t , given that the individual has never been subject to the event up to age t .

We rely on an extended Cox-proportional hazards model allowing for time-dependent variables to estimate the effect of birth order on the hazard functions of school dropout, marriage and first work. Formally, we estimate the following model for individual i in sibship j :

$$h_{ij}(t, \mathbf{W}_{ij}, \mathbf{Z}_{ij}(t), \mathbf{S}_{ij}) = h_0(t) \exp[\kappa' \mathbf{W}_{ij} + \gamma' \mathbf{Z}_{ij} + \delta' \ln(t) * \mathbf{Z}_{ij} + \lambda' \mathbf{S}_{ij}] \quad (3)$$

where $h_{ij}(t, \mathbf{W}_{ij}, \mathbf{Z}_{ij}(t), \mathbf{S}_{ij})$ is the hazard function of school dropout, marriage or first work for individual i in sibship j . $h_0(t)$ is the baseline hazard function.

In our sample, cohort members start to be at risk to drop out from school at age 6. The minimum age at first work is 5. None of cohort members has started to work outside the family firm before age 6 or get married before 14.

Proportional hazard models assume that the hazard for one individual is proportional to the hazard for any other individual and that the proportionality constant is independent

of time. Therefore, we know that a covariate violates the proportionality assumption when its interaction with a function of time gives coefficients significantly different from zero. For instance, our birth order variable violates the proportionality assumption because below a given age, first and later borns have the same probability (almost null) to dropout from school, to be married or to work (outside the family firm).

Covariates from equation 1 are thus divided in two vectors, W_{ij} and Z_{ij} , such as $X_{ij} = (W'_{ij}, Z'_{ij})'$. Z_{ij} is a vector of covariates that violate the proportionality assumption (including birth order). Therefore, we extend the Cox-proportional hazards model by adding $\ln(t) * Z_{ij}$ which is a vector of time-dependent variables (i.e. covariates that violate the proportionality assumption interacted with $\ln(t)$).²⁸ In the model where we estimate the effect of birth order on age at school dropout Z_{ij} includes mother's age, mother's age at first birth, father's activity and education and mother's activity. In the model where we estimate the effect of birth order on age at first work outside the family firm, Z_{ij} includes parents' education, mother's activity, household's wealth and place of residence. When we estimate the effect of birth order on age at marriage, only birth order is included as a time-dependent variable. Covariates in vector Z_{ij} change according to the outcome since they can violate the proportionality assumption for one outcome but not for the others. For instance, in rural areas, children are always more at risk to drop out from school than in urban areas. Therefore, we do not need to add place of residence in our time-dependent variables when we estimate the hazard function of dropping out of school. On the other hand, individuals who live in rural areas are more at risk to work outside the family firm than those who live in urban areas until 20. After 20, if they have not yet started to work outside the family firm, urban cohort members are more at risk to enter the labor market than rural ones. Thus, place of residence violates the proportionality assumption for first work outside the family firm. We need to add it in our time-dependent variables.

Our data also allow us to use a within-family model to estimate the effects of birth order on age at marriage. When using a within-family model, we only control for age and gender of individual i and add a sibship j fixed effect. Similarly to all our extended Cox-proportional hazard models we add birth order of individuals i as a time-dependent variable.

²⁸We use $\ln(t)$ because this is the most common function of time used in time-dependent covariates but any function of time could be used ([UCLA: Statistical Consulting Group](#)). Our results are robust to the use of t instead of $\ln(t)$.

4 Results

4.1 Main results

Our main results illustrate that, in the case of Madagascar, firstborns transit earlier into adulthood.

More specifically, first and second borns leave school at a younger age than their 3rd and later born siblings. After 14, fifth borns are always less at risk to drop out from school than firstborns while third and fourth borns become less at risk to drop out from school as compared to a firstborn after age 16 (Figure 1a). By staying longer in school, 4th and later borns complete higher education levels. Figure 1b indicates that they are more likely to complete lower secondary school and attain higher level of education than their older siblings. The positive effect of birth order on school attainment is consistent with what has been previously found in other developing countries as the Philippines (Eirnaes and Pörtner, 2004), Brazil (Emerson and Souza, 2008), Ecuador (De Haan et al., 2014) and Indonesia (Botzet et al., 2020). It is also in line with Lafortune and Lee (2014), who states that in liquidity-constrained households, children can benefit from having more older siblings to support their education.

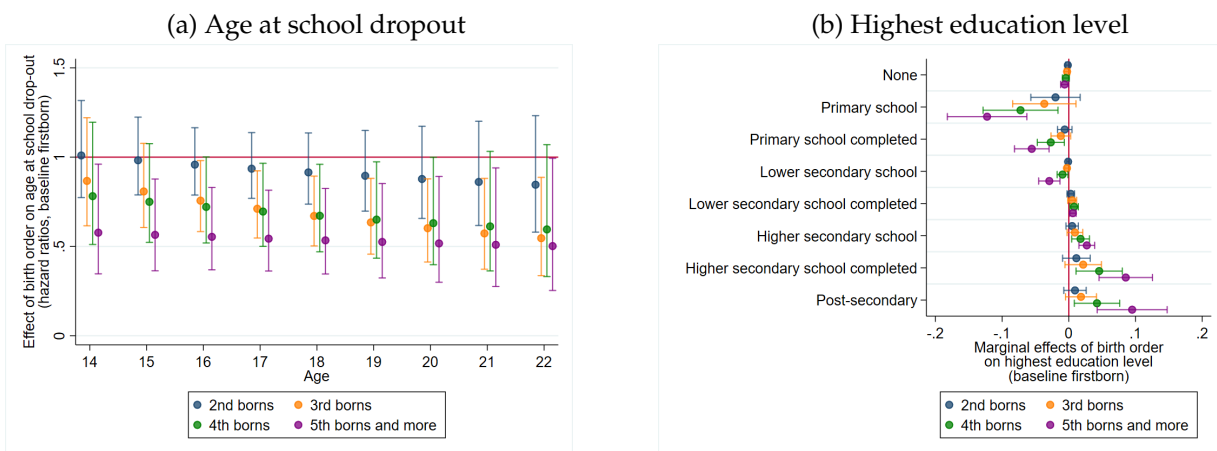
Column 4 in Table A5 shows the coefficients that correspond to the figure 1b. We compare these results to the ones obtained through a linear model whose outcome is (i) the highest grade reached by the child (columns 1 and 2) or (ii) the average grade for level, as explained in the previous section (column 3). Results are qualitatively the same, with 4th and later borns attaining more grades than their older siblings. As better cognitive skills can help children to reach higher education level, we add a measure of cognition from the 2004 wave survey to our control variables (Table A5, Column 5). Despite a large amount of missing values, the positive effect of birth order on school attainment remains valid when we control for cognitive skills.²⁹

We do not find any effect of birth order on cohort members' cognitive skills at age 14 (Table 2, Column 5) but 4th and later borns have higher cognitive skills than their oldest sibling when around 22 years old (Table 2, Column 1). This result might seem to be at odds with the one found by Calimeris and Peters (2017) which state that birth-order effects on cognition may diminish as children get older. However, columns 2 & 4 indicate that even at age 22, birth order's effect on cognitive skills is channeled by its positive effect on school attainment: when we control for school attainment, the effect of birth order is no more significant. As we do not find any direct effect of birth order on cognition, our results suggest that birth order

²⁹In column 2, the coefficient for fourth borns is not significantly different from zero but not far as p-value is 0.156. This is due to the fact that only 78 fourth born cohort members took cognition test in 2004 (Table 1).

does not influence the amount and quality of parental resources received in early childhood in Madagascar. This result is in contrast with what is found by [De Haan et al. \(2014\)](#) for Ecuador, and by [Monfardini and See \(2016\)](#) and [Lehmann et al. \(2018\)](#) for developed countries. We speculate that in the Malagasy context, the quality time parents spend with children is relatively less important because children may develop their cognitive (and non-cognitive) skills through the interactions with the members of the extended family, that are especially important in developing countries ([Cox and Fafchamps, 2007](#)), and particularly in our study context ([Ottino, 1998](#)).³⁰

Figure 1: Birth order and schooling



Notes: Figure 1a represents, for each birth order, the relative risk at age t to dropout from school, as compared to a firstborn. Hazard ratios are calculated using an extended Cox-proportional hazard model on 1,061 cohort members (we were not able to calculate age at school dropout for 46 individuals). Figure 1b illustrates the marginal effects of birth order on the probability to declare each education level as the highest level of education attained. Marginal effects are calculated after estimating an ordered probit model on 1,107 cohort members. Both models include gender, age, ethnicity, mother’s age, mother’s age at first birth, parent’s activity (wage worker, own account worker, family worker or housewife), parent’s education (no education, primary completed or college completed), place of residence (urban or rural), household’s wealth in 2004, average age difference among sibship and sibship size fixed effects.

Source: Authors’ elaboration using data from the 2004 *Madagascar Study on Academic Progress and Academic Performance* and the 2012 *Madagascar Young Adult Transitions Survey*.

No differences according to the order of birth are observed for the age at first work (Figure 2a). However, concerning first work outside the family firm, firstborns are those who start the youngest. Before 20, all siblings have lower risk to work outside the family firm than firstborns (Figure 2b). This result seems to reflect the liquidity effect described by [Tenikue and Verheyden \(2010\)](#). Due to liquidity constraints, firstborns are sent to work outside the

³⁰This would also explain the lack of significant results on the effects of birth order on non-cognitive skills, that we present in Appendix A.5.

Table 2: Effect of birth order on cognitive skills

	Cognitive skills in 2012				Cognitive skills in 2003
	Linear model				Linear model
	(1)	(2)	(3)	(4)	(5)
Ref. firstborn					
2nd child	0.003 (0.079)	-0.029 (0.059)	-0.033 (0.099)	-0.058 (0.077)	-0.102 (0.106)
3rd child	0.073 (0.104)	-0.006 (0.078)	0.150 (0.133)	0.035 (0.105)	-0.055 (0.143)
4th child	0.327** (0.133)	0.149 (0.100)	0.315* (0.176)	0.168 (0.137)	-0.115 (0.188)
5th child or more	0.405** (0.164)	0.062 (0.123)	0.449** (0.213)	0.119 (0.167)	0.054 (0.228)
Cognitive skills in 2003			0.330*** (0.037)	0.057* (0.032)	
School attainment		0.186*** (0.006)		0.181*** (0.009)	
Within-R2	0.39	0.66	0.65	0.65	0.33
Observations	1,107	1,107	672	672	672

Notes: This table reports the effects of birth order on cognitive skills. The dependent variables are (1) to (4) cognitive skills measured in 2012 and (5) cognitive skills measured in 2004. We have 435 missing values for 2004 cognitive skills leading us to estimate the effect of birth order on this outcome on a 672 cohort members sample. The effects of birth order on cognitive skills are estimated using a linear model absorbing sibship size fixed effects. All models include gender, age, ethnicity, mother's age, mother's age at first birth, parent's activity (wage worker, own account worker, family worker or housewife), parent's education (no education, primary completed or college completed), place of residence (urban or rural), household's wealth in 2004, average age difference among sibship and sibship size fixed effects. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: Authors' calculation using data from the 2004 *Madagascar Study on Academic Progress and Academic Performance* and the 2012 *Madagascar Young Adult Transitions Survey*.

family firm at younger ages than their later born siblings to provide an extra income to the household.

As second borns leave school at the same age than firstborns (Figure 1a), but are not at a higher risk of working outside the family firm than their younger siblings, they might take charge of domestic work or be employed in the family firm. However, according to Table A6, at around 14 years old (i.e., in 2004), parents rely more on earlier children for domestic activities; as collecting water, collecting wood and taking care of children and elderly. We cannot test whether second borns are more likely to be employed in the family firm once they drop out from school. In section 4.2, we will test whether gender heterogeneities in the role of

the two first borns could help us to explain why, generally speaking, first and second borns have the same risk of dropping out of school at 14 and spend the same amount of time doing domestic chores even though first borns are more likely to work outside the family firm.³¹

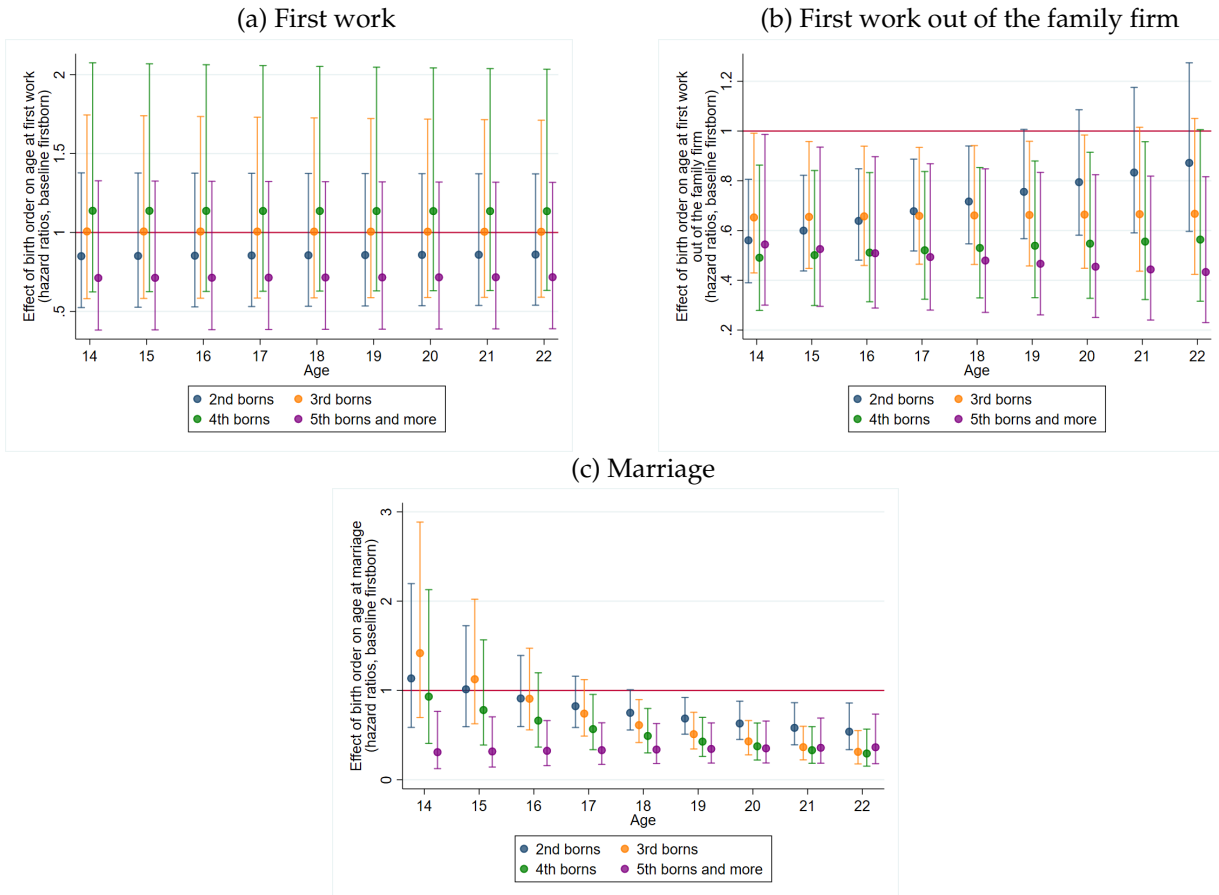
Finally, firstborns are also the ones who get married the youngest (Figure 2c). We indeed observe that youngest siblings are at lower risk of marriage when compared with firstborns. Average age at marriage is 18.5 in our sample and the risk of marriage is very low before 17. If not married before, 2nd or later born become less at risk to marry as compared to firstborn after age 17/18. Marrying a child can loosen budget constraints if the household receive a payment from the spouse family and/or if the child leaves the household after marriage.³² Household could thus benefit of an extra income thanks to the marriage of the firstborn, and invest it in the later borns' schooling.

If we put all the previous results together, we thus see that first and second borns dropout from school relatively early as compared to their later born siblings, who can thus attain higher education levels and cognitive skills. Firstborns get married and/or work outside the family firm earlier and they take charge of most domestic work. The extra income provided by first born is likely to be then invested into third and later borns siblings' education.

³¹Note that, as we'll see in section 5.2, within family models suggest that the positive effect of birth order on education also extends to the second child. Our results on age at school drop out for second borns using a between-family model could simply suffer from a lack of precision.

³²In the Malagasy context, the bride generally moves to her husband kin. The amount of bride price are rather symbolic. However, marrying a daughter can therefore loosen the households' budget constraint by having one less mouth to feed.

Figure 2: Age at first work and age at marriage



Notes: Figures 2a, 2b & 2c represent, for each birth order, the relative risk at age t to start working inside or outside the family firm or to get married, as compared to a firstborn. Hazard ratios are calculated using an extended Cox-proportional hazard model on 1,084 cohort members for age at first work (we were not able to calculate age at first work for 23 individuals), 912 cohort members for age at first work outside the family firm and 1,107 cohort members for age at marriage. All models include gender, age, ethnicity, mother’s age, mother’s age at first birth, parent’s activity (wage worker, own account worker, family worker or housewife), parent’s education (no education, primary completed or college completed), place of residence (urban or rural), household’s wealth in 2004, average age difference among sibship and sibship size fixed effects.

Source: Authors’ elaboration using data from the 2004 *Madagascar Study on Academic Progress and Academic Performance* and the 2012 *Madagascar Young Adult Transitions Survey*.

4.2 Gender heterogeneities

In this section, we explore gender heterogeneities with respect to the results presented in the previous section. We thus include an interaction between a dummy that is equal to one if the cohort member is a female and birth order in all our models. Figures 3 and 4 thus compare individuals with a same-gender firstborn. Concerning education outcomes, no important gender heterogeneities emerge. Figures 3a and 3b show very similar results to those illustrated in Figure 1a, confirming that both girls and boys are less at risk of dropout from school after 16 and of obtaining low education levels when they are third and later born. However, results for females are less significant, and we cannot exclude a null effect (except for 3rd girls for school dropout and for 5th girls for highest education level). Also, we can observe that, when the second born is a male, he stays longer in school than his oldest brother, like his younger siblings.³³ Results, not reported here, but available from the authors upon request, also show that, for boys, higher birth order also determines better cognitive skills, thanks to the higher education level attained.³⁴

Gender differences do not emerge much with respect to the age at entry in the labor market: all younger siblings are less at risk to work outside the family firm at any age. But, again, because of the small size of the gender and birth order specific groups, some of the results are imprecisely estimated and we cannot exclude that third born males and fifth born females do not differ from firstborn males (females) with respect to this specific outcome (Figure 4a & 4b).

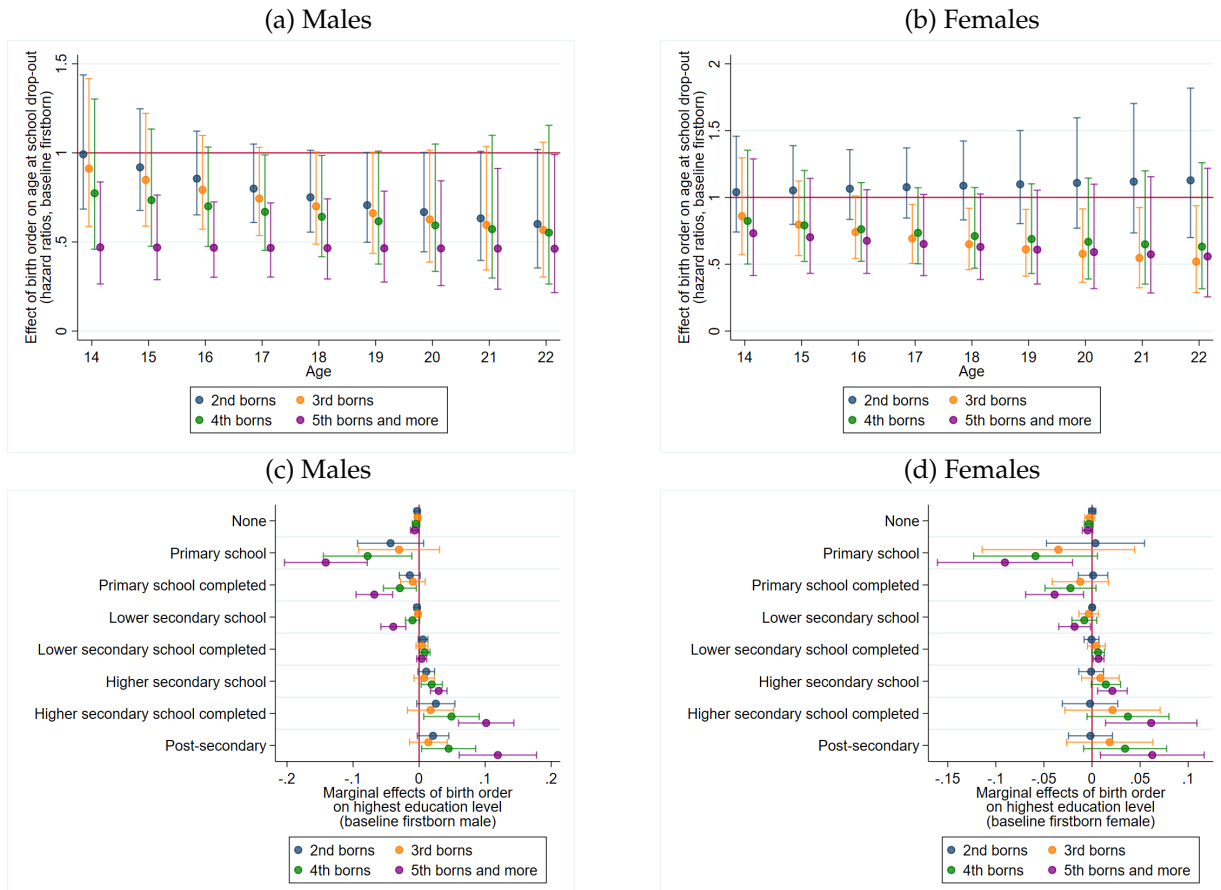
As firstborn girls and boys drop out from school earlier than their younger sisters and brothers, they are available for marriage at a younger age. Moreover, as brides generally move in their husband's family after marriage in Madagascar, marrying a daughter can allow the household relaxing the budget constraint; this is not the case for the marriage of a son. When we explore gender heterogeneities with respect to the birth order effect on the age at marriage, we find, similarly to Vogl (2013), that firstborn females marry at a younger age than later born females (4d). This does not seem to be the case for males: results in Figure 4c do not allow to affirm that a similar effect also exists for them.³⁵

³³When we estimate heterogeneity by gender, we obtain larger confidence intervals probably because of data limitations. We only have 78 females and 66 males who are fourth borns and only 113 females and 116 males who are fifth or later borns. What is reassuring is that gender heterogeneities on education outcomes estimated using within family models, give qualitatively similar and more robust results than the ones presented here. This is illustrated in Figure ??.

³⁴In what follows, we put aside cognition as an outcome because we verified that it is only indirectly affected by the order of birth, through education.

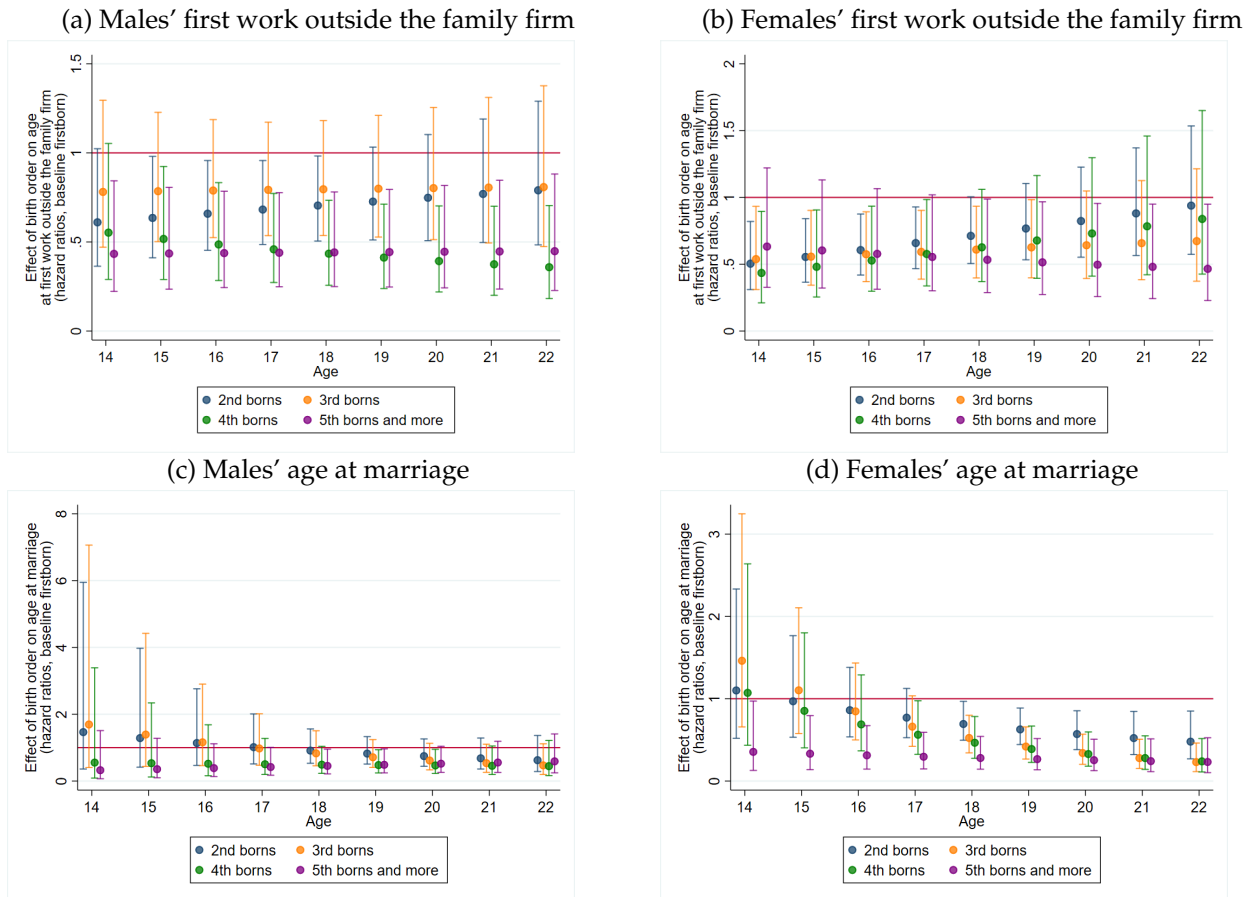
³⁵In section 5.2, we'll show that, when we use the within family model, we find that firstborn males marry at a younger age than later born males.

Figure 3: Birth order, gender and schooling



Notes: Figures 3a & 3b represent, for each birth order, the relative risk at age t to dropout from school, as compared to a same-gender firstborn, for males and females respectively. Hazard ratios calculated using an extended Cox-proportional hazard model on 1,061 cohort members (we were not able to calculate age at school dropout for 46 individuals). Figure 3c & 3d illustrate, for each gender, the marginal effects of birth order on the probability to declare each education level as the highest level of education attained. Marginal effects are calculated after estimating an ordered probit model on 1,107 cohort members. All models include age, ethnicity, mother's age, mother's age at first birth, parent's activity (wage worker, own account worker, family worker or housewife), parent's education (no education, primary completed or college completed), place of residence (urban or rural), household's wealth in 2004, average age difference among sibship and sibship size fixed effects. Source: Authors' elaboration using data from the 2004 *Madagascar Study on Academic Progress and Academic Performance* and the 2012 *Madagascar Young Adult Transitions Survey*.

Figure 4: Gender, age at first work outside the family firm and age at marriage



Notes: Figures 4a, 4b, 4c & 4d represent, for each birth order, the relative risk at age t to start working outside the family firm or to get married, as compared to a same-gender firstborn. Hazard ratios calculated using an extended Cox-proportional hazard model on 1,107 cohort members for age at marriage and 912 cohort members for age at first work outside the family firm. All models include age, ethnicity, mother's age, mother's age at first birth, parent's activity (wage worker, own account worker, family worker or housewife), parent's education (no education, primary completed or college completed), place of residence (urban or rural), household's wealth in 2004, average age difference among sibship and sibship size fixed effects.

Source: Authors' elaboration using data from the 2004 *Madagascar Study on Academic Progress and Academic Performance* and the 2012 *Madagascar Young Adult Transitions Survey*.

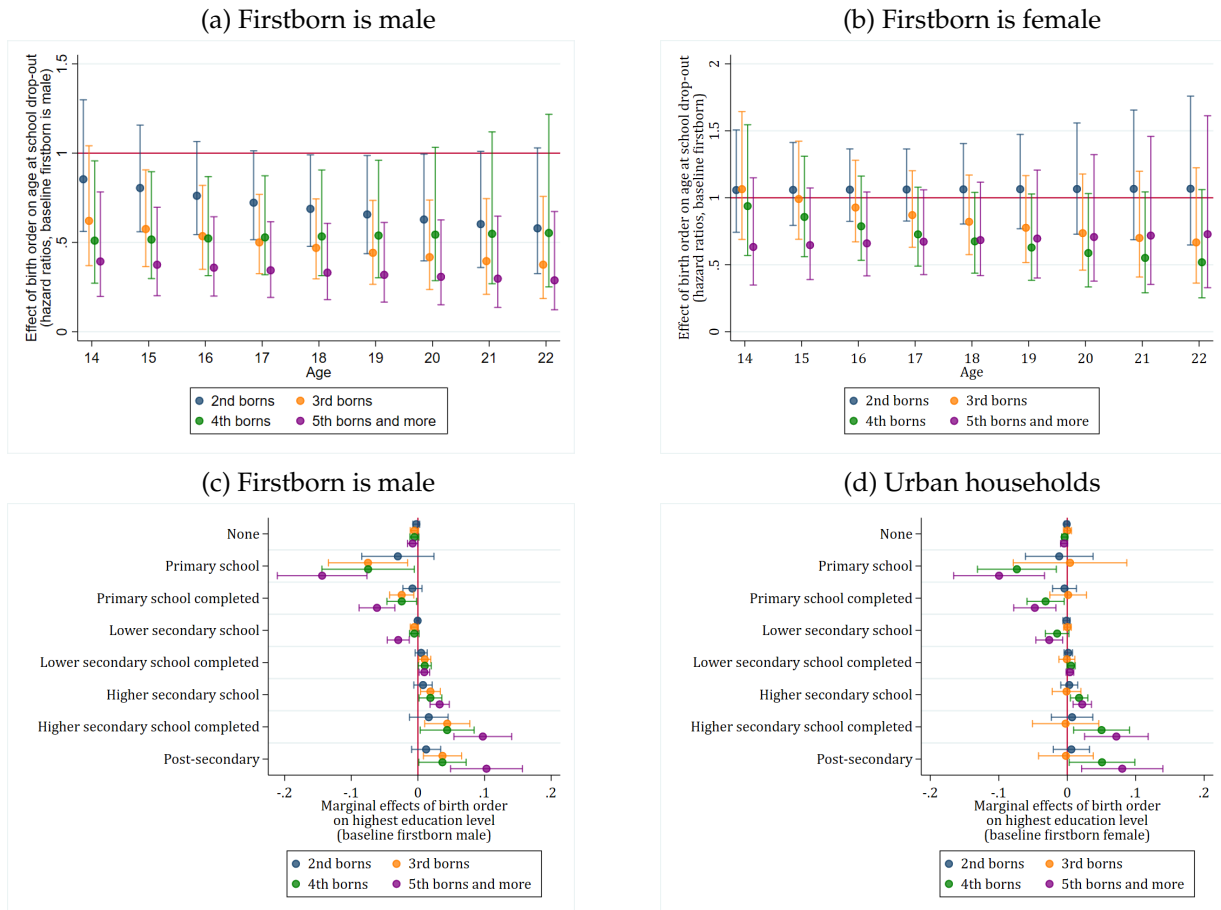
4.3 Firstborn's gender

Siblings' outcomes might thus differ according to the gender of the firstborn. As we illustrated in section 4.2 above, in the Malagasy context, when the firstborn is a boy, the gender norms imply him to take more responsibilities for the other households members. The pressure for him to leave school and enter the labor market could thus be stronger. Moreover, his productivity out of the family farm is likely to be higher than the one of a firstborn girl. Thanks to this, he is able to provide more resources to his family that can be invested, among others, in the human capital of his younger siblings. In order to test if birth order effects are stronger when the firstborn is a boy, we interacted the order of birth with a dummy indicating the gender of the firstborn.

Figure 5 shows that the birth order effect on the age at school dropout as well as on the highest education level attained, is stronger for individuals whose older sibling is a boy. The gender of the firstborn is even more relevant for determining the age at entry in the labor market for the younger siblings: while the 2nd and the following borns are at lower risk when the firstborn is a boy, only 5th borns benefit from having a sister as a firstborn.

As for the risk of marriage, we could expect that when the firstborn is a male, younger siblings, and sisters in particular, could benefit from their brother's financial contribution to delay their marriage. Surprisingly, we find that 2nd borns, as well as the 4th borns, do not seem to benefit from having an older brother for reducing their risk of marriage. Conversely we find that the risk of marriage is lower from 18 years old for all younger siblings when the firstborn is a girl. This finding supports the Vogl (2013) explanation : parents are likely to rush the marriage of their first daughters to have more time and resources to marry all their daughters. To prove our tentative explanations of the heterogeneous effect of the gender of the firstborn on sibling's' outcomes, we should go further in the analysis, and combine gender heterogeneities with firstborn's gender heterogeneities. Having a brother or a sister as firstborn is in fact likely to have different effect on boys and girls. Unfortunately our data do not allow such analysis because of the small size of the groups we end up with.

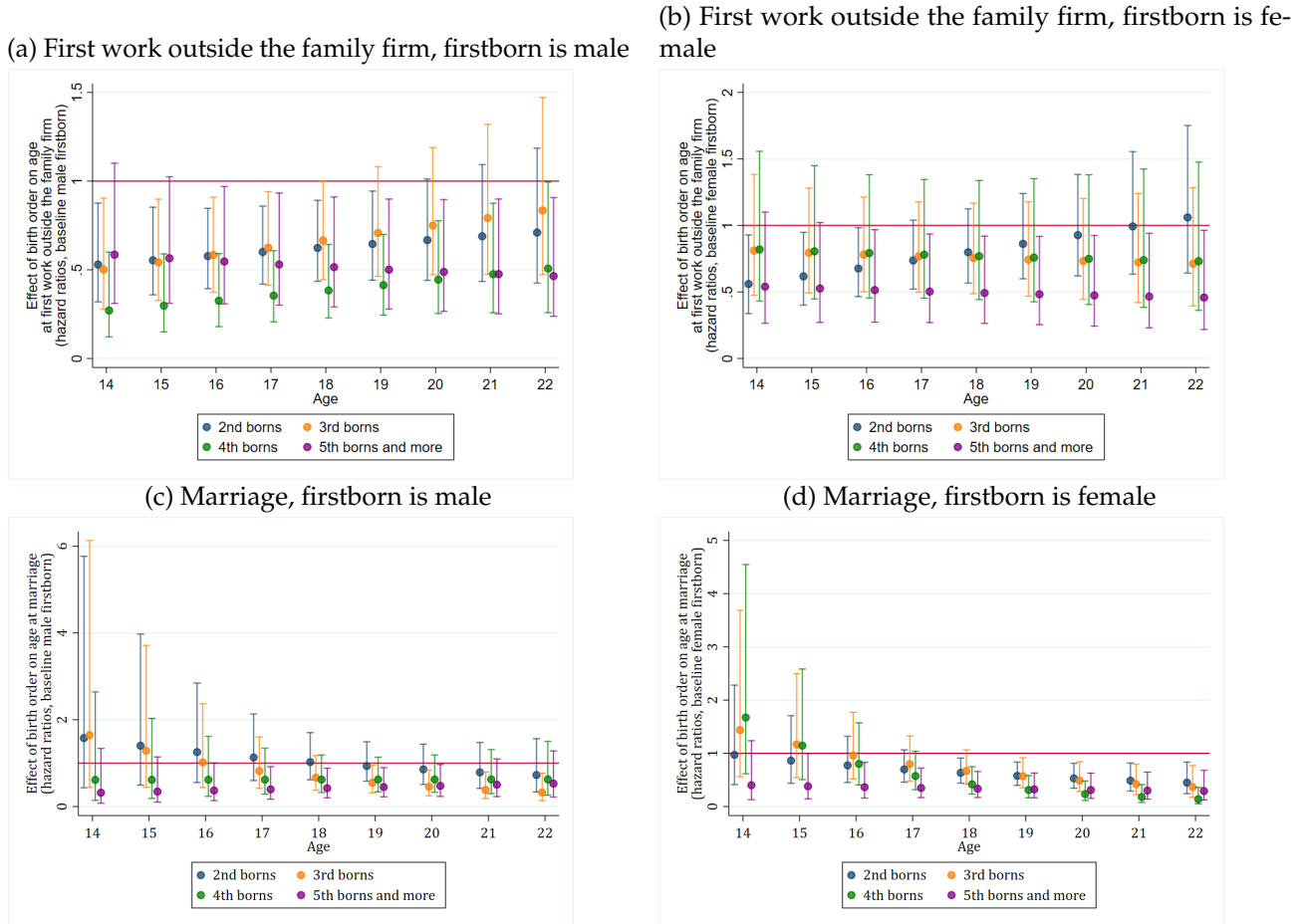
Figure 5: Firstborn’s gender and schooling



Notes: Figures 5a (5b) represents, for each birth order, the relative risk at age t to dropout from school when the firstborn is a male (female). Hazard ratios calculated using an extended Cox-proportional hazard model on 1,061 cohort members (we were not able to calculate age at school dropout for 46 individuals). Figure 5c & 5d illustrate, for each firstborn’s gender, the marginal effects of birth order on the probability to declare each education level as the highest level of education attained. Marginal effects are calculated after estimating an ordered probit model on 1,107 cohort members. All models include gender, age, ethnicity, mother’s age, mother’s age at first birth, parent’s activity (wage worker, own account worker, family worker or housewife), parent’s education (no education, primary completed or college completed), place of residence (urban or rural), household’s wealth in 2004, average age difference among sibship and sibship size fixed effects.

Source: Authors’ elaboration using data from the 2004 *Madagascar Study on Academic Progress and Academic Performance* and the 2012 *Madagascar Young Adult Transitions Survey*.

Figure 6: Firstborn’s gender and age at marriage and first work outside family firm



Notes: Figures 6a (6b) & 6c (6d) represent, for each birth order, the relative risk at age t to start working outside the family firm or to get married, depending on firstborn’s gender. Hazard ratios calculated using an extended Cox-proportional hazard model on 1,107 cohort members for age at marriage and 912 cohort members for age at first work outside the family firm. All models include gender, age, ethnicity, mother’s age, mother’s age at first birth, parent’s activity (wage worker, own account worker, family worker or housewife), parent’s education (no education, primary completed or college completed), place of residence (urban or rural), household’s wealth in 2004, average age difference among sibship and sibship size fixed effects.

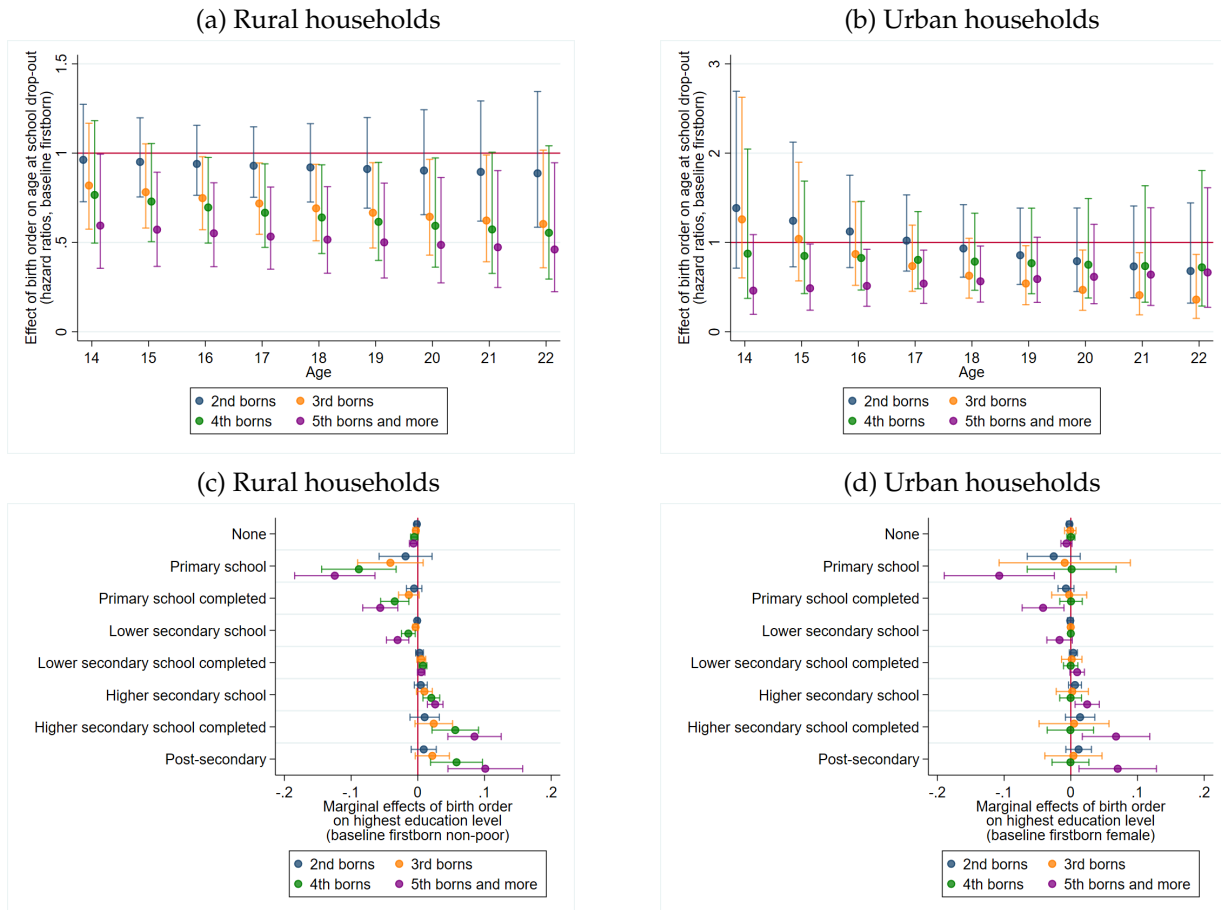
Source: Authors’ elaboration using data from the 2004 *Madagascar Study on Academic Progress and Academic Performance* and the 2012 *Madagascar Young Adult Transitions Survey*.

4.4 Rural and urban heterogeneities

One of the possible explanation of the positive effect of birth order on education, age at marriage and at entry in the labor market, is related to the fact that firstborns tend to inherit more land, since they have the responsibility to pass on the name, the goods and the traditions of the family to posterity. Later born could be compensated for the lower physical capital they inherit, with an higher investment in human capital. This explanation is more plausible in rural areas, where land is the most important asset for households. Moreover, in rural areas, budget constrains are more pronounced than in urban areas and the liquidity effect (Tenikue and Verheyden, 2010) could induce parents to ask earlier-borns a bigger effort to provide extra resources to the sibship.

To test for this, we add in our model an interaction between a dummy variable equal to one if the cohort member lived in a rural area when aged 14 (in 2004) and birth order. Results reported in figure 7 and 8 go along our intuition. For all the analysed outcomes, the positive effect of birth order is present only for individuals who lived in rural areas in 2004. The only exception is for the latest borns, who are at lower risk of school dropout between 15 and 18 and obtain higher levels of education than their older siblings, in urban areas as well.

Figure 7: Area of residence and schooling

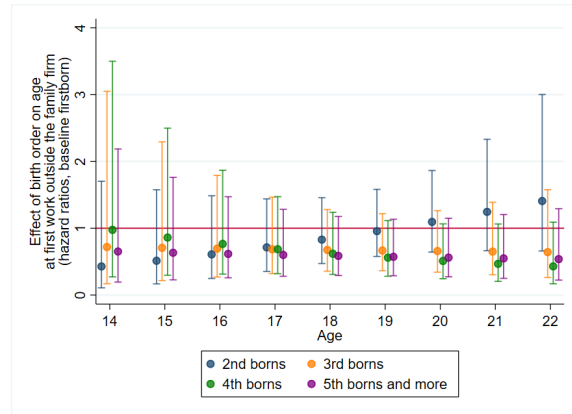
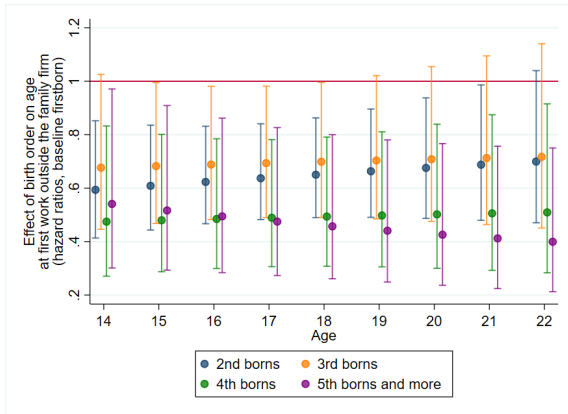


Notes: Figures 7a (7b) represents, for each birth order, the relative risk at age t to dropout from school, as compared to a firstborn living in a rural (urban) area. Hazard ratios calculated using an extended Cox-proportional hazard model on 1,061 cohort members (we were not able to calculate age at school dropout for 46 individuals). Figure 7c & 7d illustrate, for each area of residence, the marginal effects of birth order on the probability to declare each education level as the highest level of education attained. Marginal effects are calculated after estimating an ordered probit model on 1,107 cohort members. All models include gender, age, ethnicity, mother's age, mother's age at first birth, parent's activity (wage worker, own account worker, family worker or housewife), parent's education (no education, primary completed or college completed), household's wealth in 2004, average age difference among sibship and sibship size fixed effects.

Source: Authors' elaboration using data from the 2004 *Madagascar Study on Academic Progress and Academic Performance* and the 2012 *Madagascar Young Adult Transitions Survey*.

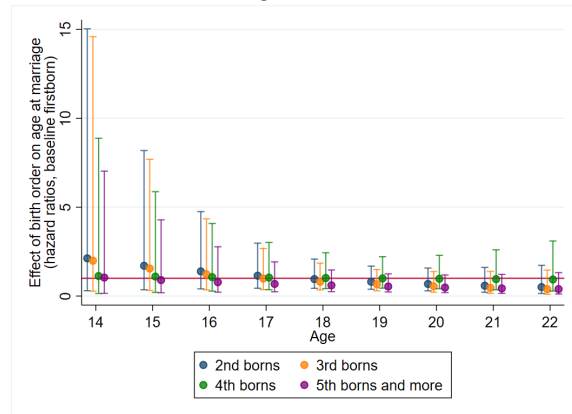
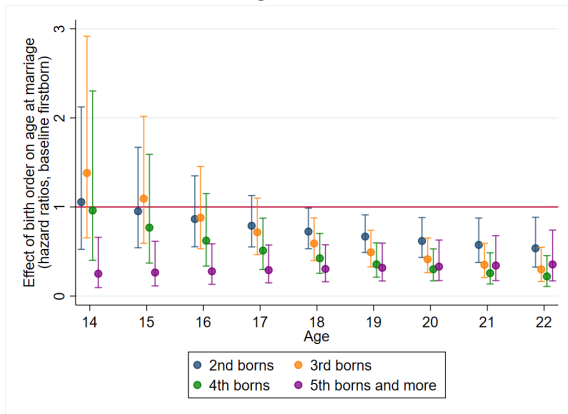
Figure 8: Area of residence and age at marriage and first work outside family firm

(a) First work outside the family firm, rural households (b) First work outside the family firm, urban households



(c) Marriage, rural households

(d) Marriage, urban households



Notes: Figures 8a (8b) & 8c (8d) represent, for each birth order, the relative risk at age t to start working outside the family firm or to get married, as compared to a firstborn living in a rural (urban) area. Hazard ratios calculated using an extended Cox-proportional hazard model on 1,107 cohort members for age at marriage and 912 cohort members for age at first work outside the family firm. All models include gender, age, ethnicity, mother's age, mother's age at first birth, parent's activity (wage worker, own account worker, family worker or housewife), parent's education (no education, primary completed or college completed), place of residence (urban or rural), household's wealth in 2004, average age difference among sibship and sibship size fixed effects. Source: Authors' elaboration using data from the 2004 *Madagascar Study on Academic Progress and Academic Performance* and the 2012 *Madagascar Young Adult Transitions Survey*.

5 Robustness checks

5.1 Social birth order

In the previous sections we used as a measure of birth order, the biological birth order based on the 2004 wave survey. This wave of the survey also allows us to know if cohort members lived with other children than their siblings when aged 14. This information allows us to construct a measure of social birth order, that we name 'age rank'. The idea is to consider in the social birth order all the children who grow up with the cohort members. Among siblings, we thus include only those who did not leave the household before the cohort member was born and those who are less than fifteen years apart from her. We add fostered children who belonged to the household before the cohort member was ten and who were not the spouse of another household's member. Relying on social birth order rather than biological one allows us to better take into account residential rivalry for resources between co-resident children (Akresh and Edmonds, 2011). According to Akresh and Edmonds (2011), in Burkina Faso, the presence of fostered children eliminates the rivalry between siblings as households rely on fostered children rather than on their biological ones to perform domestic or family firm work.

Using social birth order instead of biological birth order also allows to take into account peer effects among co-resident children. Schwefer (2018) showed that biological birth order effects on educational achievement were lower for children living in care households from the *SOS Children's Villages* NGO thanks to greater tutoring opportunities between adopted and biological children within care households.

Table 3: Social and biological birth order

	Social birth order					Total
	Oldest child	Second child	Third child	Fourth child	Fifth child or more	
Average age gap among children	3,34	3,56	3,38	3,17	2,68	3,21
Number of children in the household	4,11	4,85	5,64	6,77	8,22	5,85
Birth order measured with the 2004 wave survey						
First born	87,50	7,99	1,39	1,74	1,39	100
Second born	2,41	86,35	6,83	2,81	1,61	100
Third born	1,52	3,55	85,79	7,61	1,52	100
Fourth born	0,00	1,39	7,64	81,25	9,72	100
Fifth born or more	0,00	0,00	1,31	7,86	90,83	100
Observations	261	247	204	162	233	1,107

Notes: Authors' elaboration using data from the 2004 *Madagascar Study on Academic Progress and Academic Performance* and the 2012 *Madagascar Young Adult Transitions Survey*. Sample restricted to individuals between 19 and 25 years old.

Our results on social birth order are quite similar to our main results. The two oldest children leave school relatively early as compared to third and youngest children (Figure

A1a). Then fourth and youngest children can reach higher education levels (Figure A1b), which provides them with better cognitive skills (Table A7). Oldest children still work the youngest outside the family firm (Figure A1c). We can notice that in line with Akresh and Edmonds (2011) and Schwefer (2018), we generally find smaller coefficients associated with social age rank than when we used biological birth order.

The major difference between the results with biological birth order and the ones using social birth order concerns age at marriage. While second borns marry later than firstborns when considering biological birth order, we cannot exclude that second oldest children have the same risk to be married than oldest children when social birth order is used (Figure A1d). Among cohort members who are the oldest among their biological siblings, 7.99% become the second oldest child using social age rank (Table 3), meaning that they have grown up with an oldest fostered child. It is probably because of them that we do not find statistically significant differences in the age of marriage between the first and the second born. Our results suggest that biological and non-biological children do not compete for marriage. Biological parents of fostered children are probably still responsible of their marriage outcomes even though they do not live together. This would imply a competition on the marriage market only between biological siblings. As discussed by Vogl (2013), parents might prefer to marry their biological children in order of birth to minimize this competition and to avoid sending bad signal about the elder sibling's value on the marriage market.

5.2 Within family models

The 2012 wave survey includes a module in which cohort members are asked to name all their siblings living outside the household and to give basic information on them. This module, coupled with the data on brothers and sisters that still co-reside with the cohort members in 2012, allows us to have information on the age, the education level, the marital status (and the age at marriage, if applicable), of all siblings declared in the second wave of the survey by the cohort members.

This allows us to test some of our results - namely the ones on schooling and on age at marriage - using a within family model, that better allows to control for any family characteristic that can simultaneously affect the order of birth and the outcome of interest.³⁶

The results of the within family model are reassuring as we still find that later borns reach higher level of education than firstborns (Figure 9b). The only seeming difference is that

³⁶Notice that the birth order we use to run the within family model is only based on 2012 data and partially differs from the one measured in 2004 that we used in the previous sections. The discrepancy is due to at least two different reasons: (i) some cohort members' siblings may have died between 2004 and 2012; (ii) cohort members could have named, in the 2012 siblings' module, some individuals they had grown up with who are not their biological siblings. Differences in the two measures of birth order are indicated in Table A4.

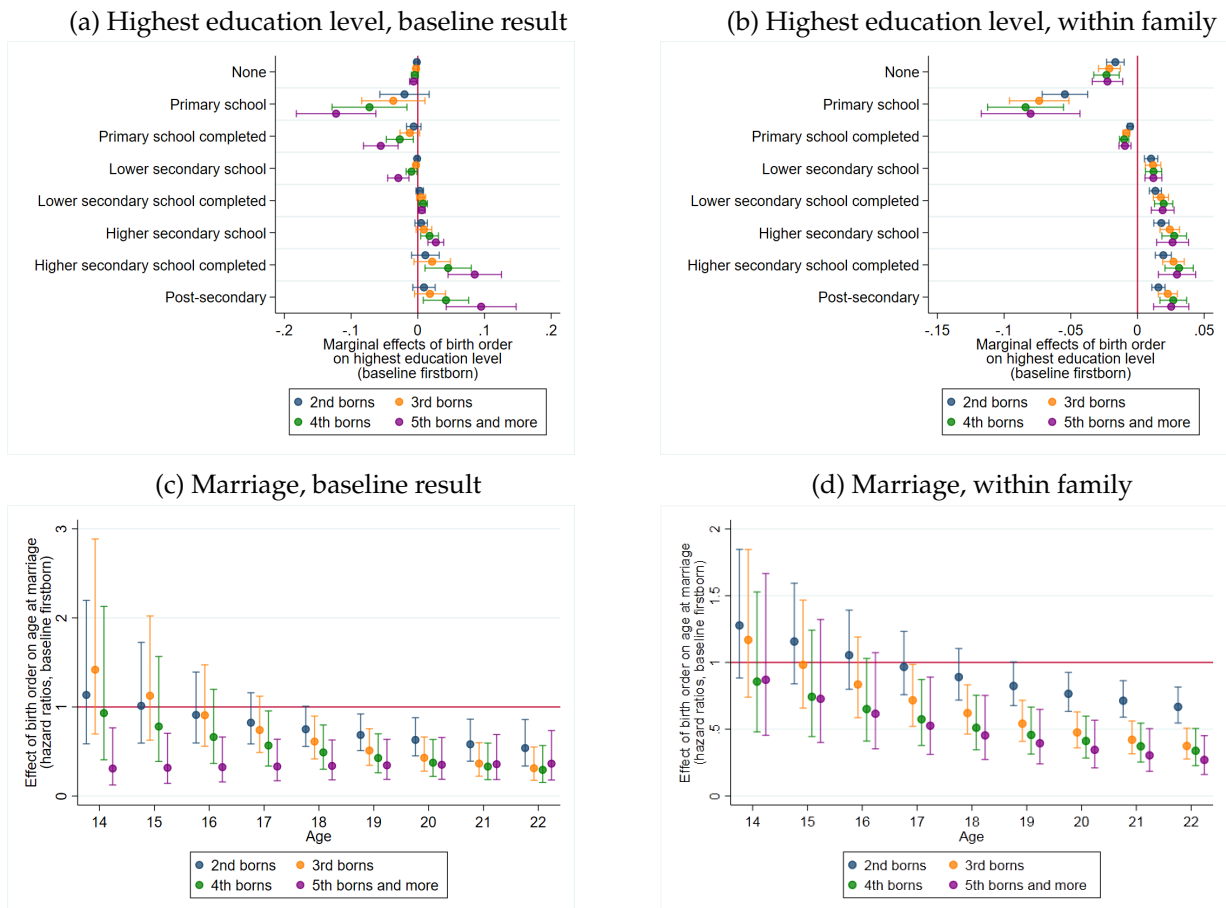
using within-family models every siblings have higher school attainment than firstborns. Concerning age at marriage, the results from the within family model are in line with our main results: firstborns are the ones who are married the youngest (Figure 9d).

When we explore the gender heterogeneities with the help of within family models, once more the results obtained with the between family models are confirmed.³⁷ The only exception is for the risk of marriage for men: the results of within family models indicate a positive effect of birth order on delaying marriage timing for males as well.

To conclude, we can observe that between- and within- family models give coherent results on the birth order effects on education outcome and on the risk of marriage for females. However, according the methodology we use, different results are obtained on the risk of marriage for males.

³⁷Results on education are qualitatively the same but more robust with the within family model: for example, 2nd and following girls clearly attain higher education levels than their older sister (Figure A2d).

Figure 9: Results comparison : between- vs within-family models, schooling outcomes



Notes: Figure 9a (9b) illustrates the marginal effects of birth order on the probability to declare each education level as the highest education level attained using sibship-size fixed effects (sibship fixed effects). Marginal effects are calculated after estimating an ordered probit model. Figure 9c & 9d represent, for each birth order, the relative risk at age t to get married, as compared to a firstborn. Hazard ratios are calculated using an extended Cox-proportional hazard model with sibship-size fixed effects (Figure 9a) or sibship fixed effects (Figure 9b) introduced as dummies. Within-family models control for individual's age and gender.

Source: Authors' elaboration using data from the 2004 *Madagascar Study on Academic Progress and Academic Performance* and the 2012 *Madagascar Young Adult Transitions Survey*.

6 Conclusion

This paper examined the effects of birth order on transition into adulthood in an extremely poor country, Madagascar. We compared first to later born individuals in terms of several key outcomes : school attainment, cognition, age at entry on the labor market and age at marriage. We relied on a panel survey, conducted in 2004 and in 2012, on a cohort of Malagasy people born between 1988 and 1992. The 2012 round of the survey was designed to specifically capture the transition from adolescence to young adulthood.

In 1833, Jane Austen wrote : 'The younger brother must help to pay for the pleasures of the elder' (Mansfield Park). Our results seem to indicate that in Madagascar we could say the opposite: 'The eldest sibling must help to pay for the pleasures of the younger'.

Applying between family models, we indeed found that firstborns transit earlier into adulthood. They leave school and work outside the household at younger ages than their later born siblings, they get less education and thus have lower cognitive abilities. Oldest girls also get married earlier. We do not find any direct effect of birth order on cognitive (and non cognitive) skills. Cognitive development is largely influenced by interaction with parents and siblings in early childbearing; the absence of a direct effect of birth order on cognitive (and non cognitive) skills, suggests that, in our study context, parental quality time and peer interactions do not differ so much according to the order of birth, probably because of the important role of the extended family and kinship network, that is well documented in Madagascar.

We speculate that parents transmit more physical capital to their earlier borns, while they invest more in the human capital of the latest ones, also thanks to the resources that their firstborns provide to the households given their earlier transition into adulthood. These dynamics are likely to be stronger in rural areas, where liquidity constraints are tight. Coherently to this, we find larger differences between eldest child and later borns for individuals living in rural households.

As birth order effects are rather social than biological, we tested the robustness of our results by using a birth order measure based on co-resident children instead of only biological siblings. We found similar results except on age at marriage. Our findings suggest that what matters for marriage is the rank among the biological siblings.

We tested the robustness of our results taking advantage of the availability of data on age at marriage and highest level of education for all cohort members' siblings. Thanks to those complete data, we were able to use a within-family model which is often presented as more reliable than between-family model. Our findings using within-family models on the full sample, are close to the ones using between-family models, and coefficients are more precisely estimated.

We could only partially explore the gender heterogeneities with respect to the order of birth. We could show that both girls and boys benefit from an higher birth order for their education and cognitive development and their entry in the labor market. Our results are less conclusive regarding the heterogeneous effect of birth order on marriage timing. Both between and within family models indicate that birth order delays girl's marriage, but the two methods give non consistent results regarding the marriage of males. We also found that birth order effects are stronger when the firstborn is a boy. This can be explained by the gender norms that prevail in Madagascar, for which the eldest boy is the most important heir: if a boy is a second born of a sibship where the first is a girl, he is likely to have a lot of pressure from his parents, as if he was the first.

It would be interesting to test if the gender of the firstborn has a different effect for males and females. Unfortunately, due to our limited sample size, we are not able to do such an analysis. This would be worth to explore with a richer dataset. Further research could also investigate birth order effects on fertility, situation on the labour market, wealth, and other adult outcomes that we could not explore because the individuals in our sample are quite young.

References

- Akresh, R. and Edmonds, E. V. (2011). Residential rivalry and constraints on the availability of child labor. Working Paper 17165, National Bureau of Economic Research.
- Alvi, E. and Dendir, S. (2011). Sibling differences in school attendance and child labour in ethiopia. Oxford development studies, 39(3):285–313.
- Attanasio, O., Cattan, S., Fitzsimons, E., Meghir, C., and Rubio-Codina, M. (2020). Estimating the production function for human capital: Results from a randomized controlled trial in Colombia. American Economic Review, 110(1):48–85.
- Barclay, K. J. (2015). A within-family analysis of birth order and intelligence using population conscription data on Swedish men. Intelligence, 49:134–143.
- Bertoni, M. and Brunello, G. (2016). Later-borns don't give up: The temporary effects of birth order on European earnings. Demography, 53(2):449–470.
- Black, S. E. (2017). New evidence on the impacts of birth order. NBER Reporter, 4:15–18.
- Black, S. E., Devereux, P. J., and Salvanes, K. G. (2005). The more the merrier? The effect of family size and birth order on children's education. Quarterly Journal of Economics, 120(2):669–700.
- Black, S. E., Gronqvist, E., and Ockert, B. (2018). Born to lead? The effect of birth order on noncognitive abilities. Review of Economics and Statistics, 100(2):274–286.
- Boccio, C. M. and Beaver, K. M. (2019). Further examining the potential association between birth order and personality: Null results from a national sample of American siblings. Personality and Individual Differences, 139(April 2018):125–131.
- Booth, A. L. and Kee, H. J. (2009). Birth order matters: The effect of family size and birth order on educational attainment, volume 22.
- Botzet, L. J., Rohrer, J. M., and Arslan, R. C. (2020). Analysing Effects of Birth Order on Intelligence, Educational Attainment, Big Five, and Risk Aversion in an Indonesian Sample. European Journal of Personality, May.
- Calimeris, L. and Peters, C. (2017). Food for thought: the birth-order effect and resource allocation in Indonesia. Applied Economics, 49(54):5523–5534.
- Carneiro, P. and Rodrigues, M. (2009). Evaluating the effect of maternal time on child development using the generalized propensity score. Institute for the study of Labor, 12th IZA European Summer school in Labor economics.

- Cox, D. and Fafchamps, M. (2007). Extended family and kinship networks: economic insights and evolutionary directions. Handbook of development economics, 4:3711–3784.
- Crenn, C. (2013). Entre Tananarive et Bordeaux: la migration malgache en France. Presses universitaires de Bordeaux.
- Cunha, F. and Heckman, J. J. (2008). Formulating, identifying and estimating the technology of cognitive and noncognitive skill formation. Journal of human resources, 43(4):738–782.
- Cunha, F., Heckman, J. J., and Schennach, S. M. (2010). Estimating the technology of cognitive and noncognitive skill formation. Econometrica, 78(3):883–931.
- Damian, R. I. and Roberts, B. W. (2015). The associations of birth order with personality and intelligence in a representative sample of U.S. high school students. Journal of Research in Personality, 58:96–105.
- Dammert, A. C. (2010). Siblings, child labor, and schooling in nicaragua and guatemala. Journal of Population Economics, 23(1):199–224.
- De Haan, M. (2010). Birth order, family size and educational attainment. Economics of Education Review, 29(4):576–588.
- De Haan, M., Plug, E., and Rosero, J. (2014). Birth order and human capital development: Evidence from ecuador. Journal of Human Resources, 49(2):359–392.
- Delaunay, V., Gastineau, B., and Andriamaro, F. (2013). Statut familial et inégalités face à la scolarisation à madagascar. International review of education, 59(6):669–692.
- Edmonds, E. V. (2006). Understanding sibling differences in child labor. Journal of Population Economics, 19(4):795–821.
- Eirnaes, M. and Pörtner, C. C. (2004). Birth order and the intrahousehold allocation of time and education. Review of Economics and Statistics, 86(4):1008–1019.
- Eloundou-Enyegue, P. and Kandiwa, V. (2007). Évolution de la concentration du confiage en afrique: l'exemple du ghana et de la zambie. Sociologie et sociétés, 39(2):101–118.
- Emerson, P. M. and Souza, A. P. (2008). Birth Order, Child Labor, and School Attendance in Brazil. World Development, 36(9):1647–1664.
- Freije, S. and Lopez-Calva, L. F. (2001). Child labor, school attendance, and poverty in Mexico and Venezuela. El Colegio de Mexico, Centro de Estudios Económicos.

- Glick, P., Randrianarisoa, J. C., and Sahn, D. E. (2011). Family background, school characteristics, and children's cognitive achievement in Madagascar. *Education Economics*, 19(4):363–396.
- Greene, W., Han, C., and Schmidt, P. (2002). The bias of the fixed effects estimator in nonlinear models. *Unpublished Manuscript, Stern School of Business, NYU*, 29.
- Haile, G. and Haile, B. (2012). Child labour and child schooling in rural ethiopia: nature and trade-off. *Education Economics*, 20(4):365–385.
- Hedges, S., Lawson, D. W., Todd, J., Urassa, M., and Sear, R. (2019). Sharing the load: How do coresident children influence the allocation of work and schooling in northwestern tanzania? *Demography*, 56(5):1931–1956.
- Hsin, A. (2007). Mothers' time with children and the social reproduction of cognitive skills. *WP, California Center for Population Research Working Paper Series*.
- INSTAT (2019). Troisieme recensement general de la population et de l'habitation (rgph-3). Technical report, INSTAT Madagascar.
- INSTAT and UNICEF (2019). Enquête par grappes à indicateurs multiples-mics madagascar, 2018, rapport final. Technical report, INSTAT and UNICEF.
- INSTAT and ORC Macro (2005). Enquête démographique et de santé, madagascar 2003–2004: Rapport de synthèse. Technical report, Calverton, Maryland, USA: INSTAT and ORC Macro.
- John, O. P., Srivastava, S., et al. (1999). The big five trait taxonomy: History, measurement, and theoretical perspectives. *Handbook of personality: Theory and research*, 2(1999):102–138.
- Kubot, K., Ramnauth, S., Revilla, J., Santos, C., Austin, M., and Gevers, C. (2015). Madagascar systematic country diagnostic. Technical report, World Bank Group.
- Laajaj, R. and Macours, K. (2017). *Measuring skills in developing countries*. The World Bank.
- Laajaj, R., Macours, K., Hernandez, D. A. P., Arias, O., Gosling, S. D., Potter, J., Rubio-Codina, M., and Vakis, R. (2019). Challenges to capture the big five personality traits in non-weird populations. *Science advances*, 5(7):eaaw5226.
- Lafortune, J. and Lee, S. (2014). All for one? Family size and children's educational distribution under credit constraints. *American Economic Review*, 104(5):365–369.
- Lanto (2007). Situation difficile pour les femmes. *Madagascar Tribune*.

- Lee, Y.-J., Parish, W. L., and Willis, R. J. (1994). Sons, daughters, and intergenerational support in taiwan. American journal of sociology, 99(4):1010–1041.
- Lehmann, J. Y. K., Nuevo-Chiquero, A., and Vidal-Fernandez, M. (2018). The early origins of birth order differences in children’s outcomes and parental behavior. Journal of Human Resources, 53(1):123–156.
- Lillard, L. A. and King, E. M. (1984). Methods for analyzing schooling choice with household survey data. Technical Report N-1963-AID1, The RAND Corporation, Santa Monica CA.
- Marazyan, K. (2015). Resource allocation in extended sibships: An empirical investigation for senegal. Journal of African Economies, 24(3):416–452.
- Markus, G. B. and Zajonc, R. (1977). Family Configuration and Intellectual Development : A Simulation. Behavioral Science, 22(1):137–142.
- Monfardini, C. and See, S. G. (2016). Birth order and child cognitive outcomes: an exploration of the parental time mechanism. Education Economics, 24(5):481–495.
- Moshoeshoe, R. (2019). Birth order effects on educational attainment: evidence from Lesotho. Education Economics, 27(4):401–424.
- Ottino, P. (1998). Les champs de l’ancestralité à Madagascar: parenté, alliance et patrimoine. Karthala éditions.
- PASEC (2005). La qualité de l’éducation à madagascar: Quelques pistes de réflexion pour une éducation de qualité pour tous. Technical report, Conférence des ministres de l’Éducation des États et Gouvernements de la Francophonie.
- PASEC (2015). Performances du système éducatif malgache, compétences et facteurs de réussite au primaire. Technical report, Conférence des ministres de l’Éducation des États et Gouvernements de la Francophonie.
- PASEC (2020). Pasec 2019. qualité des systèmes éducatifs en afrique subsaharienne francophone. performance et environnement de l’enseignement-apprentissage au primaire. Technical report, Conférence des ministres de l’Éducation des États et Gouvernements de la Francophonie.
- PAULE, N. and Professionnel, E. (2015). Les enfants naturels et leurs droits successoraux dans le droit de la famille malgache.
- Pesando, L. M. and Abufhele, A. (2019). Household determinants of teen marriage: Sister effects across four low-and middle-income countries. Studies in family planning, 50(2):113–136.

- Pronk, C. and Evers, S. (2007). Complexité de l'accès à la terre dans le sud-est de Madagascar (translation of: Pronk, C., & Evers, S. (2007). The complexities of land access in Southeast Madagascar. *Taloha, revue scientifique internationale des civilisations*, 43 (18). Taloha, revue scientifique internationale des civilisations, 43(18).
- Randriamamonjy, M. (2007). Intégrer les questions de genre dans le secteur forestier en Afrique: Madagascar.
- Rohrer, J. M., Egloff, B., and Schmukle, S. C. (2015). Examining the effects of birth order on personality. Proceedings of the National Academy of Sciences of the United States of America, 112(46):14224–14229.
- Schwefer, M. (2018). Birth order effects and educational achievement in the developing world. 282.
- Stocker, M., Razafimanantsoa Harivelo, F. N., Lalaina, M., Tokle, S. E., Ravelosoa, J. R., Aristide, T. E., Rawlings, Laura B. and Randrianatoandro, Z. A. T., Mamitiana, F. P., Quijada Torres, C., Juquois, M., Pivodic, F., El Ghandour, I., Rajenarison, L. H., Peixoto, T. C., Rakotomalala, O., Andriamihaja, N. A., Gueye, M., Amboaraso, M., and Jarotschkin, A. (2020). Madagascar economic update : Setting a course for recovery. Working Paper 155100, World Bank Group.
- Sulloway, F. J. (1996). Born to rebel: Birth order, family dynamics, and creative lives. Pantheon Books, New York, NY, US.
- Tenikue, M. and Verheyden, B. (2010). Birth order and schooling: Theory and evidence from twelve Sub-Saharan countries. Journal of African Economies, 19(4):459–495.
- Vogl, T. S. (2013). Marriage institutions and sibling competition: Evidence from South Asia. The Quarterly Journal of Economics, 128(3):1017–1072.
- Wahhaj, Z. (2018). An economic model of early marriage. Journal of Economic Behavior & Organization, 152:147–176.
- Zajonc, A. R. B. (1976). Family Configuration and Intelligence Linked references are available on JSTOR for this article : Family Configuration and Intelligence. 192(4236):227–236.

A Appendix

A.1 Descriptive statistics

Table A1: Cohort members' attrition

	Non attrited			Attrited			Difference p-value
	Mean	SE	N	Mean	SE	N	
<u>Individuals' characteristics</u>							
Female	0,53	0,50	201	0,52	0,50	1,657	0,79
Age	14,77	1,06	201	14,81	1,06	1,657	0,61
Biological birth order	2,22	1,51	201	2,75	1,85	1,657	0,00
Firstborn	0,45	0,50	201	0,34	0,48	1,657	0,00
Second born	0,22	0,41	201	0,20	0,40	1,657	0,62
Third born	0,14	0,35	201	0,15	0,36	1,657	0,57
Fourth born	0,10	0,31	201	0,12	0,32	1,657	0,65
Fifth born or more	0,08	0,28	201	0,18	0,39	1,657	0,00
Biological sibship size	4,08	2,43	201	4,85	2,47	1,657	0,00
Average age difference among the biological sibship	2,86	3,92	201	3,03	2,62	1,657	0,42
Social birth order	2,64	1,50	201	2,97	1,79	1,657	0,01
Firstborn	0,28	0,45	201	0,25	0,43	1,657	0,34
Second born	0,23	0,42	201	0,23	0,42	1,657	0,87
Third born	0,23	0,42	201	0,18	0,38	1,657	0,06
Fourth born	0,12	0,33	201	0,14	0,35	1,657	0,59
Fifth born or more	0,12	0,33	201	0,20	0,40	1,657	0,01
Social sibship size	5,38	2,18	201	5,79	2,45	1,657	0,02
Average age difference among the social sibship	3,32	1,48	201	3,27	1,56	1,657	0,62
Cognitive skills	-0,11	0,99	96	0,01	1,00	1,010	0,28
PASEC child	0,20	0,40	201	0,26	0,44	1,657	0,08
Currently in school	0,69	0,46	186	0,79	0,41	1,597	0,00
Ever worked	0,64	0,48	199	0,53	0,50	1,614	0,01
<u>Parents' characteristics</u>							
Mother							
Year of birth	1963,40	7,78	152	1962,15	7,59	1,422	0,05
Age at first birth	21,61	4,80	144	21,72	4,60	1,367	0,78
Education							
No education	0,55	0,50	201	0,52	0,50	1,657	0,41
Primary completed	0,13	0,34	201	0,16	0,36	1,657	0,39
Lower secondary completed	0,31	0,47	201	0,32	0,47	1,657	0,87
Activity							
Wage worker	0,06	0,24	170	0,08	0,27	1,465	0,35
Own account worker	0,48	0,50	170	0,44	0,50	1,465	0,30
Family worker	0,41	0,49	170	0,44	0,50	1,465	0,51
Housewife	0,02	0,13	170	0,02	0,13	1,465	0,96
Father							
Education							
No education	0,48	0,50	201	0,47	0,50	1,657	0,79
Primary completed	0,14	0,35	201	0,14	0,35	1,657	0,89
Lower secondary completed	0,37	0,48	201	0,38	0,49	1,657	0,68
Activity							
Wage worker	0,27	0,44	190	0,23	0,42	1,565	0,20
Own account worker	0,57	0,50	190	0,52	0,50	1,565	0,18
Family worker	0,14	0,34	190	0,23	0,42	1,565	0,00
<u>Household's characteristics</u>							
Urban	0,28	0,45	201	0,25	0,43	1,657	0,38
Poor household	0,38	0,49	201	0,35	0,48	1,657	0,39

*** p<0.01, ** p<0.05, * p<0.1. Source: Authors' calculation using data from the 2004 *Madagascar Study on Academic Progress and Academic Performance* and the 2012 *Madagascar Young Adult Transitions Survey*.

Table A2: Descriptive statistics on control variables

	Full sample	First child	Second child	Third child	Fourth child	Fifth child or more
Sibship size*	5,38 (2,14)	4,00 (1,68)	4,61 (1,70)	5,19 (1,62)	6,21 (1,66)	7,62 (1,70)
Age in 2012	21,97 (1,16)	22,04 (1,07)	22,02 (1,13)	21,99 (1,25)	21,94 (1,25)	21,84 (1,17)
Average age difference among the sibship*	3,07 (2,03)	3,05 (2,26)	3,09 (2,06)	3,19 (1,98)	3,03 (1,90)	2,99 (1,81)
Female	0,53 (0,50)	0,55 (0,50)	0,53 (0,50)	0,55 (0,50)	0,54 (0,50)	0,49 (0,50)
Mother's year of birth	1961,703 (6,57)	1967,34 (4,94)	1963,41 (5,18)	1960,31 (5,54)	1958,77 (4,97)	1955,79 (4,68)
Mother's age at first birth	21,81 (4,56)	21,78 (4,83)	22,25 (4,63)	22,40 (4,85)	21,31 (3,91)	21,16 (4,14)
Father's activity						
Father is a wage worker	0,23 (0,42)	0,21 (0,41)	0,21 (0,41)	0,29 (0,46)	0,22 (0,41)	0,24 (0,43)
Father is an own account worker	0,60 (0,49)	0,62 (0,49)	0,61 (0,49)	0,57 (0,50)	0,60 (0,49)	0,59 (0,49)
Father is a family worker	0,17 (0,37)	0,17 (0,38)	0,18 (0,38)	0,14 (0,34)	0,18 (0,39)	0,18 (0,38)
Father's education						
No education	0,46 (0,50)	0,45 (0,50)	0,45 (0,50)	0,49 (0,50)	0,48 (0,50)	0,44 (0,50)
Primary school completed	0,24 (0,43)	0,25 (0,43)	0,27 (0,44)	0,19 (0,39)	0,23 (0,42)	0,26 (0,44)
Lower secondary school completed	0,30 (0,46)	0,30 (0,46)	0,28 (0,45)	0,32 (0,47)	0,29 (0,46)	0,31 (0,46)
Mother's activity						
Mother is a wage worker	0,09 (0,29)	0,08 (0,28)	0,12 (0,33)	0,11 (0,31)	0,08 (0,27)	0,08 (0,27)
Mother is an own account worker	0,42 (0,49)	0,40 (0,49)	0,38 (0,49)	0,44 (0,50)	0,43 (0,50)	0,44 (0,50)
Mother is a family worker	0,40 (0,49)	0,43 (0,50)	0,43 (0,50)	0,35 (0,48)	0,40 (0,49)	0,39 (0,49)
Mother is a housewife	0,09 (0,28)	0,09 (0,28)	0,06 (0,25)	0,11 (0,31)	0,09 (0,29)	0,09 (0,28)
Mother's education						
No education	0,49 (0,50)	0,46 (0,50)	0,45 (0,50)	0,51 (0,50)	0,56 (0,50)	0,52 (0,50)
Primary school completed	0,28	0,31	0,27	0,27	0,26	0,28

Table A2, continued

	Full sample	First child	Second child	Third child	Fourth child	Fifth child or more
Lower secondary school completed	(0,45) 0,22 (0,42)	(0,46) 0,23 (0,42)	(0,45) 0,28 (0,45)	(0,45) 0,21 (0,41)	(0,44) 0,18 (0,39)	(0,45) 0,19 (0,39)
Wealth index*	22,89 (18,53)	22,07 (19,15)	22,69 (18,63)	24,22 (19,27)	24,00 (18,94)	22,29 (16,72)
Cultivated surface*	3,01 (7,24)	2,96 (8,77)	2,80 (7,87)	3,03 (5,92)	3,22 (7,80)	3,17 (4,68)
Urban*	0,23 (0,42)	0,23 (0,42)	0,19 (0,40)	0,21 (0,41)	0,24 (0,43)	0,26 (0,44)
Proximity to infrastructure*	38,60 (28,51)	38,00 (29,84)	37,28 (27,13)	39,34 (27,57)	38,58 (29,14)	40,15 (28,83)
Ethnicity						
Antandroy	0,05 (0,22)	0,05 (0,21)	0,03 (0,18)	0,05 (0,22)	0,04 (0,20)	0,08 (0,27)
Antesaka	0,03 (0,17)	0,02 (0,15)	0,04 (0,20)	0,03 (0,17)	0,04 (0,20)	0,02 (0,15)
Betsileo	0,22 (0,41)	0,18 (0,38)	0,22 (0,41)	0,21 (0,41)	0,25 (0,43)	0,26 (0,44)
Betsimisakara	0,12 (0,32)	0,15 (0,36)	0,14 (0,35)	0,07 (0,25)	0,08 (0,28)	0,10 (0,31)
Merina	0,28 (0,45)	0,27 (0,45)	0,27 (0,45)	0,30 (0,46)	0,32 (0,47)	0,25 (0,43)
Sakalava	0,04 (0,21)	0,06 (0,24)	0,05 (0,22)	0,04 (0,20)	0,03 (0,18)	0,02 (0,15)
Sihanaka	0,05 (0,22)	0,06 (0,24)	0,05 (0,21)	0,06 (0,24)	0,03 (0,18)	0,05 (0,21)
Tanala	0,03 (0,18)	0,03 (0,17)	0,03 (0,17)	0,06 (0,24)	0,03 (0,16)	0,02 (0,13)
Tsimihety	0,05 (0,22)	0,06 (0,24)	0,05 (0,21)	0,06 (0,24)	0,03 (0,18)	0,05 (0,21)
Other	0,12 (0,32)	0,12 (0,33)	0,10 (0,30)	0,11 (0,32)	0,10 (0,31)	0,14 (0,35)
Observations	1,107	288	249	197	144	229

Table A2, continued

	Full sample	First child	Second child	Third child	Fourth child	Fifth child or more
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Notes: The table presents mean values for the full sample and birth order. Standard deviations are within parentheses. Sample restricted to individuals between 19 and 25 years old. * denotes variables measured in 2004. Sibship size is measured as the number of siblings among a sibship. Age, average age difference among the sibship and mother's age at first birth are measured in years. The variable "Female" is a dummy equal to 1 if the cohort member is a female. Parents activities and education are measured thanks to dummies denoting the highest level of education completed by the parent and his/her type of activity. Wealth index, cultivated surface and proximity to infrastructure are indexes constructed thanks to principal component analyses. They are transformed to fall into [0;100]. Ethnicity is measured thanks to dummies equal to 1 for each ten most important ethnicity in Madagascar. Smaller ethnicity are gathered in the modality "Other".

Source: Authors' elaboration using data from the 2004 *Madagascar Study on Academic Progress and Academic Performance* and the 2012 *Madagascar Young Adult Transitions Survey*.

Table A3: Descriptive statistics all cohort members siblings' characteristics by birth order

	Birth order, all siblings declared in the 2012 survey					Total
	First born	Second born	Third born	Fourth born	Fifth born or more	
Age	24,52	23,16	20,74	18,66	16,06	21,31
Female	0,49	0,49	0,50	0,49	0,47	0,49
Observations	1,344	747	645	504	760	4,000
Highest education level	3,08	3,19	3,09	2,91	2,54	2,98
Observations	1,314	743	641	497	737	3,932
Age at first marriage	20,07	20,31	19,50	19,34	18,87	19,88
Observations	514	259	147	91	103	1,114

Notes: The table presents mean values for the full sample and birth order. Full sample is cohort members and all their siblings declared in the 2012 wave survey. We only have information on highest education level for 3,932 individuals. Age at first marriage is available only for individuals already married.

Source: Authors' elaboration using data from the 2004 *Madagascar Study on Academic Progress and Academic Performance* and the 2012 *Madagascar Young Adult Transitions Survey*.

Table A4: 2012 and 2004 birth order

	Birth order measured with the 2012 wave survey					Total
	First born	Second born	Third born	Fourth born	Fifth born or more	
Average age gap among sibship	2,70	3,43	3,31	3,02	2,81	3,07
Sibship size	2,68	3,81	4,40	5,20	6,83	4,23
Birth order measured with the 2004 wave survey						
First born	87,15	8,33	2,43	0,69	1,39	100
Second born	30,92	51,00	8,84	4,82	4,42	100
Third born	11,68	23,86	41,62	11,68	11,17	100
Fourth born	10,42	18,06	20,83	34,03	16,67	100
Fifth born or more	9,17	10,48	18,34	14,85	47,16	100
Observations	571	321	230	147	205	1,107

Notes: Authors' elaboration using data from the 2004 *Madagascar Study on Academic Progress and Academic Performance* and the 2012 *Madagascar Young Adult Transitions Survey*. Sample restricted to individuals between 19 and 25 years old.

A.2 Main results

Table A5: Effect of birth order on schooling outcomes

	Highest grade		Average grade for level	Highest level	
	Linear model (1)	Linear model (2)	Linear model (3)	Ordered probit (4)	Ordered probit (5)
Ref. firstborn					
2nd child	0.174 (0.284)	0.277 (0.327)	0.230 (0.291)	0.096 (0.107)	0.142 (0.140)
3rd child	0.424 (0.374)	0.833* (0.441)	0.511 (0.383)	0.181 (0.141)	0.379** (0.189)
4th child	0.957** (0.478)	0.823 (0.580)	1.117** (0.489)	0.377** (0.180)	0.406 (0.248)
5th child or more	1.844*** (0.588)	1.840*** (0.704)	2.038*** (0.602)	0.719*** (0.222)	0.814*** (0.302)
Cognitive skills in 2003		1.512*** (0.123)			0.656*** (0.056)
Within-R2	0.39	0.49	0.38	0.13	0.18
Observations	1,107	672	1,107	1,107	673

Notes: This table reports the effects of birth order on different measures of school attainment. The dependent variables are (1) & (2) highest completed grade, (3) average grade attained for each level of education and (4)& (5) highest attained level of education. We have 435 missing values for 2004 cognitive skills leading us to estimate the effect of birth order on the highest completed grade and level on a 672 cohort members sample when we add 2004 cognitive skills in control variables. The effects of birth order on highest grade and average grade for level are estimated using a linear model absorbing sibship size fixed effects. The effects of birth order on the highest level of education attained are estimated using an ordered probit model with sibship size fixed effects added as dummy variables. All models include gender, age, ethnicity, mother's age, mother's age at first birth, parent's activity (wage worker, own account worker, family worker or housewife), parent's education (no education, primary completed or college completed), place of residence (urban or rural), household's wealth in 2004, average age difference among sibship and sibship size fixed effects. *** p<0.01, **p<0.05, * p<0.1.

Source: Authors' calculation using data from the *Madagascar Young Adult Transitions Survey*.

Table A6: Birth order and time use in 2004

	Dep Var: Time use in hours per week			
	(1) Time for domestic chores	(2) Time for water	(3) Time for wood	(4) Time for care (children and elders)
Birth order : Ref. firstborn				
2nd child	-1.257 (0.777)	-0.551 (0.461)	-0.739** (0.314)	-0.520* (0.301)
3rd child	-2.021* (1.032)	-1.228** (0.613)	-0.971** (0.417)	-0.386 (0.401)
4th child	-3.678*** (1.312)	-1.629** (0.780)	-1.242** (0.531)	-1.277** (0.510)
5th child or more	-4.026** (1.619)	-2.600*** (0.962)	-1.420** (0.655)	-1.165* (0.629)
Adjusted R2	0.16	0.07	0.17	0.07
Adjusted within-R2	0.18	0.07	0.18	0.09
Observations	1,064	1,071	1,071	1,071

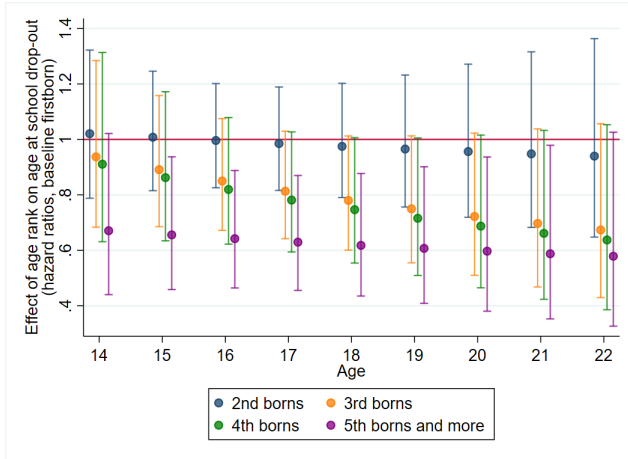
This table reports the effects of birth order on time use in 2004. The dependent variables are (1) hours per week spent doing domestic chores, (2) hours per week spent fetching water, (3) hours per week spent fetching wood and (4) hours per week spent taking care of the children and the elderly in the household. All models include gender, age, ethnicity, mother's age, mother's age at first birth, parent's activity (wage worker, own account worker, family worker or housewife), parent's education (no education, primary completed or college completed), place of residence (urban or rural), household's wealth in 2004, average age difference among sibship and sibship size fixed effects. *** p<0.01, ** p<0.05, * p<0.1.

Source: Authors' calculation using data from the 2004 *Madagascar Study on Academic Progress and Academic Performance* and the 2012 *Madagascar Young Adult Transitions Survey*.

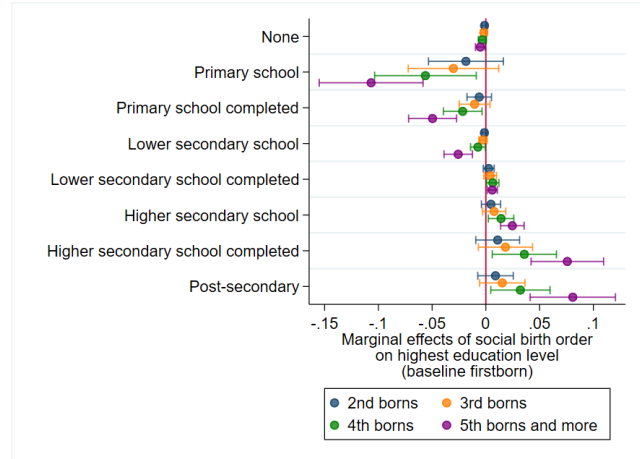
A.3 Social birth order

Figure A1: Social birth order and transitions into adulthood

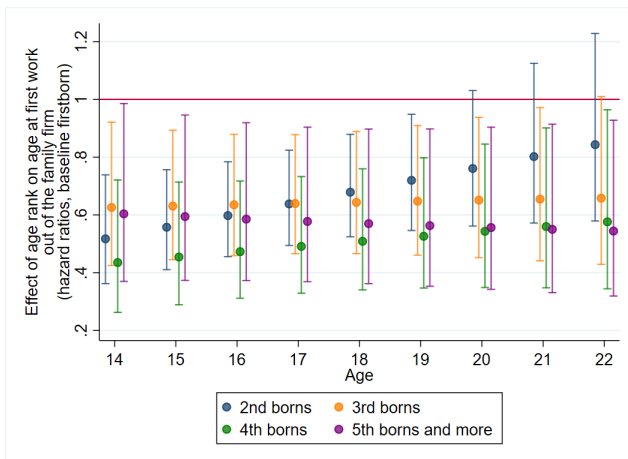
(a) School dropout



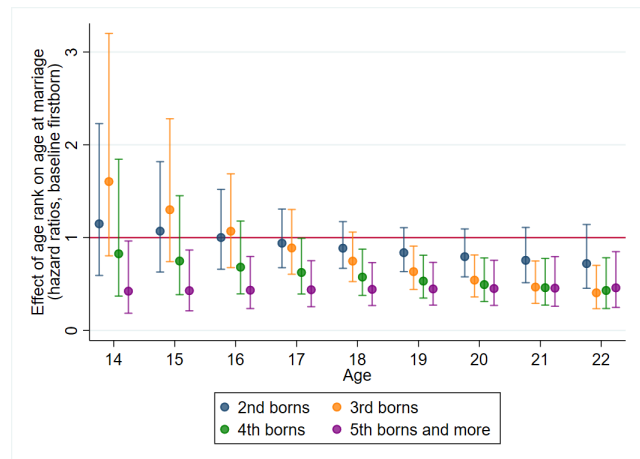
(b) Highest education level



(c) Work outside the family firm



(d) Marriage



Notes: Figures A1a, A1b, A1c & A1d represent, for each age rank, the relative risk at age t to dropout from school, to start working outside the family firm or to get married, as compared to the oldest child in the household. Hazard ratios calculated using an extended Cox-proportional hazard model on 1,061 cohort members for age at school dropout (we were not able to calculate age at school dropout for 46 individuals) and 1,107 cohort members for age at marriage. Age at first work outside the family firm is calculated only for cohort members who have a family firm i.e. if at least one parent were own account worker or a family worker. The hazard function for age at first work outside the family firm is estimated on a 849 cohort members sample. All models include gender, age, ethnicity, mother's age, mother's age at first birth, parent's activity (wage worker, own account worker, family worker or housewife), parent's education (no education, primary completed or college completed), place of residence (urban or rural), household's wealth in 2004, average age difference among sibship and sibship size fixed effects.

Source: Authors' elaboration using data from the 2004 *Madagascar Study on Academic Progress and Academic Performance* and the 2012 *Madagascar Young Adult Transitions Survey*

Table A7: Effect of social birth order on cognitive skills

	Cognitive skills in 2012				Cognitive skills in 2003
	(1)	(2)	(3)	(4)	(5)
Ref. firstborn is the oldest					
child in the household					
2nd child	0.011 (0.076)	-0.061 (0.072)	-0.050 (0.090)	-0.060 (0.071)	-0.012 (0.098)
3rd child	0.087 (0.093)	-0.013 (0.089)	0.052 (0.112)	-0.010 (0.089)	-0.003 (0.123)
4th child	0.240** (0.111)	0.059 (0.110)	0.156 (0.139)	0.065 (0.110)	-0.038 (0.152)
5th child or more	0.376*** (0.129)	0.038 (0.124)	0.243 (0.156)	0.040 (0.124)	0.132 (0.170)
Cognitive skills in 2003			0.323*** (0.037)	0.057* (0.032)	
School attainment		0.187*** (0.008)		0.180*** (0.009)	
Within-R2	0.38	0.65	0.44	0.65	0.31
Observations	1,107	671	671	671	671

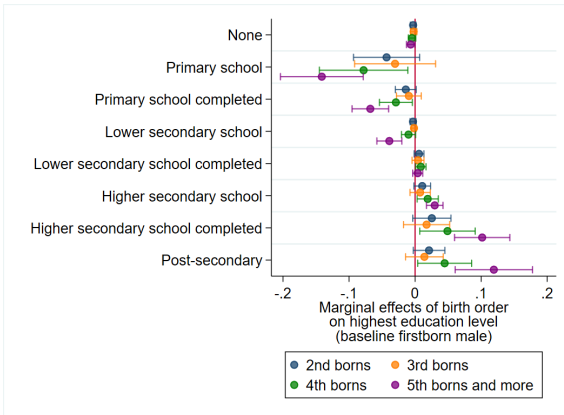
Notes: This table reports the effects of social birth order on school attainment and cognitive skills. The dependent variables are (1) & (2) highest completed grade, (3) average grade attained for each level of education, (4) highest attained level of education, (5) to (8) cognitive skills measured in 2012 and (9) cognitive skills measured in 2004. We have 435 missing values for 2004 cognitive skills leading us to estimate the effect of birth order on this outcome on a 672 cohort members sample. The effects of birth order on highest grade, average grade for level and cognitive skills are estimated using a linear model absorbing sibship size fixed effects. The effects of birth order on the highest level of education attained are estimated using an ordered probit model with sibship size fixed effects added as dummy variables. All models include gender, age, ethnicity, mother's age, mother's age at first birth, parent's activity (wage worker, own account worker, family worker or housewife), parent's education (no education, primary completed or college completed), place of residence (urban or rural), household's wealth in 2004, average age difference among sibship and sibship size fixed effects. *** p<0.01, ** p<0.05, * p<0.1.

Source: Authors' calculation using data from the 2004 *Madagascar Study on Academic Progress and Academic Performance* and the 2012 *Madagascar Young Adult Transitions Survey*.

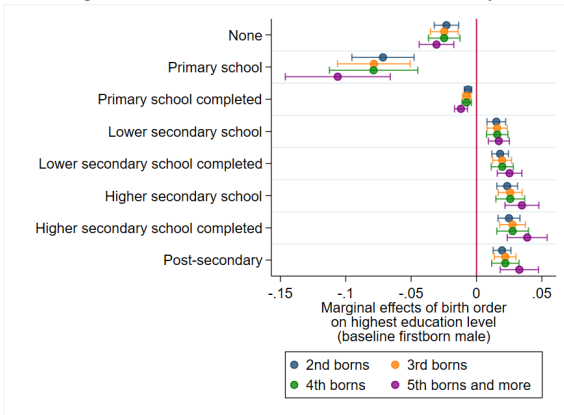
A.4 Within-family models

Figure A2: Results comparison : between- vs within-family models and gender heterogeneity, highest education level

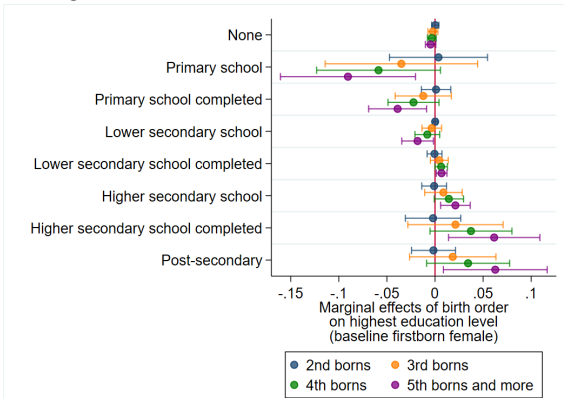
(a) Highest education level, baseline result for males



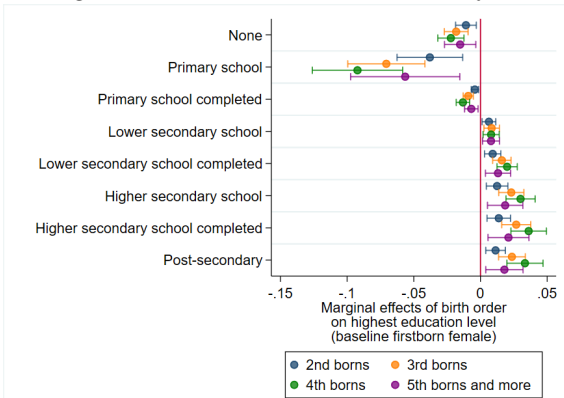
(b) Highest education level, within family for males



(c) Highest education level, baseline result for females



(d) Highest education level, within family for females



Notes: Figure A2 illustrates the marginal effects of birth order on the probability to declare each education level as the highest education level attained using sibship-size fixed effects (baseline results) or sibship fixed effects (within-family models). Marginal effects are calculated after estimating an ordered probit model. Within-family models control for individual's age and gender.

Source: Authors' elaboration using data from the 2004 *Madagascar Study on Academic Progress and Academic Performance* and the 2012 *Madagascar Young Adult Transitions Survey*.

Figure A3: Results comparison : between- vs within-family models and gender heterogeneity, age at marriage



Notes: Figure A3 illustrates for each birth order, the relative risk at age t to get married, as compared to a firstborn. Hazard ratios are calculated using an extended Cox-proportional hazard model with sibship-size fixed effects (baseline results) or sibship fixed effects (within-family models) introduced as dummies. Within-family models control for individual's age and gender.

Source: Authors' elaboration using data from the 2004 Madagascar Study on Academic Progress and Academic Performance and the 2012 Madagascar Young Adult Transitions Survey.

A.5 Non-cognitive skills

The formation of non-cognitive skills is strongly influenced by the context in which the individual grows up, and in particular by the investment of parents in the first years of life (Cunha et al., 2010). The way parents interact with their child varies considerably depending on the number of siblings, on the experience of the parents themselves and, in some contexts, on the gender of the child. Firstborns can, for example, benefit from more attention from parents, who have more time to dedicate to them, while last children can benefit most from their parents' experience (Zajonc, 1976; Markus and Zajonc, 1977; De Haan et al., 2014; Monfardini and See, 2016; Lehmann et al., 2018). Moreover, parents are often more strict with their first children and this could lead them to develop greater persuasive and communication skills (Black et al., 2018). Conversely, later children are likely to suffer from the comparison with their older siblings and this could induce them to develop more their creativity skills to differentiate from them (Sullo way, 1996). Child development is also influenced by the interactions with siblings: older siblings, for example, are likely to develop more their sense of responsibility (Sullo way, 1996; Black et al., 2018), their patience, as well as their pedagogical skills (Zajonc, 1976; Markus and Zajonc, 1977). All this implies that a child's birth order can have important effects on her non-cognitive development with an indirect impact on her chances of success in her adult's professional life.

Most of the literature on the effects of birth order on non-cognitive skills focuses on developed countries. It is unclear if results can be extended to poor countries, where budget constraints are more pronounced and thus economic motivations are likely to play a more important role for parents when they need to decide how much to invest in their child (Eirnaes and Pörtner, 2004; Emerson and Souza, 2008; Tenikue and Verheyden, 2010; De Haan et al., 2014; Lafortune and Lee, 2014). Also, these phenomena are strongly influenced by cultural and social norms, that are context-specific. For instance, given the importance of extended family in developing countries (Cox and Fafchamps, 2007), interactions with individuals outside the household could particularly shape children personality.

Existing literature shows no or very little effect of birth order on personality (Damian and Roberts, 2015; Rohrer et al., 2015; Lehmann et al., 2018; Boccio and Beaver, 2019; Botzet et al., 2020). Only Black et al. (2018) find a negative effect of birth order on non-cognitive skills in Sweden. Black et al. (2018) take advantage of the military enlistment data from the Swedish War Archive. This dataset provides results to psychological tests that Swedish men used to take when they enlisted in the military.³⁸ Men were interviewed by a certified psychologist who had to assess their emotional stability, persistence, willingness to assume responsibility, ability to take initiative and if they were socially outgoing. Black et al. (2018) use an overall measure of those personality traits to conduct the analysis. They find that later born males

³⁸Until 2010, all Swedish men had to enlist in the military.

perform significantly worse on non-cognitive skills. The effect is stronger for boys with older brothers than for boys with older sisters. Differences in personality depending on birth order and sibship's sex composition can be explained by the [Sulloway \(1996\)](#)'s family niche model. According to [Sulloway \(1996\)](#), later borns have to be creative to differentiate themselves from their older (same sex) siblings. They become more unconventional to attract parental attention. Those differences in personality seem to influence the occupational choices in Sweden, where male firstborns are more likely to be in occupations, like top manager, that require positive non-cognitive skills ([Black et al., 2018](#)).

The *Madagascar Young Adult Transition Survey* includes a module of 116 questions aimed to assess cohort members non-cognitive skills. We describe them in the following section.

A.5.1 Measurement of Personality

Cohort member's non-cognitive skills were assessed by a 116 questions test. Respondents had to rate on a 5 points Likert scale whether they fully disagree (rated 1) or fully agree (rated 5) that a statement describes them. Statements used are a mix of commonly used items aimed to measure non-cognitive skills.³⁹ For example, respondents had to declare whether they agree or not that the statement "I like to tidy" describes them.

We combined the 116 items to build a commonly used taxonomy of non-cognitive abilities: the Big-5 personality traits. According to [John et al. \(1999\)](#), the Big 5 "represent personality at the broadest level of abstraction, and each dimension summarizes a large number of distinct, more specific personality characteristics". Big-5 dimensions are known under the acronym OCEAN: openness, conscientiousness, extraversion, agreeableness and neuroticism. They are particularly accurate for developed countries. As warned by [Laajaj and Macours \(2017\)](#) and [Laajaj et al. \(2019\)](#), Big-5 taxonomy might not emerge in developing countries. The major issue is that in developing economies, non-cognitive skills are assessed thanks to face-to-face surveys while they are mostly assessed on computers in developed economies. Biases in responses might especially arise in face-to-face surveys in developing countries because of interactions between respondents and interviewers, items' translations and lower educational level that can make questions more difficult to understand. Specifically, acquiescence bias (tendency to agree with every statements, even when they are contradictory) might be more common. To check whether the Big-five taxonomy emerges in our data, we conducted a factorial analysis, after correcting for acquiescence bias, on our respondents' answers to the 116 items aimed at measuring non-cognitive skills. The personality traits that emerge from the factorial analysis are slightly different from the Big-five taxonomy. They are : responsibility,

³⁹A detailed list of usual scales and items used to assess non-cognitive skills is accessible at <https://ipip.ori.org/>.

initiative, extraversion, emotional stability and openness (See Tables A8 to A11 for a detailed list of items and personality traits they belong to).

The internal consistency of our personality traits' constructs is satisfactory. For each personality trait except openness, Cronbach's Alphas are over 0.7.⁴⁰ Three of the personality traits that emerge from our factorial analysis are common to the Big-5 personality traits (extraversion, emotional stability and openness). To check whether they accurately measure extraversion, emotional stability or openness, we also constructed a naive measurement of non-cognitive skills. We simply averaged answers to items that belong to a determined trait (See Tables A8 to A11 for the detailed naive classification of items within each personality traits). The naive and factorial analysis constructs of common personality traits are sufficiently correlated to each other (0.46 for openness, 0.6 for extraversion and 0.7 for emotional stability, see table A12). For the sake of simplicity, we only use personality traits that emerged from factorial analysis when analyzing the effect of birth order on non-cognitive skills.⁴¹

A.5.2 The effect of birth order on non-cognitive skills

We use a linear model absorbing sibship size fixed effects to estimate the effects of birth order on z-score of our measures of non-cognitive skills (Table A13, see equation 1). We do not find any effect of birth order on non-cognitive skills. Some gender and wealth heterogeneities seem to emerge (Table A14). Fourth born girls take less initiative than firstborn girls but are more emotionally stable. In poor households, third borns are more extrovert than firstborns. However, those results are too weak to be correctly interpreted. The absence of birth order effects on non-cognitive skills is in line with the scarce literature on this topic in developing countries (i.e. Botzet et al. (2020)).

Table A8: Responsibility measurement (Cronbach's Alpha =0.95)

	Mean	SE	Factor loading	"Naive" classification
I am always up to my tasks	3,99	0,74	0,64*	Conscientiousness
I like to step up to the plate	4,06	0,73	0,63*	Conscientiousness
I keep my promises	4,04	0,75	0,60*	Agreeableness
I always keep my word	4,03	0,72	0,60*	Agreeableness
I know how to keep calm	3,96	0,71	0,60*	Emotional stability
I like order and regularity	4,15	0,68	0,59*	Conscientiousness
I am a person who sets goals	4,09	0,73	0,58*	Conscientiousness

⁴⁰Cronbach's Alpha assesses the extent to which items are measuring the same underlying construct. A minimum threshold of 0.7 is often applied in the litterature (Laajaj and Macours, 2017).

⁴¹Our results are robust to the use of the "naive" measurement of the personality traits.

Table A8, continued

	Mean	SE	Factor loading	"Naive" classification
I like to tidy	4,17	0,67	0,57*	Conscientiousness
I like when everything is in its place	4,18	0,66	0,57*	Conscientiousness
I do my job without waiting	3,83	0,78	0,57*	Conscientiousness
I take the initiative of conversations	3,79	0,8	0,56*	Extraversion
I do the work with conviction	4,18	0,66	0,55*	Conscientiousness
I immediately begin the tasks to be done	3,89	0,72	0,55*	Conscientiousness
I respect group decisions	4,08	0,7	0,55*	Agreeableness
I get to work without waiting	3,87	0,78	0,55*	Conscientiousness
I stand in solidarity with the members of my group	3,96	0,78	0,54*	Extraversion
I do not assume my responsibilities (R)	4,09	0,77	0,54*	Conscientiousness
I never get bored	3,81	0,81	0,54*	Openness
I know how to take up challenges	3,74	0,84	0,54*	Conscientiousness
I get involved in collective/community activities	4	0,82	0,53*	Extraversion
I leave it to others to take the initiative	3,83	0,88	0,53*	Extraversion
I know how to keep the secrets	4,11	0,75	0,52*	Agreeableness
I never leave a job without completing it	3,9	0,81	0,52*	Conscientiousness
I'm always busy with something interesting	3,67	0,83	0,52*	Openness
I do things by following a plan	3,81	0,77	0,51*	Conscientiousness
I like to put order	4,15	0,69	0,50*	Conscientiousness
I sometimes feel dishonest (R)	4,18	0,77	0,50*	Agreeableness
I leave my stuff lying around (R)	4,05	0,8	0,50*	Conscientiousness
I never leave work (to be done)	3,64	0,87	0,50*	Conscientiousness
I am easily intimidated (R)	3,96	0,83	0,49*	Extraversion
I quickly realize the tasks to do	3,65	0,8	0,49*	Conscientiousness
I enjoy my work	3,72	0,85	0,48*	Conscientiousness
I am consumed by my own problems (R)	3,69	0,91	0,48*	Emotional stability
I like to tidy up all around	3,85	0,77	0,48*	Conscientiousness
I do things quickly	3,79	0,82	0,48*	Conscientiousness
I leave my room in disorder (R)	4,18	0,76	0,47*	Conscientiousness
I can clearly articulate ideas	3,61	0,8	0,47*	Conscientiousness
I am always ready	4,24	0,74	0,47*	Conscientiousness
I delight in disorder (R)	4,23	0,8	0,47*	Conscientiousness
I am true to my own values	3,87	0,86	0,47*	Agreeableness
I exaggerate with my troubles (R)	3,91	0,84	0,47*	Emotional stability
I pay attention to details	3,83	0,81	0,46*	Conscientiousness
I'm easily discouraged (R)	3,98	0,84	0,46	Conscientiousness
I give up easily (R)	3,96	0,84	0,45	Conscientiousness
I leave it to others to decide (R)	3,71	0,93	0,45	Extraversion
I leave my things hanging out (R)	4,03	0,84	0,45	Conscientiousness
I seldom associate myself with others	3,96	0,85	0,44	Extraversion
I finish the tasks whatever the obstacles encountered	3,55	0,9	0,44	Conscientiousness

Table A8, continued

	Mean	SE	Factor loading	"Naive" classification
I believe that honesty is the foundation of trust	4,12	0,84	0,43	Agreeableness
I like to belong to a group	3,73	0,88	0,43	Extraversion
I do not get distracted when I work	3,71	0,87	0,42	Conscientiousness
The disorder does not bother me (R)	3,98	0,89	0,41	Conscientiousness
I do not know how to seize opportunities (R)	3,37	0,94	0,41	Openness
I do not finish what I started	3,88	0,88	0,41	Conscientiousness
I know how to handle difficult situations	3,56	0,98	0,40	Conscientiousness
It's difficult for me to make decisions (R)	3,48	0,99	0,40	Conscientiousness
I am interested in very few things (R)	3,67	0,88	0,39	Openness
I am a workaholic	3,47	0,93	0,39	Conscientiousness
I feel comfortable with people	3,88	0,81	0,38	Extraversion
I always act first	3,66	0,82	0,37	Extraversion
I forget to put things in their place (R)	3,66	0,9	0,36	Conscientiousness
It's often hard for me to have fun (R)	3,61	0,98	0,36	Openness
I forget to put things in their place (R)	3,63	0,91	0,34	Conscientiousness
I have trouble expressing my feelings (R)	3,29	0,98	0,32	Extraversion
I am uncomfortable in group work (R)	3,79	0,93	0,31	Extraversion
I do not continue with what I decided to do before (R)	3,54	0,96	0,30	Conscientiousness
Disorganized people don't bother me (R)	3,83	1	0,30	Conscientiousness
I interact with different people during meetings	2,25	0,8	-0,46	Openness

Notes: Items used to build responsibility measurement. According to [Attanasio et al. \(2020\)](#), only items which have a contribution (factor loading) higher than the average contribution in absolute terms are used for the factor's interpretation. They are noted by a star. All items are corrected for acquiescence bias and reverse coded for the ones who needed it (reverse coded items are identified by (R)).

Table A9: Extraversion measurement (Cronbach's Alpha = 0.7)

	Mean	SE	Factor loading	"Naive" classification
I do not speak a lot (R)	2,95	0,99	0,60*	Extraversion
I am not talkative (R)	2,94	0,98	0,60*	Extraversion
I am not often talkative (R)	2,89	0,96	0,55*	Extraversion
I talk easily	3,25	1,02	0,38*	Extraversion
I do not like taking the lead (R)	2,67	0,97	0,37*	Extraversion
I avoid drawing attention to myself (R)	3,13	1,14	0,37*	Extraversion
I'm not very curious about what's going on in the world (R)	3,29	1,04	0,36*	Openness
I like to lead groups	3,16	1,06	0,35*	Extraversion
I am competent in several fields	3,03	0,99	0,33	Openness
I work best when I'm alone (R)	2,94	1,02	0,32	Extraversion
I am a difficult person to understand (R)	3,17	1	0,31	Emotional Stability
I stay away from strangers (R)	3,45	1	0,28	Extraversion
I differ from the unpleasant tasks (R)	3,05	0,98	0,26	Conscientiousness
I prefer to do it alone (R)	3,45	0,96	0,26	Extraversion
I lie to get out of things (R)	3,91	0,96	-0,36*	Agreeableness

Notes: Items used to build extraversion measurement. According to [Attanasio et al. \(2020\)](#), only items which have a contribution (factor loading) higher than the average contribution in absolute terms are used for the factor's interpretation. They are noted by a star. All items are corrected for acquiescence bias and reverse coded for the ones who needed it (reverse coded items are identified by (R)).

Table A10: Emotional stability measurement (Cronbach's Alpha = 0.74)

	Mean	SE	Factor loading	"Naive" classification
I am often sad (R)	3,49	1,05	0,58*	Emotional stability
I rarely worry	3,25	0,93	0,50*	Emotional stability
I am often worried (R)	3,21	1,05	0,49*	Emotional stability
I feel hopeless (R)	3,78	0,96	0,47*	Emotional stability
I am unflappable	3,23	1,04	0,44*	Conscientiousness
I rarely get angry	3,22	1,1	0,42*	Emotional stability
I am not often worried	3,21	1,04	0,41	Emotional stability
I panic easily (R)	3,64	0,92	0,41	Emotional stability
I get frustrated quickly (R)	3,71	0,89	0,40	Emotional stability
I panic easily (R)	3,79	0,91	0,40	Emotional stability
I have bad presentiments (R)	3,75	0,98	0,36	Emotional stability
I see problems everywhere (R)	3,52	0,95	0,32	Emotional stability
I am not enjoying (R)	3,77	0,92	0,30	Emotional stability
I have a lot of fun	2,99	0,95	0,28	Emotional stability

Notes: Items used to build emotional stability measurement. According to [Attanasio et al. \(2020\)](#), only items which have a contribution (factor loading) higher than the average contribution in absolute terms are used for the factor's interpretation. They are noted by a star. All items are corrected for acquiescence bias and reverse coded for the ones who needed it (reverse coded items are identified by (R)).

Table A11: Openness measurement (Cronbach's Alpha = 0.64)

	Mean	SE	Factor loading	"Naive" classification
I am very interested in other countries and their cultures	3,24	1,06	0,52*	Openness
In any situation I can find something interesting	3,13	0,9	0,47*	Openness
I like to draw attention to myself	2,82	1	0,45*	Extraversion
I think my life is very interesting	3,29	0,91	0,37	Openness
I always have something to say	2,73	0,91	0,37	Extraversion
I know how to captivate people's attention	3,17	0,92	0,36	Extraversion
I find the world very interesting	3,44	1,03	0,34	Openness
I am interested in many things	3,15	0,98	0,26	Openness

Notes: Items used to build openness measurement. According to [Attanasio et al. \(2020\)](#), only items which have a contribution (factor loading) higher than the average contribution in absolute terms are used for the factor's interpretation. They are noted by a star. All items are corrected for acquiescence bias.

Table A12: Correlation Matrix of Personality Traits

	Constructs from PCA					Naive constructs				
	Responsible	Initiative	Extraversion	Emotional stability	Openness	Openness	Conscientiousness	Extraversion	Agreeableness	Emotional stability
Constructs from PCA										
Responsible	1.000									
Initiative	0.054**	1.000								
Extraversion	-0.071***	-0.074***	1.000							
Emotional Stability	-0.087***	-0.093***	0.132***	1.000						
Openness	-0.049*	-0.047*	0.065**	0.092***	1.000					
Naive constructs										
Openness	0.579***	0.238***	0.284***	0.071***	0.463***	1.000				
Conscientiousness	0.919***	0.218***	0.009	0.038	0.094***	0.622***	1.000			
Extraversion	0.617***	0.188***	0.605***	0.073***	0.170***	0.638***	0.641***	1.000		
Agreeableness	0.809***	-0.069***	-0.093***	-0.014	-0.096***	0.412***	0.698***	0.444***	1.000	
Emotional stability	0.507***	0.184***	0.008	0.703***	0.057**	0.410***	0.559***	0.442***	0.398***	1.000

Notes: z-scores are used. *** p<0.01, ** p<0.05, * p<0.1

Table A13: The effect of birth order on non-cognitive skills

	(1)	(2)	(3)	(4)	(5)
	Initiative	Responsibility	Extraversion	Emotional stability	Openness
Birth order : Ref. firstborn					
2nd child	-0.107 (0.104)	-0.118 (0.097)	0.141 (0.101)	-0.076 (0.102)	-0.087 (0.098)
3rd child	-0.183 (0.138)	-0.182 (0.128)	0.114 (0.134)	-0.120 (0.135)	0.112 (0.130)
4th child	-0.160 (0.175)	-0.068 (0.163)	0.114 (0.170)	0.033 (0.172)	0.021 (0.166)
5th child or more	-0.266 (0.215)	-0.081 (0.200)	0.235 (0.209)	-0.134 (0.212)	0.071 (0.204)
Adjusted R2	0.03	0.06	0.03	0.08	0.06
Adjusted within-R2	0.03	0.06	0.04	0.08	0.05
Observations	1,062	1,062	1,062	1,062	1,062

Notes: This table reports the effects of birth order on z-score of measurement for (1) initiative, (2) responsibility, (3) extraversion, (4) emotional stability & (5) openness using a linear model absorbing sibship size fixed effects. *** p<0.01, ** p<0.05, * p<0.1.

Source: Authors' calculation using data from the 2004 *Madagascar Study on Academic Progress and Academic Performance* and the 2012 *Madagascar Young Adult Transitions Survey*.

Table A14: Heterogeneous effects of birth order on non-cognitive skills

	(1) Initiative	(2) Responsibility	(3) Extraversion	(4) Emotional stability	(5) Openness
Panel A. Birth order and gender					
Birth order : Ref. firstborn					
2nd child	-0.014 (0.142)	-0.197 (0.132)	0.163 (0.138)	-0.098 (0.139)	-0.096 (0.134)
3rd child	-0.126 (0.174)	-0.124 (0.162)	0.113 (0.169)	-0.077 (0.171)	0.150 (0.165)
4th child	0.060 (0.207)	-0.228 (0.193)	0.011 (0.201)	-0.192 (0.204)	-0.076 (0.196)
5th child or more	-0.278 (0.230)	-0.041 (0.214)	0.338 (0.223)	-0.204 (0.226)	0.191 (0.217)
2nd child * female	-0.165 (0.178)	0.147 (0.166)	-0.051 (0.173)	0.053 (0.175)	0.007 (0.169)
3rd child * female	-0.087 (0.192)	-0.116 (0.179)	-0.024 (0.187)	-0.057 (0.189)	-0.097 (0.182)
4th child * female	-0.389* (0.209)	0.286 (0.195)	0.157 (0.203)	0.454** (0.206)	0.143 (0.198)
5th child or more * female	0.070 (0.187)	-0.108 (0.174)	-0.266 (0.181)	0.183 (0.183)	-0.306* (0.177)
Female	-0.017 (0.121)	-0.123 (0.113)	-0.030 (0.118)	-0.427*** (0.119)	-0.130 (0.115)
Adjusted R2	0.03	0.06	0.04	0.09	0.07
Adjusted within-R2	0.03	0.06	0.04	0.08	0.05
Observations	1,062	1,062	1,062	1,062	1,062
Panel B. Birth order and poverty					
Birth order : Ref. firstborn					
2nd child	-0.099 (0.119)	-0.073 (0.111)	0.153 (0.116)	-0.009 (0.119)	-0.042 (0.114)
3rd child	-0.216 (0.150)	-0.157 (0.140)	-0.003 (0.146)	-0.175 (0.150)	0.132 (0.143)
4th child	-0.102 (0.184)	-0.029 (0.172)	0.160 (0.179)	0.017 (0.184)	0.106 (0.175)
5th child or more	-0.349 (0.220)	-0.020 (0.206)	0.268 (0.213)	-0.074 (0.219)	0.117 (0.210)
2nd child * poor household	0.004 (0.190)	-0.114 (0.178)	-0.038 (0.184)	-0.177 (0.190)	-0.095 (0.181)
3rd child * poor household	0.139 (0.206)	-0.013 (0.193)	0.416** (0.200)	0.272 (0.206)	0.019 (0.197)
4th child * poor household	-0.169 (0.232)	-0.029 (0.217)	-0.137 (0.225)	0.245 (0.232)	-0.165 (0.221)
5th child or more * poor household	0.367* (0.202)	-0.059 (0.189)	-0.051 (0.196)	0.099 (0.201)	0.049 (0.192)
Poor household	-0.022 (0.138)	-0.010 (0.129)	-0.189 (0.134)	-0.173 (0.137)	0.093 (0.131)
Adjusted R2	0.03	0.06	0.04	0.06	0.05
Adjusted within-R2	0.03	0.06	0.05	0.06	0.04
Observations	1,062	1,062	1,062	1,062	1,062

Notes: This table reports the effects of birth order, interacted with gender (Panel A) or a dummy equal to 1 if the household was poor in 2004 (Panel B), on z-score of measurement for (1) initiative, (2) responsibility, (3) extraversion, (4) emotional stability & (5) openness using a linear model absorbing sibship size fixed effects. *** p<0.01, ** p<0.05, * p<0.1. Source: Authors' calculation using data from the 2004 *Madagascar Study on Academic Progress and Academic Performance* and the 2012 *Madagascar Young Adult Transitions Survey*.