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Birth Order, Socioeconomic Background and Educational Attainment*

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Abstract

This paper examines the effect of birth order on educational attainment in the United States and the underlying mechanism producing these effects. Using a family fixed effects model, we find negative birth order effects on educational outcomes. However, this effect varies depending on the household's income, being the strongest for households with the highest income and diminishing as households' income decreases. In addition, we show that the timing of income across childhood is important for completed education, as the largest gap in educational attainment between siblings emerges between those who were born and spent their early childhood in wealthier households.

JEL Classification: D1, I2, J1

Keywords: birth order, human capital development, household income, education

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1 Introduction

What determines a child's success in life? Previous studies have shown that family socioeconomic factors (e.g., background income, wealth, and family size) play an essential role in shaping a child's educational attainment, affecting the individual's future income. Children born into families with higher socioeconomic status tend to attain more education and achieve higher financial success compared to children born into families with lower socioeconomic status.[1]

At the same time, we observe high heterogeneity in educational attainment even within families. Therefore, this paper will focus on how birth order influences educational attainment within families, among siblings, with a particular concern on the differences that a family's socioeconomic status might induce.

The evidence of birth order effects on various outcomes indicates a reliable divide between high-income and low-income countries (De Haan, Plug, and Rosero 2014). Our analysis focuses on the US and investigates whether birth order effects are also different within the same country, depending on the household's income level. This study is the first to apply US data and investigates in-depth whether birth order has different impacts depending on families' income levels. We find that first-born children acquire, on average more education than their younger siblings. This effect is the strongest among the wealthiest households, and it diminishes with the reduction in incomes such that it can become positive for the poorest household in certain specifications. [2].

Using data from Mexico, a middle-income country, Esposito, Kumar, and Villaseñor (2020) finds similar effects when they focus on the interplay between a house-

[1] Lundborg, Nilsson, and Rooth (2014),Chetty, Hendren, Kline, and Saez (2014)),Chetty, Hendren, Lin, Majerovitz, and Scuderi (2016), Chetty and Hendren (2018)

[2] Positive birth order effects- first-born children perform worse than their siblings; Negative birth order effects- first-born children have better educational outcomes than their siblings

hold's economic status and birth order; higher wealth is associated with stronger negative birth order effects on educational outcomes. De Haan et al. (2014), using data from Ecuador, finds positive birth order effects, which are reversed for the wealthy and highly educated families. These papers focus on parental income contemporaneous with children's outcomes.

Our paper also distinguishes itself from previous studies by using a long panel dataset, Panel Study of Income Dynamics (PSID), that covers the years 1968-2017 to extract information on parental income when children were young. Thus, we are able to link socioeconomic characteristics during childhood with completed education as an adult. In this manner, we can assess if parents' financial constraints cause them to invest differently among their children when they are young and how this affects long-term educational outcomes. Furthermore, novel in the literature, we extend the analysis to incorporate the timing of parental income. We show that parents' income in early childhood has the strongest impact on birth order.

Consistent with previous findings in the United States and in other developed countries, higher birth order is associated with fewer years of completed education and lower likelihood of high school graduation. Using a family fixed effects estimation, we show that a second-born child acquires, on average, 0.221 fewer years of schooling than the older sibling; the second-born child has a 4.6 percentage point lower probability of completing high school and a 4.9 percentage point lower probability of earning a graduate degree. We split our sample by parental income and show that the wealthier the family the more educated the first born is relative to their sibling. In our preferred specification, the first-born in a family ranked within the highest quintile of income acquires 1.18 additional years of schooling relative to the second-born; this difference decreases to 0.66 for the second quintile and becomes statistically indistinguishable from 0 for the lowest quintile. These results are consistent with lower socioeconomic status reducing the advantages of the first-born children.

By focusing on the household's economic status throughout several stages of childhood, we show that the highest effect of income on birth order occurs during early childhood. We find that one standard deviation increase in parental income in early childhood decreases educational attainment by 0.228 standard deviations for the second child compared to the first-born. This difference diminishes as we time the parental income to higher age intervals, becoming insignificant for teenage years. Thus, the largest gap in educational attainment between siblings is between those who were born and spent their early childhood in wealthier households. A family's socioeconomic status in late childhood has less of an impact on birth order effects than in early childhood. These results are consistent with models of skill formation in children that show that timing of income across childhood is important for adult outcomes given that early childhood represents a critical period for cognitive development (Carneiro, García, Salvanes, and Tominey 2021, Cunha and Heckman 2007, Caucutt and Lochner 2020, Cunha, Heckman, and Schennach 2010, Almond and Currie 2011). However, within the birth order effects context, these results are surprising; increased labor participation of the first-born child that favors later-born children (which is unlikely to happen during early childhood), is the mechanism through which liquidity constraints are frequently used to explain positive birth order effects in developing countries. Our results are consistent with a steeper learning curve of effective parenting practices for low-income parents which would tend to favor the later-born children and reduce the advantages the first-born commonly experience.

The paper is organized as follows: section 2 provides an overview of the theoretical and empirical literature. Section 3 introduces the data description. Section 4 investigates the causal effect of birth order and the mechanism that produces birth order effects. Section 5 presents the results. Section 6 describes the robustness checks performed. The final section provides concluding remarks.

2 Background

Various disciplines, such as psychology, sociology, and economics have analyzed whether there is a systematic difference in cognitive abilities and/or educational attainment as well as overall success in life, based on birth order.

Several theories provide justifications for birth order effects, physiological, as well as psychological and socioeconomic ones. We will elaborate on the literature that emphasizes social interactions between siblings and their parents, the dilution of family resources, and how these mechanisms are affected by the family's socioeconomic characteristics. There are three widely cited theories in the literature that relate birth order to children's outcomes.

Confluence hypothesis (Zajonc and Markus 1975, Zajonc, Markus, and Markus 1979, Zajonc and Sulloway 2007) was developed to explain the relationship between birth order and intelligence. The authors argue that a child's intellectual abilities are influenced by family members' dynamic average intelligence, which is referred to as the child's intellectual environment. A first-born child has access to the highest intellectual environment when she is the only child, and the arrival of siblings harms this environment. However, older siblings have the opportunity to consolidate their academic skills, which would improve their educational achievements by teaching their younger siblings. The two opposite effects may lead to a wide range of intellectual performance outcomes, influenced by birth order and children's age. The advantage of being a first-born child manifests only when one becomes an adult because it takes time to achieve the maximum benefit from teaching the younger siblings [3].

[3] Other studies have found that birth order effects are negative starting at an earlier age (Bonesrønning and Massih (2011), Lehmann, Nuevo-Chiquero, and Vidal-Fernandez (2018)) which would tend to indicate that the tutoring effect is not the only one that has a positive impact on first born's

Resource dilution theory (Blake 1981) refers to the fact that all parental resources and inputs (e.g. money, time or cultural activities) are limited. Thus, as family size increases, the parental resources are divided among more children, with each child receiving fewer resources. First-born children have an advantage because they receive all parental resources until their siblings are born. However, younger children- born later in parents' life- might have access to resources generated by older siblings and higher income of older parents. Price (2008) uses data from the American Time Survey to investigate parental time allocation to each child and finds that a first-born child receives 20-30 minutes more parental time each day than a second-born child. Lehmann et al. (2018) notices that, as early as age one, later-born children score lower on cognitive tests than their siblings; the gap increases until school entry and remains statistically significant after that. They show that variations in parental behavior can explain a large portion of the birth order differences. They find that parents spend less time reading to their later-born children, are less likely to provide appropriate toys or activities for the child, and spend less time teaching them basic concepts, such as numbers, the alphabet, colors, and shapes, at home [4]. The allocation of resources that favors first-born children is not limited to childhood. De Haan (2010) determines that in the U.S., after graduating from high school, first-borns receive a higher financial transfer from parents than their younger siblings. Mechoulan and Wolff (2015) finds a similar result when looking at French data.

The third strand of literature focuses on strategic parenting choices. Hotz and Pantano (2015) argue that parents are stricter with their first-born children and impose harsher penalties in response to bad behavior and poor school performance to establish a reputation of toughness and deter similar behavior amongst younger

educational attainment.

[4] Lehmann et al. (2018)'s analysis cannot capture if some of these activities are performed by the first-born child, compensating for the parents, which would reinforce the child's advantage through teaching effects

siblings. They show that parents' strictness and children's school performance declines with birth order. Pavan (2016) finds that differences in parental behavior among siblings can explain more than half of the gaps in their test scores. Averett, Argys, and Rees (2011) find that first-born children tend to exhibit less risky behavior. In addition, Hotz et al. (2015)) determines that firstborns are more strictly monitored on homework, and have more stringent limitations on their television viewing which lead to improved outcomes later in life.

The confluence model, resource dilution and strategic parenting theories suggest, with some caveats, that first-born children benefit from their pecking order and, thus, acquire more education than their later-born siblings. However, given the complexity of the family dynamics described above, it is very likely that the strength of different mechanisms is affected by financial constraints and family socioeconomic characteristics. Poverty can exacerbate the issue of resource dilution which would favor the first-born, but it can also lead to the first-born being more likely to work which would favor the latter-born's schooling. Even in countries, such as the U.S., where child labor outside of the household is severely curtailed, if the family is financially constrained older children will be at disadvantage in continuing their education after the end of the compulsory period. They are more likely to be involved in household chores and helping to raise their younger siblings if the resources for paid caregivers are limited. This would increase their cognitive abilities through teaching effects, but caretaking obligations leave them less time to study and continue their education.

Literature focusing on country-level trends found that first-born children perform on average better than their younger siblings in developed countries, but most studies analyzing the trends in developing countries find that the opposite is true, indicating that limited resources tend to favor the later-born children. Empirical studies revealed that birth order has a positive effect on educational attainment in low-income countries, including Brazil (Emerson and Souza 2008), Taiwan (Parish and Willis 1993), and the Philippines (Eirnæs and Pörtner 2004), while negative birth order effect has been found in high-income countries, including Norway (Black, Devereux, and Salvanes 2005), France (Mechoulan et al. 2015, West Germany (Härkönen 2013) and the U.S. (Kantarevic and Mechoulan 2006; De Haan 2010)

Several within-country studies focus on how family socioeconomic characteristics affect birth order.

Expanding on the resource dilution theory, Lafortune and Lee (2014) develop a model, combining convex returns to education and credit constraints and show that schooling of a child is positively correlated with birth order in low-income families. To test the theory's predictions, they use father's educational background, as a proxy for family income and data from the United States, South Korea and Mexico . They find that when fathers have no formal education, each subsequent child receives between 0.2 and 0.7 years more education than the previous child; however this effect is reduced when fathers have more schooling, and it even reverses for the most educated fathers in Mexico and the United States. Their results are thus consistent with liquidity constraints hurting first-born children most.

Using Mexican data, Esposito et al. (2020) find significant heterogeneity across the income ladder: higher wealth is associated with stronger negative birth order effects on educational outcomes. Their paper is one of the most comprehensive studies on how socioeconomic background affects birth order effects. Moshoeshoe (2019) and Tenikue and Verheyden (2010) create a wealth index based on household ownership of durable goods, land, and livestock and analyze the influence of wealth over birth order effects. Tenikue et al. (2010) used data from 12 Sub-Saharan countries to find that, on average, later-born children acquire more education, but that effect is reversed in wealthier households. Using Lesothan data, Moshoeshoe (2019) shows that birth order effects are negative, which is surprising for a developing country. However, he finds that birth order effects are affected by family wealth, as the negative birth order effects diminished for poorer families. Even though the average birth order effects in the two studies have opposite signs, wealth favors the accumulation of education for the first-born child in both.

De Haan et al. (2014), using data from Ecuador, finds positive and persistent birth order effects from infancy to adolescence. First-borns are also more likely to be involved in child labor, receive less maternal time, and are breastfed for a shorter time. Focusing on the family's socioeconomic characteristics, they find that these birth order effects are reversed for wealthy and highly educated families.

Maeba (2017) uses cash transfers in Nicaragua to observe birth order effects on school attendance, grade progression, enrollment, and child labor engagement for children ages 6 to 16. His results show that cash transfers conditional on school attendance reinforces the previous positive birth order effects, while the unconditional cash transfers do not change the birth order effects. Thus, he concluded that liquidity constraints are unlikely to be the underlying mechanism for birth order effects in Nicaragua.

Black et al. (2005) focus on Norway and use mother's education as a proxy for financial constraints. In contrast to the previous studies, they show that the magnitude of birth order effects does not differ much between families with different degrees of mother's education. Using data from West Germany, Härkönen (2013) also finds that birth order effects do not vary according to families' socioeconomic characteristics.

3 Data Description

Data used in previous studies examining birth order effects on adult outcomes do not usually include socioeconomic characteristics during childhood.

Black et al. (2005), using data from Norway, analyzes children's completed education in adulthood considering the family's background contemporaneous with the outcome. Therefore, the authors cannot assess how socioeconomic characteristics during the formative years of childhood influence birth order effects. De Haan et al. (2014)) use family's socioeconomic status during childhood in their analysis, but again focus on contemporaneous outcomes, such as children's intellectual abilities or educational attainments at the time. Given our interest in the effects of birth order on completed education, and that most of the theoretical explanations for these effects focus on various individual circumstances occurring during childhood and adolescence, we extract the data that allows us to connect the economic characteristics during childhood with completed education as an adult. In this manner, we can assess if parents' financial constraints lead to children experiencing different family dynamics when they are young, and how this affects long-term educational outcomes.

In the present study, we thus use the Panel Study of Income Dynamics (PSID), which is a detailed longitudinal survey data that allows us to link individuals with their families' economic characteristics during childhood, along with background demographics for their parents and siblings. Even though numerous studies analyzed the effects of childhood circumstances on different adult outcomes (see Almond, Currie, and Duque 2018 for a survey), to the best of our knowledge, no previous study has examined the effect of birth order on educational attainment by family income background.

PSID is a longitudinal survey of a representative sample of U.S. individuals and their families. The study began in 1968 with a sample of approximately 4,800 households and followed them and their descendants. The data were collected annually until 1997 and biennially since 1997, with the most recent data wave in 2019.

3.1 Sample

The sample analyzed consists of individuals for whom we have information on the birth order and the total number of children attributed to the mother. Individuals who have missing values for these variables are excluded from the analysis. The sample would shrink considerably if we relied on the children attributed to the father.

We further restrict our sample to individuals over 25 years old in 2017 to help ensure that most of them have completed their education. We define the family size as the mother's total number of children rather than children in the family unit. To ensure that we have the completed family size (i.e., no more children will be added to the family), we restrict the sample to those with mothers who are older than 44 years. We also obtained demographic information on their parents from PSID files and linked them using the variables for the 1968 interview number and person number (ER30001 and ER30002).

We are interested to explore whether timing of family income matters for differentiated levels of educational attainment within families. In cases when values for the children's age are missing, we use the reported age in other waves to infer them. [5]

We focus on households with two parents during childhood and compute average parental income for different childhood periods, when children were between 1-6 (early), 7-13 (middle), and 14-17 (late) years of age.

Panel A of Table 1 presents descriptive statistics for a larger sample, which is used for estimating the effect of birth order on the educational outcome. In contrast, in panel B, the sample is further restricted to children for whom parental income is observed. The number of indexed individuals is 11,253. The sample consists mainly of families with two or three children, while 22.43% and 12.17% are families with four and five children, respectively. The average education is 13.10 years, and 82% completed

[5] e.g., If we observe the age for an individual in 1990 and 1992, we input the age for 1991

high-school. There is a balanced gender composition, and 52.29% of children are White, 32.51% are Black, and 15.20% represent other races. To assess the effect of birth order across the economic ladder on the educational outcome, we focus on the first two children recorded in the survey and for whom parental income is reported during childhood. Parental income is presented in 2015 dollars as an average over the children's different age groups. The average is calculated only if we can observe at least 40% of family income during that period to ensure that it represents the family income background. The mean of parental income is approximately $\$68,636$ with a minimum of $\$5,789$ and a maximum of $\$550,595$ for the age group 1-6 years old. Focusing on the children, the average years of education is 14, 14% have a graduate degree, while 52% have at least an associate degree.

In Table 2, we report the children's and parental' average education along with the relative frequency of children and mother's marital status by income categories. The average education and the percent of married mothers are higher in wealthier households than in lower-income families.

4 Methods and Results

4.1 Birth Order Effects

In Table 3, we show results for a family fixed effects estimation of educational attainment on birth order categorical variable by family size to disentangle the effect of birth order from family size. Family size decreases while educational levels increase over time in our data. Thus, the relationship between birth order and education could capture mere cohort effects due to fewer higher birth order children within a family and higher educational levels for younger generations (Black et al. 2005). We include the year of birth fixed effects to account for this cohort specific effects. We also include a gender dummy variable since girls receive, on average, more education than boys. Family fixed effects remove all time-invariant observed and unobserved family characteristics.

In panel A of Table 3, the outcome represents years of education, while in panel B, the outcome represents high school completion. Each additional child acquires less education than the first-born child which means that the last-born child performs the worst in terms of educational outcome. For instance, in a family with three children, the second-born child receives on average 0.279 fewer years of education, and a third-born child receives on average .437 fewer years of schooling than the first-born child. Examining high school graduation for the same family size, the second-born child is less likely to complete high school by 5 percentage points, and the third-born child is less likely to complete high school by 9 percentage points than the first-born child. These results confirm the findings of Kantarevic et al. (2006) that show that in the US first-born children are more likely to complete high-school.

Regarding the effect of being a second-born child, considerable variation based on family size does not seem to exist (Table 3). The difference in educational attainment between first-born and second-born children ranges from -0.188 to -0.326 years. Also, the second-born dummy variable is not mechanically correlated with family size. To maximize the number of observations, we continue our analysis by focusing on the effect of being a second-born child regardless of family size. Our sample includes families with two to five children.

Figure 1 shows the density of education by birth order. The red and green areas represent the density of the education variable for first-born children and second-born children, respectively. A higher percentage of second-born children acquire only eight to eleven years of education compared with older siblings. The spike at twelve years of education, which represents high school completion in the U.S., is dominated by first-born children who also outperform their younger sibling(s) in terms of graduate education completed.

In Table 4, the column headers represent the educational outcome, focusing only on the second-born child. We restrict the sample to families where first- and second-borns can be identified and have no missing values for parental income and demographics. The results indicate that a second-born child accomplishes 0.22 fewer years of education than a first-born child. With respect to the mean, second borns are also 5%, less likely to obtain a high school degree and 33% less likely to have a graduate degree.

4.2 The Empirical Model

$$Y_{ij} = \alpha_1 SB_{ij} + \alpha_2 SB_{ij} * I_j + \alpha_3 X_{ij} + \mu_j + \varepsilon_{ij} \tag{1}$$

where Y_{ij} represents the completed years of education of individual i in family j, SB_{ij} is a dummy variable that is assigned a value of 1 if the child i is second born in family j, X_{ij} is a vector with a set of controls that includes a dummy variable for gender, year of birth fixed effects, and variables that control for parental demographics (mother's and father's education, age difference between siblings, and indicators for mother's marital status at childbirth and race). I_j represents an indicator of socioeconomic status. We focus on three types of indicators to signify socioeconomic status. In the first case, I_j is a dummy variable *No Poverty* that takes value 1 if household is 185% above poverty line; in the second case, we split parental income in tertiles and I_j represents indicator variables, which are assigned a value of 1 if the parental income belongs to respective tertile; and in the third case, we split our sample based on parental income in quintiles, and I_j represent a set of indicators assigned a value of 1 if the parental income belongs to respective quintile; μ_j captures the family fixed effect, and ε_{ij} is the error term.

The mother's age at childbirth is mechanically correlated with the birth order, so by including it in the estimation, the coefficients of birth order would be more significant (Kantarevic et al. 2006). However, in a family fixed effects estimation, the indicators for the year of birth convey the same information as maternal age at childbirth, so the latter is omitted.

We use a family fixed effects approach because it controls for unobserved but fixed omitted variables (e.g., common family background, genetics, or parental preferences for education). It also controls for time-invariant characteristics within a family, including family size, the age difference between siblings, race, and parental education. Additionally, we include interaction terms between the second-born dummy and observable characteristics at the family level. The inclusion of these controls does not significantly affect the main coefficients of interest.

Fixed effects estimates are susceptible to attenuation bias from measurement error Angrist, Lavy, and Schlosser (2010). This problem arises from the fact that deviation from the family means removes both good and bad variation, thus eliminating useful information in the variable of interest. The magnitude of our OLS[6] and family fixed effects are not significantly different because our variable of interest (i.e., birth order) is not likely to be affected by measurement error.

5 Results

5.1 Main Results

We present the effect of timing of parental income and birth order on children's education in Table 5. Parental income is deflated to 2015 constant dollars, normalized

[6] OLS results are available upon request

at year level, and then the average for different periods is calculated . Each period is noted in the panel header. Parental income is computed only if the family income is available for at least 40% of the period desired. For example, for ages 1-6, we need at least three years of family income history. In contrast, for ages 7-13, we need at least four years of family income history to ensure that the average is representative over these periods. We report the results of four regressions. Initially, we run a pooled ordinary least square (POLS) and family fixed effects (FFE), controlling only for gender, year of birth fixed effects, and parental income; then, we add interaction terms for parental demographics (mother's and father's education, mother's marital status at childbirth, race, age difference between siblings) and the second-born child dummy along with their main effects.

In panel A of Table 5, column 4, the family fixed effects estimation with controls shows that a one standard deviation increase in parental income, when children were between 1 and 6 years old, decreases the educational attainment by 0.214 standard deviations for the second child compared to their younger sibling. This means that there is a larger gap in educational attainment among siblings that belong to wealthier households. The effect decreases as the age interval on which we focus increases and becomes insignificant for older childhood. Financial constraints or advantages in late childhood have less of an impact on birth order effects than in early childhood. Similar to our findings, Kantarevic et al. (2006) notice that conditional on postsecondary education, there is no clear advantage to being first-born and conclude that even though financial constraints play a role, some factors early in life contribute to the first-born premium.

Given that family's socio-economic characteristics in early childhood are the most significant for birth order differentiated educational outcomes, we focus on that period in our analysis. We use the parental income at age 1-6 to generate the dummy variables for *No Poverty*, and indicators for tertiles and quintiles. In Table 6, we report the results of four regressions: pooled ordinary least squares (POLS) and family fixed effects (FFE) without and with parental characteristics.

In panel A of Table 6, we use a *No Poverty* dummy variable, which is assigned a value of 1 if the household is 185 percent over the poverty threshold. To create this dummy variable, we take the family income for each year when the children were between 1 and 6 years old, divide it by the Census poverty threshold, and calculate the average of this fraction. The PSID data provided the poverty threshold, and it is based on gender and age of the household head, family size, and the number of people under the age of 18 in the household for every year that was analyzed. Using the *No Poverty* dummy variable described above, we can compare the birth order effects in low-income families (defined as having an average family income that is 185 percent below the federal poverty threshold), with those from higher-income backgrounds. The 185 percent threshold identifies whether poor households are eligible for federally funded social programs, such as the assisted lunch program, which is another way to identify the students from a low-income background (Bartik and Hershbein 2018). The coefficient for the poor households in column 4 (our preferred specification) has a positive sign, while for wealthier households, it is negative. However, these coefficients are all statistically insignificant.

Furthermore, in panel B of Table 6, using the collected data, we create family income tertiles for individuals during the age category 1-6 years old. Among wealthier households, there is a statistically significant negative effect of being the second-born child of .403 years for the second tertile and .591 for the third tertile, while the effect is insignificant for the poorest tertile. Thus, being born first has the largest effect for the richest category and decreases in magnitude for the poorer ones.

The main results are reported in Table 6, panel C. We assign each household to an income quintile, based on U.S. income distribution data and household income when children were between the ages of 1 and 6. The income distribution at the country level is not available for tertiles. Then, we use the income quintile in which each household spent the most years. In case of a tie, we use the lowest quintile, because being in a lower quintile would substantially impact children's educational attainment. Using U.S. income distribution for creating quintiles is more accurate than dividing the income data in quintiles, as we did for tertiles in Panel B because we can rank the households based on the actual distribution of incomes across the country. The first three columns show that the second child accomplishes significantly more education than the first-born child when the household belongs to the poorest quintile.

In the last column, given that we have a lower percentage of households in the poorest quintile (6.07% of the sample- 146 observations; Table 1), adding parental characteristics to the regression decreases the estimation power shown by the large standard error in column 4, so our coefficient becomes statistically insignificant.

The second-born child is acquiring, on average, less education compared to an older sibling for all, but the lowest quintile. The birth order effect on education among households in the fifth quintile is -1.179 fewer years of schooling, which is statistically significant at the 1 percent level. This sharply contrasts with the birth order effects among the poorest households which are insignificant. As the parental income quintile increases, the magnitude of the coefficients showing a decline in educational attainment for the second child relative to the first child also increases, ranging from -0.66 to -1.18 years.

Our results thus indicate that the resource dilution hypothesis that was put forward, as the main explanation for how socioeconomic conditions affects birth order effects, is incomplete. In the following section we explore further mechanisms.

6 Discussion

Our results are consistent with models of skill formation where timing of income across childhood is important for adult outcomes, given that early childhood is a critical period for cognitive development (Carneiro et al. 2021, Cunha et al. 2007, Caucutt et al. 2020, Cunha et al. 2010). These results also portray a more complex image of the reasons that birth order effects in low income families in the U.S. might mirror those from developing countries, which combine early childhood and late childhood/adolescence effects.

For instance, some of the early childhood effects are based on the evidence that mothers spend less time with first-borns and breastfeed them for a shorter time than later-born children (De Haan et al. 2014) which is the opposite of what we observe on average in the U.S. (Price 2008). At the same time, numerous studies conducted in the U.S. (see Heckman and Mosso 2014 for a survey) provide evidence that children from low-income families incur disadvantages in their development, on a variety of dimensions.

Cunha, Elo, and Culhane (2013) show that maternal knowledge about child development affects the maternal choices of investments in the human capital of children; in addition, disadvantaged parents exhibit lower levels of parenting knowledge.[7] In a study on high school decisions taken within Italian households, Giustinelli and Pavoni (2017) find that children from less advantaged families display lower initial perceived knowledge and acquire information at a slower pace, particularly about college-preparatory schools. This evidence points to a steeper learning curve for effective parenting practices, which would tend to favor the later-born children for

[7] In a survey article, Kalil and Ryan (2020), document substantial differences in parenting practices between richer and poorer families, including parental engagement and time use. Lower-income, less-educated parents are less likely to spend quality time or be engaged in educational activities with their children which compounds their relative economic disadvantage.

low-income families, regardless of financial constraints.

In their model of strategic parenting, Hotz et al. (2015) argue that parents are stricter with their first-born children and show that this style of parenting, on average, leads to better educational outcomes. Kalil et al. (2020) document substantial differences in parenting practices between families with different socioeconomic status, with poorer parents adopting a more authoritarian approach. If rigidity in parenting practices decreases with higher-order children, and the level of rigidity exhibited by rich parents towards their first-born leads to the highest educational achievement, then later-born children in poor families would be raised with a level of rigidity more conducive to higher educational achievement than their older siblings.

The later childhood effects in developing countries are based on the fact that first-borns are more likely to drop out of school to start working and bring in additional income, which would favor later- born siblings if families are financially constraint (De Haan et al. 2014). Given that parental income is not significant for birth order effects when children are of ages 14-17, these effects do not seem to be particularly important in the US. The insignificance of family's income during late childhood/adolescence is consistent with the findings corroborated by the human development literature in the U.S. showing that parental income in later childhood has a weak impact on children's educational outcomes (Caucutt et al. 2020, Bulman, Fairlie, Goodman, and Isen 2021, Hilger 2016).

7 Robustness Checks

In this section, we perform a series of sensitivity analyses by testing different birth order and income measures. Ideally, we would analyze birth order only from biological parents, but the small sample size in the panel data is insufficient for analysis. In our main analysis, we focus on the birth order of children attributed to the mother which offers the largest number of observations; additionally, it is a reliable measure because children are more likely to live with their mothers. As a robustness check, Table 7 presents birth order effects on the educational outcome by family size, using the birth order of children that are attributed to the father. The number of distinct families generated using father ID numbers dropped to 3,269 from the previous 5,368 using mother ID numbers. The magnitude of coefficients concurs Table 3, which presents birth order effects of children attributed to the mother, where later born children attain less education than the first-borns.

Table 8 presents higher-order births, where we combine third- to fifth-order children in the same category and use income measures (e.g., No Poverty dummy variable) and indicators for tertiles and quintiles. Coefficients are comparable with those in Table 6 where only the first two children are included. Column 3 contains the most accurate income measure because quintiles are created based on the U.S. income distribution. Later-born children acquire more education than the first-born child among the first quintiles, which is significant for the second-born child. However, the second-born child has fewer years of schooling than the first-born child for higher quintiles, and this gap increases with wealthier quintiles.

Further, in Table 9, we use two different measures of birth order. In panel A, birth order is used as a continuous variable. In panel B, we use a relative birth order measure, constructed by implementing the formula proposed by Eirnæs et al. (2004):

$$\frac{p-1}{n-1}$$

where p is the individual's birth order, and n is the family size. The first-born child is assigned the value 0, while the last-born child is assigned the value 1. This birth order measure allows us to incorporate higher birth orders without concern for the positive correlation between birth order and family size. Regardless of the measure used for birth order, the results follow the same pattern. The difference in educational outcome among siblings belonging to poor households is statistically insignificant, while the negative effect is significant for wealthier households.

8 Conclusion

This paper aims to determine whether birth order has distinct impacts on the child's educational outcomes depending on households' socioeconomic status.

We use a long panel data set that allows us to link socioeconomic characteristics during childhood with completed education as an adult. We focus on the household's economic status in several stages of childhood and show that the highest effect of income on birth order is in early childhood. By applying a family fixed effects approach, we find a negative effect of birth order on educational attainment in the U.S. among wealthier households which becomes less significant for lower-income families. Thus, we conclude that the largest gap in educational attainment is between siblings who were born and spent their early childhood in wealthier households.

Our results suggest that credit constraints, which are used to explain different birth order effects based on income level either within or across countries, are just a partial explanation. Parenting strategies that vary depending on socioeconomic background are a complementary mechanism.

Table 1: Descriptive Statistics

Variables	Observations	Mean	Standard Deviation	Minimum	Maximum
Panel A: Five Children Families Sample					
Years of Completed Education	11,253	13.10	2.29	1	17
High School Degree	11,253	0.82	0.38	0	1
Age	11,253	41.39	9.84	25	77
Percent of Female	11,253	0.50	-	0	1
Percent of White	5,812	52.29	-	0	1
Percent of Black	3,613	32.51	-	0	1
Percent of Other	1,690	15.20	-	0	1
Relative Frequencies of Two Children Families	3,582	31.83	-	0	1
Relative Frequencies of Three Children Families	3,778	33.57	-	0	1
Relative Frequencies of Four Children Families	2,524	22.43	-	0	1
Relative Frequencies of Five Children Families	1,369	12.17	-	0	1
Panel B: Second Born Sample					
Years of Completed Education	4,930	13.38	2.29	1	17
Age	4,930	37.44	6.48	25	54
Relative Frequencies of First Born being a Girl	4,930	0.50	-	0	1
Relative Frequencies of High School Degree	4,930	0.85	-	0	1
Relative Frequencies of Associate Degree	4,930	0.44	-	0	1
Relative Frequencies of Graduate Degree	4,930	0.11	-	0	1
Parental Income-Children 1-6 Years Old	2,108	$ 68,636.51	$ 45,660.67	$ 5,789.05	$ 550,494.30
Parental Income- Children 7-13 Years Old	2,108	$ 88,097.44	$ 77,879.44	$ 4,939.61	$ 837,132.40
Parental Income- Children 14-17 Years Old	2,108	$101,745.90	$ 135,030.80	$ 5,022.01	$ 924,766.30

Note: The sample includes individuals who are at least 25 years old in 2017 and whose mother is older than 44 years. Income is measured in 2015 constant dollars.

Table 2: Descriptive Statistics (mean) of Control Variable by Income Groups

CATEGORIES	Number of Children	Relative Frequency	Education	Mothers' Education	Fathers' Education	Siblings' Age Difference	Relative Frequency of Married Mothers
Poverty							
Relative Frequencies of Bellow Poverty Households	266	11.06	12.62	12.00	11.87	2.82	0.71
Relative Frequencies of Above Poverty Households	2,138	88.94	14.39	14.10	14.03	3.23	0.94
Tertiles							
Relative Frequencies of Households in Tertile 1	802	33.36	13.35	12.80	12.54	3.17	0.82
Relative Frequencies of Households in Tertile 2	802	33.36	14.16	13.79	13.76	3.24	0.96
Relative Frequencies of Households in Tertile 3	800	33.28	15.08	15.03	15.08	3.15	0.98
Quintiles							
Relative Frequencies of Households in Quintile 1	146	6.07	13.01	12.70	12.04	2.68	0.70
Relative Frequencies of Households in Quintile 2	476	19.80	13.40	12.91	12.61	3.12	0.83
Relative Frequencies of Households in Quintile 3	730	30.37	13.92	13.34	13.28	3.25	0.93
Relative Frequencies of Households in Quintile 4	642	26.71	14.66	14.38	14.50	3.29	0.96
Relative Frequencies of Households in Quintile 5	410	17.05	15.30	15.53	15.60	3.17	0.99

Note: Categories were created based on parental income when children were between 1 and 6 years old.

Table 3: The Effect of Birth Order on Children's Education

Family size	2 children	3 children	4 children	5 children
Panel A. Dependent Variable: Child's Education				
Second Born	-0.326***	-0.279***	-0.188*	-0.302*
	(0.101)	(0.092)	(0.108)	(0.165)
Third Born		-0.437***	-0.324**	-0.346*
		(0.156)	(0.140)	(0.194)
Fourth Born			-0.419**	-0.841***
			(0.203)	(0.242)
Fifth Born				-1.088***
				(0.309)
Gender	0.772***	0.433***	0.556***	0.570***
	(0.088)	(0.073)	(0.082)	(0.111)
Observations	3,582	3,778	2,524	1,369
R^2	0.101	0.041	0.075	0.082
Distinct families	2,207	1,741	966	454

Family size	2 children	3 children	4 children	5 children
Panel B. Dependent Variable: High School Degree				
Second Born	-0.082***	-0.051***	-0.046**	-0.038
	(0.019)	(0.016)	(0.021)	(0.033)
Third Born		-0.090***	-0.069**	-0.036
		(0.025)	(0.032)	(0.034)
Fourth Born			-0.101**	-0.127***
			(0.043)	(0.040)
Fifth Born				-0.147***
				(0.049)
Gender	0.055***	0.046***	0.081***	0.063***
	(0.015)	(0.014)	(0.017)	(0.023)
Observations	3,582	3,778	2,524	1,369
R^2	0.112	0.052	0.093	0.075
Distinct families	2,207	1,741	966	454

Family fixed effects estimation. Controls not shown include dummies for year of birth. Family size (2-5 children) are specified in the column header.
Note: Robust standard errors are clustered at family level.
Significance levels: *** $p < 0.01$ ** $p < 0.05$ * $p < 0.1$

Table 4: The Effect of Birth Order on Children's Education (Degree)

Dependent Variable:	Education	High School	Associate Degree	Graduate Degree
Second Born	-0.380***	-0.085***	-0.046**	-0.036***
	(0.079)	(0.015)	(0.018)	(0.014)
Gender	0.608***	0.046***	0.147***	0.050***
	(0.063)	(0.012)	(0.015)	(0.011)
Mean	13.38	0.847	0.443	0.113
Coefficient/Mean	0.028	0.100	0.104	0.319
Observations	4930	4930	4930	4930
R^2	0.066	0.076	0.05	0.029
Number of Distinct Families	2,465	2,465	2,465	2,465

Family fixed effects estimation. Controls not shown include dummies for year of birth.
Note: Robust standard errors are clustered at family level.
Significance levels: *** $p < 0.01$ ** $p < 0.05$ * $p < 0.1$

Table 5: The Effect of Standardized Parental Income and Birth Order on Children's Education

Panel A: Parental Income when Children were between 1 and 6 years old				
Dependent Variable: Education	POLS	POLS with controls	FFE	FFE with controls
Second Born	-0.398***	-0.336***	-0.135	-0.541
	(0.075)	(0.075)	(0.122)	(0.626)
SB*Parental Income 1-6	-0.404***	-0.263***	-0.212**	-0.214*
	(0.090)	(0.085)	(0.094)	(0.112)
Observations	2108	2108	2108	2108
R-squared	0.120	0.257	0.109	0.115
Number of distinct families	1,054	1,054	1,054	1,054

Panel B: Parental Income when Children were between 7 and 13 years old				
Dependent Variable: Education	POLS	POLS with controls	FFE	FFE with controls
Second Born	-0.360***	-0.329***	-0.124	-0.290
	(0.076)	(0.077)	(0.123)	(0.605)
SB*Parental Income 7-13	-0.108**	-0.100*	-0.111**	-0.097*
	(0.052)	(0.053)	(0.052)	(0.059)
Observations	2108	2108	2108	2108
R^2	0.109	0.255	0.106	0.113
Number of distinct families	1,054	1,054	1,054	1,054

Panel C: Parental Income when Children were between 14 and 17 years old				
Dependent Variable: Education	POLS	POLS with controls	FFE	FFE with controls
Second Born	-0.393***	-0.361***	-0.163	0.030
	(0.076)	(0.076)	(0.123)	(0.589)
SB*Parental Income 14-17	-0.021	-0.016	-0.021	0.000
	(0.032)	(0.032)	(0.034)	(0.031)
Observations	2108	2108	2108	2108
R^2	0.089	0.254	0.104	0.111
Number of distinct families	1,054	1,054	1,054	1,054

Estimation strategy is specified in the column header.
Pooled Ordinary Least Square (POLS, column 1) includes indicators for gender, year of birth and parental income.
Pooled Ordinary Least Square with controls (POLS with controls, column 2) includes indicators for gender and year of birth, and parental demographics: mother's and father's education, race, mother's marital status at birth, age difference between siblings, and parental income.
Family Fixed Effects (FFE, column 3) includes indicators for gender, and year of birth.
Family Fixed Effects with controls (FFE with controls, column 4) includes indicators for gender and year of birth, and parental demographics: interaction terms of the second-born dummy with mother's and father's education, race, mother's marital status at birth, and age difference between siblings.
Parental Income represents deflated standardized income two years before the child was born and when children were were 1-6, 7-13 and 14-17 years old. Note: Robust standard errors are clustered at family level.
Significance levels: *** $p < 0.01$ ** $p < 0.05$ * $p < 0.1$

Table 6: The Effect of Parental Income and Birth Order on Children's Education

Panel A: No Poverty

Dependent Variable: Education	POLS	POLS with controls	FFE	FFE with controls
Second Born	-0.163	-0.182	0.056	0.014
	(0.212)	(0.218)	(0.225)	(0.568)
Second Born * No Poverty	-0.273	-0.204	-0.267	-0.140
	(0.220)	(0.224)	(0.222)	(0.252)
Observations	2108	2108	2108	2108
R^2	0.135	0.240	0.105	0.111
Number of distinct families			1,054	1,054

Panel B: Parental Income by Tertiles

Dependent Variable: Education	POLS	POLS with controls	FFE	FFE with controls
Second Born	-0.092	-0.099	0.123	-0.629
	(0.114)	(0.119)	(0.155)	(0.606)
Second Born * Tertile 2	-0.336**	-0.303*	-0.373**	-0.403**
	(0.161)	(0.163)	(0.161)	(0.176)
Second Born * Tertile 3	-0.486***	-0.453***	-0.514***	-0.591***
	(0.160)	(0.161)	(0.159)	(0.195)
Observations	2108	2108	2108	2108
R^2	0.159	0.244	0.113	0.120
Number of distinct families			1,054	1,054

Panel C: Parental Income by Quintiles

Dependent Variable: Education	POLS	POLS with controls	FFE	FFE with controls
Second Born	0.491*	0.470*	0.650**	-0.110
	(0.259)	(0.255)	(0.279)	(0.652)
Second Born * Quintile 2	-0.684**	-0.669**	-0.661**	-0.655**
	(0.295)	(0.291)	(0.297)	(0.297)
Second Born * Quintile 3	-0.879***	-0.840***	-0.871***	-0.877***
	(0.283)	(0.279)	(0.286)	(0.293)
Second Born * Quintile 4	-0.983***	-0.931***	-0.955***	-0.992***
	(0.287)	(0.283)	(0.291)	(0.307)
Second Born * Quintile 5	-1.119***	-1.059***	-1.097***	-1.179***
	(0.301)	(0.296)	(0.299)	(0.328)
Observations	2108	2108	2108	2108
R^2	0.157	0.245	0.116	0.122
Number of distinct families			1,054	1,054

Estimation strategy is specified in the column header.
Pooled Ordinary Least Square (POLS, column 1) includes indicators for gender and year of birth.
Pooled Ordinary Least Square with controls (POLS with controls, column 2) includes indicators for gender and year of birth, and parental demographics: mother's and father's education, race, mother's marital status at birth, and age difference between siblings.
Family Fixed Effects (FFE, column 3) includes indicators for gender and year of birth.
Family Fixed Effects with controls (FFE with controls, column 4) includes indicators for gender and year of birth, and parental demographics: interaction terms of the second-born dummy with mother's and father's education, race, mother's marital status at birth, and age difference between siblings.
No Poverty is a dummy variable which takes value 1 if the household was 185 percent above poverty threshold. Income indicators are calculated based on parental income, when children were between 1 and 6 years old. Note: Robust standard errors are clustered at family level.
Significance levels: *** $p < 0.01$ ** $p < 0.05$ * $p < 0.1$

Table 7: The Birth Order Effects on Education
using Birth Order from Father's Side

Family size	2 children	3 children	4 children	5 children
Panel A. Dependent Variable: Child's Education				
Second Born	-0.273**	-0.302***	-0.199	0.214
	(0.134)	(0.110)	(0.169)	(0.279)
Third Born		-0.560***	-0.538**	-0.002
		(0.188)	(0.221)	(0.323)
Fourth Born			-0.941***	-0.734*
			(0.327)	(0.391)
Fifth Born				-1.09**
				(0.505)
Observations	2,315	2,159	1,269	626
R^2	0.096	0.06	0.08	0.178
Number of Distinct Families	1,420	1,036	546	267

Family size	2 children	3 children	4 children	5 children
Panel B. Dependent Variable: High School Degree				
Second Born	-0.071***	-0.043**	-0.019	-0.063
	(0.021)	(0.021)	(0.028)	(0.048)
Third Born		-0.064**	-0.059	-0.225***
		(0.031)	(0.038)	(0.064)
Fourth Born			-0.098*	-0.285***
			(0.052)	(0.082)
Fifth Born				-0.382***
				(0.105)
Observations	2,315	2,159	1,269	626
R^2	0.105	0.077	0.102	0.158
Number of Distinct Families	1,420	1,036	546	267

Family fixed effects estimation. Controls not shown include dummies for gender and for year of birth.
Note: Robust standard errors are clustered at family level. Family size (2-5 children) are specified in the column header.
Significance levels: *** $p < 0.01$ ** $p < 0.05$ * $p < 0.1$

Table 8: Robustness Check
Additional Birth Orders

Dependent Variable: Education	(1)	(2)	(3)
Birth Order 2	0.123	0.181	0.555
	(0.374)	(0.402)	(0.471)
Birth Order 3 Plus	0.006	0.121	0.311
	(0.707)	(0.770)	(0.837)
Birth Order 2 * No Poverty	-0.357*		
	(0.189)		
Birth Order 3 Plus * No Poverty	-0.223		
	(0.260)		
Birth Order 2 * Tertile 2		-0.302*	
		(0.167)	
Birth Order 2 * Tertile 3		-0.333*	
		(0.178)	
Birth Order 3 Plus * Tertile 2		-0.105	
		(0.248)	
Birth Order 3 Plus * Tertile 3		0.080	
		(0.282)	
Birth Order 2 * Quintile 2			-0.522*
			(0.310)
Birth Order 2 * Quintile 3			-0.817***
			(0.305)
Birth Order 2 * Quintile 4			-0.922***
			(0.310)
Birth Order 2 * Quintile 5			-1.043***
			(0.325)
Birth Order 3 Plus * Quintile 2			-0.578
			(0.409)
Birth Order 3 Plus * Quintile 3			-0.676
			(0.416)
Birth Order 3 Plus * Quintile 4			-0.635
			(0.438)
Birthe Order 3 Plus * Quintile 5			-0.605
			(0.474)
Observations	3159	3159	3159
R^2	0.085	0.086	0.091
Number of Distinct Families	1,457	1,457	1,457

Family fixed effects estimation. Controls not shown include indicators for gender and year of birth; and interaction terms of the birth order dummy with mother's and father's education, race, mother's marital status at birth, and age difference between siblings.
Note: Robust standard errors are clustered at family level
Significance levels: *** $p < 0.01$ ** $p < 0.05$ * $p < 0.1$

Table 9: Robustness Check
Different Measures of Birth Order

Dependent Variable: Education Panel A. Birth Order Continuous	(1)	(2)	(3)
Birth Order	0.076	-0.057	0.151
	(0.337)	(0.357)	(0.389)
Birth Order * No Poverty	-0.147		
	(0.127)		
Birth Order * Tertile 2		-0.114	
		(0.134)	
Birth Order * Tertile 3		-0.261*	
		(0.145)	
Birth Order * Quintile 2			-0.286
			(0.199)
Birth Order * Quintile 3			-0.387*
			(0.200)
Birth Order * Quintile 4			-0.425**
			(0.211)
Birth Order * Quintile 5			-0.452**
			(0.227)
Observations	3321	3321	3321
R^2	0.082	0.083	0.084
Number of Distinct Families	1,536	1,536	1,536

Dependent Variable: Education Panel B. Relative Birth Order	(1)	(2)	(3)
Relative Birth Order	-0.060	-0.021	0.528
	(0.269)	(0.265)	(0.350)
Relative Birth Order * No Poverty	-0.238		
	(0.216)		
Relative Birth Order * Tertile 2		-0.091	
		(0.222)	
Relative Birth Order * Tertile 3		-0.388*	
		(0.231)	
Relative Birth Order * Quintile 2			-0.597*
			(0.333)
Relative Birth Order * Quintile 3			-0.782**
			(0.328)
Relative Birth Order * Quintile 4			-0.938***
			(0.340)
Relative Birth Order * Quintile 5			-0.980***
			(0.358)
Observations	3321	3321	3321
R^2	0.083	0.085	0.087
Number of Distinct Families	1,536	1,536	1,536

Family fixed effects estimation. Controls not shown include indicators for gender and year of birth; and interaction terms of the birth order with mother's and father's education, race, mother's marital status at birth, and age difference between siblings.
Note: Robust standard errors are clustered at family level
Significance levels: *** $p < 0.01$ ** $p < 0.05$ * $p < 0.1$

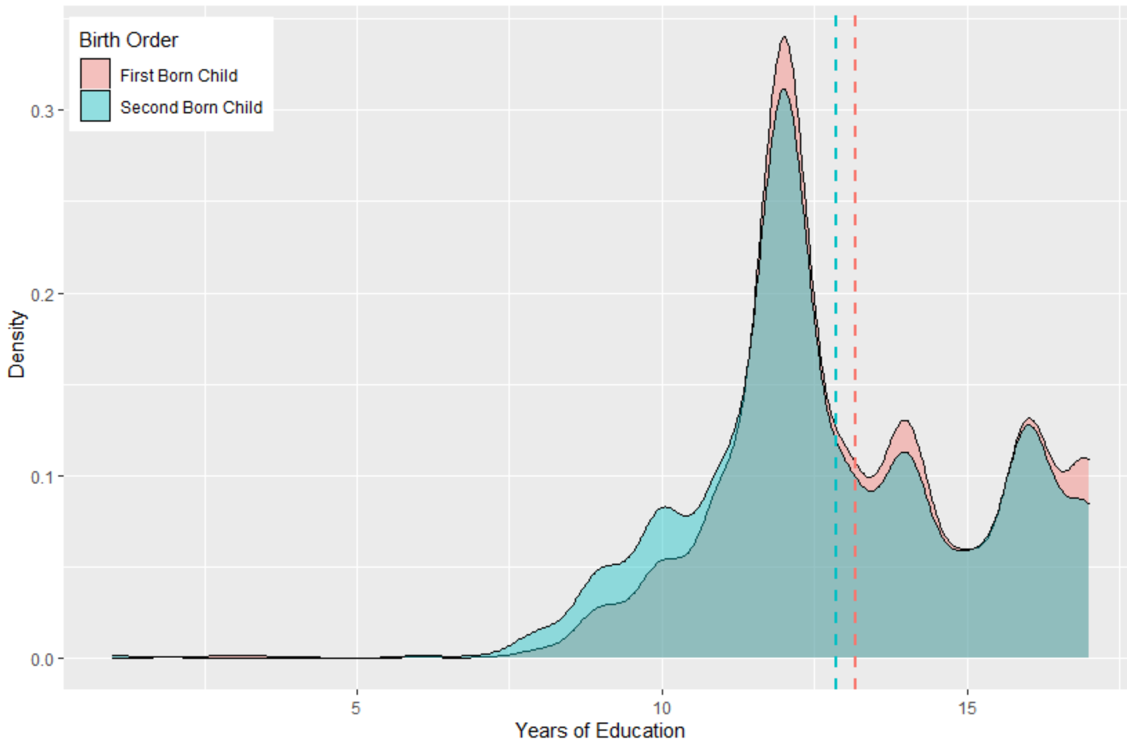

Figure 1: Education Density by Birth Order

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