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 households' income, being the strongest for households with the highest income and diminishes as households' income decreases. In addition, we show that the timing of income across childhood is important for completed education, and the largest gap in educational attainment between siblings is between those born and spent their early childhood in wealthier households.

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 the child's educational attainment, affecting their 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). Empirical studies have found 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 (Stéphane Mechoulan and Wolff 2015, West Germany (Härkönen 2013) and the U.S. (Kantarevic and Stephane Mechoulan 2006, De Haan 2010). [2].

We focus on the US and investigate whether within-country birth order effects are also different depending on the household's income level. We find that first-born children acquire, on average more education than their younger siblings. This effect is

[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

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. For the first time, the analysis of the effects of parental income on birth order is extended to incorporate its timing, and we show that income in early childhood has the strongest impact on birth order.

This is the first paper using US data that investigates in-depth whether birth order has different impacts depending on family's income levels. Esposito, Kumar, and Villaseñor (2020) using data from Mexico, a middle-income country finds similar effects when they focus on the interplay between households' 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, a low-income country 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 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. In addition, we explore whether the timing of the parental income matters for birth order effects.

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 educa-

tion 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 in the highest quintile of income acquires 1.18 additional years of education 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.

We focus on a household's economic status in several stages of childhood and show that the highest effect of income on birth order is in 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 child. This difference decreases 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 born and spent their early childhood in wealthier households. Financial conditions in late childhood have 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 and that early childhood is 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, in the context of birth order effects, these results are surprising as increased labor participation of the first-born child that favors the 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 that 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, and 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 and 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 are going to elaborate on the literature that emphasizes social interactions between siblings and their parents and the dilution of family resources, as well as how these mechanisms are affected by the family's socioeconomic characteristics.

The confluence hypothesis (Zajonc and G. Markus 1975, Zajonc, H. Markus, and G. 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 he 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.

These 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].

Another important theory on birth order is the resource dilution theory (Blake 1981). This theory 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 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) find that as early as age one, later-born children score lower on cognitive tests than their siblings, and 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, alphabet, colors, and shapes, at home [4]. The allocation of resources that favors first-born

[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 educational attainment.

[4]Their analysis can not capture if some of these activities are performed by the first-born child

children is not limited to childhood. De Haan (2010) determines that in the US, after graduating high school, first-borns receive a higher financial transfer from parents than their younger siblings. Stéphane Mechoulan et al. (2015) finds a similar result when looking at French data.

The third strand of literature concerned with birth order effects focuses on strategic parenting choices. Hotz and Pantano (2015) argue that parents are more strict 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 siblings. They show that parents' strictness declines with birth orders, as does children's school performance. Pavan (2016) finds that differences in parental behavior among siblings can explain more than half of the gap in their test scores. In addition, first-born children are supervised more than younger ones; thereby, first-born children tend to exhibit less risky behavior (Averett, Argys, and Rees 2011), are more strictly monitored on homework, and have more stringent limitations on their television viewing (Hotz et al. 2015), all factors that 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 will 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 US where children under the age of 16 are not allowed to work outside of the household,

instead which would reinforce their advantage through teaching effects

if the the family is financially constrained the older child will be at disadvantage in continuing their education after the compulsory education period ends. 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 beyond a certain level.

The 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.

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

Lafortune and Lee (2014) develop a model combining convex returns to education and credit constraints and show that schooling of a child will be positively correlated with his/her birth order for low-income families. They use father's education as a proxy for family income and data from the United States, South Korea and Mexico to test the theory's predictions. They show that in families with fathers with no education, each subsequent child received between 0.2 and 0.7 years more education than the previous child, but this effect is reduced for fathers with more education, and it even reverses for the most educated fathers in Mexico and the United States. Their results are thus consistent with liquidity constraints favoring later-born children.

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 whether wealth influences birth order effects. In a study done using data from 12 Sub-Saharan countries, Tenikue et al. (2010) 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 are 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-born 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 whether children between the ages of 6 and 16 work or not. His results show that cash transfer conditional on school attendance reinforces the previous positive birth order effects, while the unconditional cash transfers do not change the birth order effects. He thus 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 does not vary according to families' socioeconomic characteristics.

3 Data Description

Data used in previous studies do not include economic characteristics during childhood and outcomes as an adult. The most relevant study on this topic, Black et al. (2005), use administrative data from Norway;. However, the sample size was large (1.4 million), the data did not include family economic circumstances during childhood as the family background was contemporaneous with the outcome (adult's education). Therefore, the authors cannot assess how childhood socioeconomic characteristics influence birth order effects. Other papers (De Haan et al. (2014)) use family's socioeconomic status during childhood, 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 there are numerous studies analyzing the effects of childhood circumstances on 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 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 shrinks considerably if we would rely on the children attributed to the father.

We further restrict our sample to individuals over 25 years old in 2019 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 that 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 educational attainment within families. The variable age is thus crucial for determining parental income during childhood. We use the reported age in wave t and survey year to impute the age where missing values are present.[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

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

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 high-school. There is a balanced gender composition, and 52.29% of children are White, 32.51% are Black, and 15.20% are other races. To assess the effect of birth order across the economic ladder on the educational outcome, we focus on the first two children present 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. The average years of education are 14, and 14% have a graduate degree while 52% have at least an associate degree.

4 Methods and Results

4.1 Birth Order Effects

In Table 2, we run 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 education levels increase over time. Thus, the relationship between birth order and education may describe cohort effects due to fewer higher birth order children within a family and higher education levels for younger generations (Black et al. 2005). We include the year of birth fixed effects

to account for trends and gender dummy variable to control that 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 2, 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 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, there does not seem to be a considerable variation based on family size (Table 2). 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. They also outperform their younger sibling(s) in terms of graduate education completed.

In Table 3, the column headers represent the educational outcome focusing only on the second-born child. We restrict the sample to families where first- and second-born can be identified and have no missing values for parental income and demographics. The results indicate that a second-born child receives 0.22 fewer years of education than a first-born child. They are also 5%, with respect to the mean, less likely to obtain a high school degree and 33% less likely to have a graduate degree.

4.2 The Empirical Model

$$Y_{ij} = \alpha_1 SB_{ij} + \alpha_2 SB_{ij} * No\ Poverty_j + \alpha_3 X_{ij} + \mu_j + \varepsilon_{ij} \tag{1}$$

$$Y_{ij} = \delta_1 SB_{ij} + \delta_2 SB_{ij} * T_{2j} + \delta_3 SB_{ij} * T_{3j} + \delta_4 X_{ij} + \mu_j + \varepsilon_{ij} \tag{2}$$

$$\begin{aligned} Y_{ij} = \beta_0 + \beta_1 Second\ Born_{ij} + \beta_2 Second\ Born_{ij} * Q_{2j} + \beta_3 Second\ Born_{ij} * Q_{3j} + \\ + \beta_4 Second\ Born_{ij} * Q_{4j} + \beta_5 Second\ Born_{ij} * Q_{5j} + \beta_6 * X_{ij} + \mu_j + \varepsilon_{ij} \end{aligned} \tag{3}$$

where Y_{ij} represents the completed years of education of individual i in family j, $Second\ Born_{ij}$ 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 and year of birth fixed effects, and it controls for parental demographics (e.g., mother's and father's education, age difference between siblings, and indicators for mother's marital status at childbirth and race);The dummy variable $No\ Poverty$ takes value 1 if household is 185% above poverty line; T_{2j}, T_{3j} are indicator variables, which are assigned a value of 1 if the parental income belongs to respective tertile; and similarly Q_{2j}, Q_{3j}, Q_{4j}, and Q_{5j} are indicator variables 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.

It is appealing to 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, removing useful information in the variable of interest. The magnitude of our OLS[6] and family fixed effects are not very different because our variable of interest (i.e., birth order) is not likely to be affected by measurement error.

[6]OLS results are available upon request

5 Results

5.1 Main Results

We present the effect of timing of parental income and birth order on children's education in Table 4. Parental income is deflated to 2015 constant dollars and standardized at year level, and then the average is calculated for different periods. 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 and year of birth fixed effects; then we add controls for parental demographics, such as mother's and father's education, mother's marital status at childbirth, race, and the age difference between siblings.

In panel A of Table 4, column 4, the family fixed effects estimation with controls shows that 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. We explore further what those factors might be.

Our results are consistent with models of skill formation in children that show that timing of income across childhood is important for adult outcomes, and 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 US might mirror those from developing countries. The explanations put forward to explain the positive effects of birth order in developing countries combine early childhood and late childhood/adolescence effects. Some of the 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 latter born children (De Haan et al. 2014), which is the opposite of what we observe on average in the US (Price 2008). At the same time, numerous studies in the US (see HeckmanMosso2014 for a survey) provide evidence that children from low income families incur disadvantages in their development, on a a variety of dimensions. Cunha et al. (2013) show that maternal knowledge about child development affects the maternal choices of investments in the human capital of children, and that disadvantaged parents exhibit lower levels of parenting knowledge. 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.

This evidence points to a steeper learning curve for effective parenting practices which would tend to favor the later born for low income families, independent of financial constraints.

In their model of strategic parenting, Hotz et al. (2015) argue that parents are more

strict with their first born children and show that this style of parenting on average leads to better educational outcomes. Kalil and Ryan 2020, document substantial differences in parenting practices between families with different socioeconomic status, with poorer parents adopting a more authoritarian approach which has a negative impact on child development. If rigidity in parenting practices decreases with higher order children, later born children in poor families would benefit from it, whereas later born children in wealthy families are raised in too permissive style relative to the first borns.

The later childhood effects in developing countries are based on the fact that first born are more likely to drop out of school to start working and bring an an 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 lack of significance of family's income in late childhood/adolescence is consistent with the findings from the human development literature that show that early income is a more important determinant of educational attainment than is income earned at later ages (Caucutt et al. 2020).

Our analysis focuses on how socio-economic conditions affect birth order effects. First born from lower income families might be more likely to drop out of school and start working, but our results suggest that, contrary to what is happening in developing countries, this will not necessarily lead to a differentiated outcome for the first born and later born siblings.

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. We report the

results of four regressions: pooled ordinary least squares (POLS) and family fixed effects (FFE) without and with parental characteristics in Table 5.

In panel A of Table 5, 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 head of the household, 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, but they are all statistically insignificant.

Furthermore, in panel B of Table 5, we create family income tertiles for individuals during the age category between 1 and 6 years old based on our data. 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 from Equation 1, Equation 2 and Equation 3 are reported in Table 5, 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. 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 income distribution at the country level is not available for tertiles. The first three columns show that the second child receives significantly more education than the first-born child when the household belongs to the poorest quintile. This is similar to average birth order effects observed in developing countries, including Brazil (Emerson et al. 2008); Taiwan (Parish et al. 1993); and the Philippines (Eirnæs et al. 2004). 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 a older sibling if the parental income during childhood was among wealthier households. 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. There is a decline in educational attainment for the second child relative to the first child as the parental income quintile increases, ranging from -0.66 to -1.18 years. The birth order effect among wealthier households is consistent with average birth order effects among developed countries found by Black et al. (2005) in Norway and Kantarevic et al. (2006), and De Haan (2010) in the U.S.

Based on the fact that parents might be at the beginning of their careers and have limited savings to invest in the first-born child's education (Parish et al. 1993), it is expected that later-born children would perform better than older children in poor households. Even in a developed country such as the U.S., in families with lower income, the first-born can legally start working at 16 years old in most of the states, which affects their educational attainment. Consequently, their younger siblings could benefit from the income earned by the first-born and complete additional years of schooling.

The positive birth order effect among poorer households and the negative sign of the interaction terms between the second-born and quintiles, as well as the increase in the coefficients' magnitude along the economic ladder, confirm the results found in the literature: while second-born children perform better in poorer countries, this advantage is not observed in wealthier countries. This suggests that the resource dilution hypothesis is a plausible mechanism behind the birth order effects.

6 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 would have been insufficient for analysis. Instead, 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 mother. As a robustness check, Table 2 presents birth order effects on the educational outcome by family size using the birth order of children that are attributed to the father. The magnitude of coefficients are similar to those in Table 7, which presents birth order effects of children attributed to the mother, where later born children attain less education than first-born children.

The number of distinct families generated using father ID numbers dropped to 3,269 from the previous 5,368 using mother ID numbers.

Table 7 presents higher-order births, where we combine fourth- and 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 5 in which 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 8, we use two different measures of birth order. In panel A, birth order is used as a continuous variable, while in panel B, relative birth order which is constructed using 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.

7 Conclusion

This paper aims to determine whether birth order has distinct impacts on different categories of income levels in the United States. The existing research literature provides a mixed picture of the effect of birth order on education. Research has shown positive birth order effects in developing countries, while, in developed countries, there are negative birth order effects.

Applying a family fixed effects approach, we can confirm the negative effect of birth order on educational attainment in the U.S. among wealthier households. At the same time, there is a positive birth order effect among low-income families. This suggests that birth order effects are related to the financial resources dilution hypothesis because poorer households in the U.S. follow the pattern in developing countries, and wealthier households follow the pattern in developed countries.

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: 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 3: 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 4: 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-squared	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 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.
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 5: 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 6: 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 7: 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 8: 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-squared	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: *** $p < 0.01$ ** $p < 0.05$ * $p < 0.1$

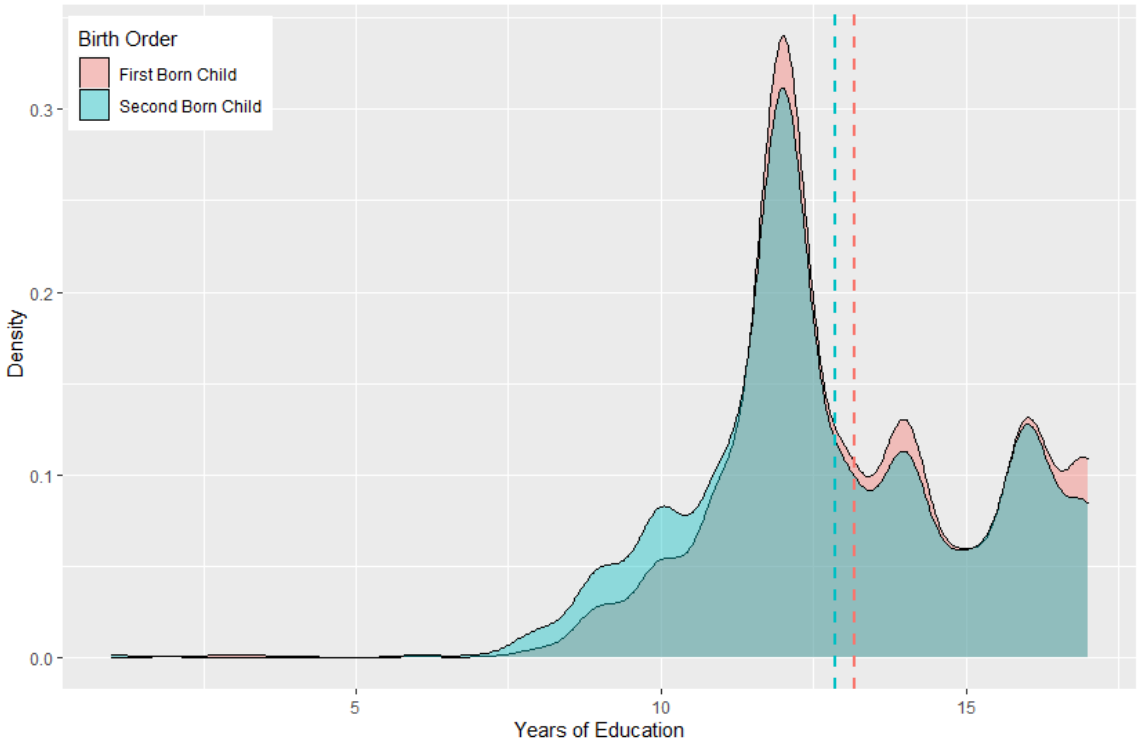

Figure 1: Education Density by Birth Order

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