Birth Order and Child Cognitive Outcomes: an Exploration of the Parental Time Mechanism

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Birth Order and Child Cognitive Outcomes: Does Parental Time Matter?

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1 Introduction

Inequalities in individual economic outcomes have recently been examined in line with the evolution of household conditions, as family size becomes smaller, and more women enter the labour force, postponing the decision to bear children. A growing literature investigates the link between family size and birth order on the one hand, and inequalities in achievements and outcomes on the other hand. Though pioneer studies fall under the fields of psychology and sociology, economic research is rapidly catching up, focusing on education and income outcomes, among others. Existing birth order studies predominantly referred to developed countries and showed that children with higher birth order positions perform worse in terms of cognitive development and educational outcomes (Black et al., 2005, 2011; Booth and Kee, 2009; De Haan, 2010; Gary-Bobo et al., 2006; Heiland, 2009; Kantarevic and Mechoulan, 2005; Lehmann et al., 2012; Silles, 2010).

A possible explanation for the negative link between birth order and child outcomes may lie on parental investments on their children. Successfully establishing the existence of this link may not only provide a possible answer to overcome birth order effects, if present, but also lend a better explanation to the mechanism of intergenerational transmission. Financial, material, and time resources may be considered as investments into the child 'quality' production (Becker, 1974). These parental investments will differ not only according to family finances and parental characteristics, such as educational attainment, but also according to child-specific characteristics, such as gender, birth order position, and number of children born in the family. For instance, a larger family size leads to a smaller share of resources per child, given that family resources have to be divided among a greater number of offspring, assuming parents aspire to provide equally among their children. Birth order effects could then favor the children with lower birth order positions, essentially because they were born earlier and would have received more resources from the parents. This is consistent with the so-called financial resource dilution explanation of birth order effects found by De Haan (2010) using a sample from the state of Wisconsin, wherein parents spend less money on later-born children.

Among the resources allocated by parents to children, time investments are believed to be another crucial factor that contributes to the improvement of child educational and human capital outcomes. Price (2008) showed that in the U.S., first-born children receive more quality time each day from the parents as compared to their second-born counterparts at the same age, suggesting that birth order effects in child cognitive outcomes might be due to differences in parental time received by the child.

In this paper, we provide an empirical assessment of this argument using data from the Child Development Supplement (CDS) of the Panel Study of Income Dynamics (PSID). This representative sample of U.S. population is particularly suitable for answering our research questions, since it contains information on both child cognitive outcomes measured by standardized tests and the detailed use of time collected through diaries. We are then able to consider a rich set of time investments received by the child: looking at both paternal and maternal time, and at the same time distinguishing among total time, total quality time with the parent either actively engaged with or simply around the child, and quality time with the parent actively engaged with the child.

We start by re-establishing the expected negative birth order effects on verbal cognitive tests on our sample of biological siblings living with both parents, using both Ordinary Least Squares (OLS) and family Fixed Effects (FE) estimation strategies and allowing for birth order impacts to vary for different family sizes. Then, similarly to De Haan et al. (2012), we investigate the parental time allocation mechanism as a possible explanation, looking at birth order patterns in time spent by children with their respective mother or father. From initial OLS regressions, we find that later-born children receive less time from both parents, in particular, less quality time during the age bracket of 0 to 12 years with respect to their older sibling at the same age. These results are coherent with those of Price (2008). Next, we argue that these birth order patterns are mostly driven by between families variation. With family fixed effects estimation - made possible by the presence of siblings in the data - the birth order coefficients turn out to be generally diminished, with the noticeable exception of quality time spent with the father during the age period of 5 to 18 years. The conclusion we draw is that birth order effects in cognitive test scores are unlikely to be driven by differences in quality time spent with either parent.

The paper is organized as follows. Section 2 shortly presents the relevant background literature. Section 3 describes the data source and variables used. Section 4 illustrates the empirical strategy and discusses the results. Lastly, Section 5 concludes.

2 Background

Existing literature on the so-called 'birth order effects' has for a long time been prevalent in the field of psychology (Kidwell, 1981; Sulloway, 2007; Zajonc, 1976). Here, differences in outcomes such as intellectual attainments and personalities are explained either by the differing intellectual environments experienced by the child, as in the so-called confluence model (Zajonc, 1976), or by the distinct roles that each child plays in the family, as suggested in the family dynamics model (Sulloway, 2007). Adoption into the field of economics remains relatively new, and focuses mainly on inequalities in human capital and labour market outcomes measured in terms of educational attainment (Black, Devereux, and Salvanes, 2005; Blake, 1981; Booth and Kee, 2009; Kantarevic and Mechoulan, 2006), test scores (Blake, 1981; Conley, Pfeiffer, and Velez, 2007; Leibowitz, 1974), and income earnings (Behrman and Taubman, 1986; Kantarevic and Mechoulan, 2006). Although there are some studies that claim little or no birth order effect (Hauser and Sewell, 1985), most empirical findings in the economic literature refer to developed countries and show negative or U-shaped results (Hanushek, 1992). Meanwhile, positive birth order effects are spotted by a few recent studies for developing countries (De Haan et al., 2012; Tenikue and Verheyden, 2010).

Among the studies that looked at birth order effects in educational outcomes, Heiland (2009) found that U.S. first-borns of the 1979 cohort of National Longitudinal Survey of Youth (NLSY79) have higher scores in the Peabody Picture Vocabulary Test-Revised

(PPVT-R), a standardized test of early verbal ability. Kantarevic and Mechoulan (2006) used a PSID sample and claimed that a 'first-born advantage' in terms of educational attainment is already evident as early as high school age, and it persists until the professional life as measured by income earnings. Conley, Pfeiffer, and Velez (2007) found on a PSID-CDS children sample that first-borns generally perform better in Woodcock-Johnson Revised (WJ-R) Tests of Achievement than their younger siblings. Black, Devereux, and Salvanes (2011) found on a Norwegian sample that lower birth order children have higher scores in intellectual quotient. All the above-mentioned studies exploit the presence of siblings in the data and adopt family fixed effects estimation to identify birth order effects, net of unobserved confounders at the household level. On the other hand, Silles (2010) resorted to an instrumental variable approach based on parental reproductive capacity and sibling sex composition. Using data from the National Child Development Study, she documented a negative family size effect on test scores and behavioural development, as well as negative birth order effects for a given family size.

The spotted negative relationship between birth order and outcomes can be explained by the mechanism of resource allocation within the household. Maintaining the assumption that provision of more resources improves child outcomes, a family with a larger number of children lets each child receive a smaller share of the family resources, as compared to a child born in a smaller family (Becker, 1974; Becker and Tomes, 1976). As higher birth order children are more likely to be born in bigger families, a later-born child will also receive fewer resources, since the resources have already been previously allocated to the earlier-born children. Becker and Lewis (1973) proposed a quantity-quality trade-off in the family, saying that larger family sizes produce lower 'quality' children since more people have to share the available resources. Birth spacing between siblings may also factor in the resource allocation. Buckles and Munnich (2012) found that an additional year between siblings is favourable to the older child's test scores. Meanwhile, siblings with a smaller age gap are more exposed to sibling competition for parental resources than siblings with a larger age gap, hence the former are more likely to receive less resources and experience birth order effects. Recent empirical evidence supporting the financial resource dilution explanation is provided by De Haan (2010), on a sample of individuals who graduated from Wisconsin high schools. Lehmann et al. (2012) investigated the role of prenatal and early childhood conditions as a source of birth order effects on early cognitive and non-cognitive test scores, concluding that variations in a range of pre- and post-natal investment do not explain the existing negative birth order effect.

Even if parents decide to allocate resources more equally among the children, the result still creates a cumulative inequality. This is the so-called equity heuristic model proposed by Hertwig, Davis, and Sulloway (2002). Compared to the first-borns who enjoy being the 'only child' when the younger siblings have not been born, and the last-born children who become the 'only child' when the older siblings leave the household, middle-born children never have the opportunity of being the 'only child' in the family. As such, middle-born children always share the parental resources with other siblings and always receive smaller cumulative shares of the resources. Unlike the earlier-born children, later-born children experience a poorer resource environment, such as less parental time during the child's early years. One reason for birth order effects within the equity heuristic framework is that they may be more of a function of perception than actual, such that children perceive themselves as being treated unequally, even though they are treated equally. Parents may also have a different definition of 'equality' from the children's. Nevertheless, the equity heuristic explanation shows that birth order effects may occur even though parents aim to be equal at all times. With a neighbor-matching estimation that allows for the comparison of first-borns and second-borns from similar two-children households of American Time Use Survey (ATUS) respondents, Price (2008) found that parents provide approximately equal amounts of quality time to their children at each point in time, but spend less time with each child as they both get older, resulting in less cumulative parental quality time by second-born children. In the following part of the paper, we depart from this suggestion and investigate whether differences in parental time received by the child can explain birth order effects in child cognitive outcomes.

3 Data

Our empirical strategy exploits information on both the time use and test scores of the children surveyed in the Child Development Supplement (CDS) of the Panel Study of Income Dynamics (PSID) where we are able to estimate birth order effects in both child outcomes and in parental time inputs.

The Panel Study of Income Dynamics is a longitudinal data of United States individuals, with information regarding their economic, demographic, sociological, and psychological status and well-being. The interview started in 1968, with the initial sample of 4,800 families coming from a cross-sectional national sample drawn by the Survey Research Center (SRC) and a national sample of low-income families from the Survey of Economic Opportunity (SEO) conducted by the Bureau of the Census for the Office of Economic Opportunity. The succeeding interviews followed the original sample through the years.

The CDS dataset interviews PSID children, with the first wave in 1997, followed by the 2002/03 and 2007 waves. It looks into the human capital development of the interviewed children, with information on home environment, family processes, time diaries, school environment, and cognitive, emotional, and physical performance. The survey includes up to two randomly-chosen eligible children in a family. The CDS-I contains 3,563 children of 0 to 12 years old belonging to 2,394 families (88%). The CDS-II successfully re-interviewed 2,907 children from 2,019 families (91%) from 5 to 18 years old, while the CDS-III has 1,506 children (90%) from 10 to 18 years old. Those more than 18 years old are included either in the Transition into Adulthood (TA) dataset or the main PSID.

To increase our sample size, we pool the CDS waves and use outcome observations from the 2002 and 2007 waves, when the children are between 5 to 18 years old. Selected regressors called *lagged* variables are taken from the prior wave to avoid reverse causality. To illustrate, a child with an outcome observed in 2002 has corresponding lagged variables observed in 1997, while a child with an observed outcome in 2007 has corresponding lagged variables observed in 2002. We obtain a sample consisting of 396 PSID-CDS sibling-pair children (or a total of 792 children) from 5 to 18 years old, with the average age at 12 years, who are living in intact families[1] of 2 to 5 children and have non-missing information on the relevant variables.

3.1 Cognitive outcomes

We explore three standardized measures of the child's cognitive skill taken from the Woodcock Johnson Revised (WJ-R) Test of Achievement. Contrary to raw scores, which are essentially the number of items completed in the test, standardized scores are adjusted according to the respondent's age.[2] Verbal outcomes are measured by the letter word and passage comprehension test components. The letter word test assessment measures symbolic learning (matching pictures with words) and reading identification skills (identifying letters and words). It starts from the easiest items such as the identification of letters and pronunciation of simple words, progressing to the more difficult items, such that college students and adults would start on a different item than do pre-school children. The passage comprehension assessment measures comprehension and vocabulary skills using multiple-choice and fill-in-the-blank formats. The applied problem test captures mathematical skill in solving practical problems in mathematics.[3]

3.2 Parental time

Since the seminal work of Becker and Tomes (1976), child outcomes are seen as a product of a combination of inputs such as material/financial and time. In empirical studies, attempts to consider parental time resource have started out with the usage of proxies such as parental employment and weekly work hours (Bernal, 2008; Blau and Grossberg, 1992; Todd and Wolpin, 2003).[4] The recent availability of time diaries is a significant progress with respect to the use of proxies, allowing for a direct measure of time that children spend with their mothers and fathers. A limited literature exploited this advantage relying on the PSID-CDS data (Carneiro and Rodrigues, 2009; Del Boca, Flinn, and Wiswall, 2014; Del Boca, Monfardini, and Nicoletti, 2012; Hsin, 2007). The general finding is that parental time is a productive input for young children, though with a declining effect as the children grow up.

[1] Intact families are two-parent households, wherein parents and children are biologically related to each other.

[2] The age standardization process allows for a comparison of children's test scores by eliminating the discrepancy in the results due to different ages.

[3] The data also contain a non-cognitive outcome called *behavioural problem index*, but we limit our analysis to the cognitive outcomes.

[4] Maternal employment has been found to have ambiguous effects on children outcomes (Blau and Grossberg, 1992; James-Burdumy, 2005), since maternal non-working time is not necessarily entirely spent with the children. For instance, employed mothers may compensate for work hours by spending more of their available time with their children and less time on other activities such as leisure (Huston and Aronson, 2005).

In the PSID-CDS, time use information is available from the child's perspective on a random weekday and a random weekend, specifying the type of activity performed, the amount of time spent on each activity over a 24-hour period, and the company involved in performing the activity (i.e. 'Who was doing this activity with the child?', 'Who (else) was there but not directly involved in the activity?'). Accordingly, we can consider different definitions of time that children spend with their parents. Aside from *Total time*, we replicate a comparable broadly-defined quality time measure that is the aggregate of the four different activity categories defined by Price (2008). This is composed of activities that the child performs with the parent, in which either the child is the primary focus of the activity or there is a reasonable amount of interaction. These activities are: reading, playing, doing homework, talking, teaching, doing arts and crafts, eating, playing sports, attending performing arts, participating in religious practices, looking after, and physical care. Moreover, we distinguish between a total *Quality time*, including all the time wherein the parent is directly involved with the child or just around supervising, and *Quality Engaged time*, where the parent is instead actively engaged (This definition is used by Price (2008)[5]). The latter is a more stringent definition of quality time, and is a sub-set of the former.

Table 1 describes these three measures of time spent with the mother and the father, when the children are in the age range of 0 to 12 years (We call this measure *Lagged Time*) and when they are aged 5 to 18 years (*Current Time*). Because we take the outcome measures when the children are between 5 to 18 years, *Current time* corresponds to contemporaneous observations of outcome measures and time inputs, while *Lagged time* are time inputs observed in the wave prior to the period when the outcome measure was observed. The column entitled *Week* displays our estimate of weekly time, obtained by multiplying the *Weekday* amount by five, multiplying the *Weekend* amount by two, and getting the summation of the two products. We use weekly hours as the unit of measurement of parental time for ease of interpretation. The patterns follow conventional wisdom, with all parental times increasing in the weekend with respect to weekday, decreasing as the child ages, and with maternal figures always higher than the corresponding paternal ones.

3.3 Variables description

The summary statistics of the relevant variables for our study are shown in Table 2. About half of the sample who are aged 5 to 18 years at the period when the outcomes are observed are males, and 13% are blacks. First-borns of 2-children families are 23% of the sample, while 23% are second-borns. About 12% of the sample are instead first-borns of 3-children families, 17% are second-borns and 11% third-borns. The data seem to contain enough information to separate birth order positions by family size, at least

[5] Price (2008) used the American Time Use Survey where time use of the parents is recorded, implying their active engagement.

for those families with two and three biological offspring.[6] The figures for 4- to 5-children families are thinner, and we expect identification of their specific birth order effects not to be as reliable as those from the other family sizes. Indeed, while the average number of children in the family is 2.7, almost half of the sample are 2-children families (45%), 41% are 3-children families, and only 14% are families with 4- to 5-children. Figure 1 presents the distribution of ages by birth order positions of the children, which testifies that the sample contains variation in ages at each birth order position, an important requirement not to confound birth order effects with those of age.

In the bottom part of Table 2 are the descriptives for the age standardized cognitive tests: letter word (LWSS), passage comprehension (PCSS) and applied problem (APSS).

Figure 2 provides descriptive evidence of the negative relationship between the different birth order positions and the three cognitive outcomes, with the averages of all the three tests decreasing for later-born children. In the following section we revisit this descriptive evidence through econometric modelling and explore if, and to which extent, the birth order effects are driven by parental time inputs.

4 Empirical strategy

4.1 Birth order effect on cognitive outcomes

We establish birth order effects on the child outcomes by way of a reduced-form child production function model, in which past and current child and family characteristics and input measures produce the child test score output (see Todd and Wolpin, 2007).

$$Test_{ij} = \gamma_0 + \gamma_1 BOFS_{ij} + \gamma_2 T2_{ij} + \gamma_3 X_{ij} + \gamma_4 Z_j + \varepsilon_{ij} \tag{1}$$

The dependent variable $Test_{ij}$ is the cognitive test outcome observed for child i born in family j. We create a set of dummy variables $BOFS_{ij}$ capturing the family-specific birth order positions. This differentiates the birth order effect by family size, distinguishing, for example, a second-born of a 2-children family from a second-born of a 3-children family. The dummy variable $T2_{ij}$ indicates the year of observation of the child (i.e. 2007 versus 2002); X_{ij} stands for observable child-specific variables such as age, gender, race, maternal childbirth age, and birth weight[7]; Z_j contains household-specific characteristics including income, parental years of education, and parental employment status.

The random term ε_{ij} is thought of as a two-way error component:

$$\varepsilon_{ij} = \alpha_i + \psi_j + \rho_{ij}$$

It includes a child-specific time-constant unobserved heterogeneity term α_i, a household-specific unobserved heterogeneity component ψ_j, and an idiosyncratic error ρ_{ij}.

[6] Birth order variables are time-invarying. A first-born child maintains the same position, even when an additional child is borne into the family.

[7] Birth weight is likely to be highly correlated with family size and birth order. For instance, a later-born child from a larger family size will more likely have a lower birth weight due to being born to an older mother (Rosenzweig and Zhang, 2009).

We estimate the birth order effects, γ_1, with the following approaches:

1. **Pooled OLS**, which provides consistent estimates of the above coefficients of interest only under the assumption that all the right-hand side variables, including the inputs, are orthogonal to α_i and ψ_j

2. **Fixed effects**, which differences the variables between the two children observed in a household and identifies birth order effects net of unobserved family-specific components, possibly correlated with the observed regressors, under the assumption that family unobserved heterogeneity is common to siblings.

$$\Delta_j Test_{ij} = \gamma_1 \Delta_j BOFS_{ij} + \gamma_2 \Delta_j T2_{ij} + \gamma_3 \Delta_j X_{ij} + \Delta_j \varepsilon_{ij}$$

Table 3 reports OLS and FE estimated birth order effects on the three test outcomes, using first-borns of each family size as the reference category. [8] Results on families with 4 to 5 children turn out to be generally not significant, most likely due to the few cases available in the sample. Therefore, we limit our comments to the results for families with two and three offspring. The OLS coefficients of Letter Word and Passage Comprehension tests show that last-borns have significantly lower verbal outcomes than their older siblings, but do not perform worse in mathematical tests measured by Applied Problem test. For the latter, the only negative significant coefficient is found for the second-born in 3-children families. This is similar to findings by Bonesrønning and Massih (2011) using Norwegian data. However, the effects we find might be biased due to omitted unobserved heterogeneity potentially correlated with family size or other observed characteristics.

FE estimation confirms the presence of sizable birth order effects in verbal skills, penalizing the second-borns of 2-sibling families, and both the second- and third-borns of 3-sibling families. This evidence is consistent with the findings in the literature, e.g., Black, Devereux, and Salvanes (2011), Kantarevic and Mechoulan (2006), and Heiland (2009), among others. However, similar to other recent U.S. studies (Hotz and Pantano, 2013; Lehmann et al., 2012), we find that later-born children do not suffer any penalty in their mathematics performance.

According to our estimates, second-born children in 2-children families score 3.6 less in the Letter World (about 20% of the test's standard deviation) than their older brothers or sisters at the same age. In 3-children families, the second- and third-borns score respectively 4.3 and 6.2 less than the first-borns in the Passage Comprehension (about 25% and 40% of the test standard deviation).

4.2 Does parental time explain birth order effects?

To investigate whether the above birth order effects are coursed through variation across siblings in time received from parents, we explain the latter by way of the following

[8]The family size-specific birth order variables we use is congruent to regressing according to family sizes, with the *first-borns of each family size* as the reference birth order category.

OLS and family FE regressions:

$$Time_{ij} = \beta_0 + \beta_1 BOFS_{ij} + \beta_2 T2_{ij} + \beta_3 X_{ij} + \beta_4 Z_j + v_{ij} \quad (2)$$

where the right-hand side variables follow those defined above.[9] $Time_{ij}$ stands for the different measures of time received by child i born in family j: *Total*, *Quality*, and *Quality Engaged* (see Section 3.2). We look separately at time inputs from the mothers and from the fathers, and distinguish between *Current time* (at ages between 5 and 18 years) and *Lagged time* (the same child 5 years before, at ages 0 to 12 years old).

Starting with the results with respect to the mothers (Table 4), OLS results show a general negative and significant relationship between the birth order variables and maternal time, with more pronounced effects of birth order position observed for the period when the children were 12 years old and younger, which we called *Lagged time* representing an earlier input with respect to the period when the test score outcome was observed. According to the OLS estimates, second-borns of 2-children receive from mothers: about 3 hours less *Total time*, 3.5 hours less *Quality time*, and 1.5 hours less *Quality Engaged time* per week than their older sisters or brothers at the same age. In 3-children families, there are no differences in time received between first- and second-born children. There is however a 'last born disadvantage,' wherein the third-born from a 3-children family suffers a high loss of about 6 hours *Total time*, 4.5 hours *Quality time*, and 1.8 hours *Quality Engaged time* per week with respect to first-borns at the same age and with the same observable characteristics.

Turning to fathers (Table 5), OLS results are similar to those obtained for mothers, showing negative and significant birth order effects in time when the children were 12 years old or younger (*Lagged time*). Interestingly, fathers appear to differentiate more than mothers do in terms of the time they allocate to their offspring. In 2-children families, the second-borns receive: about 3.5 hours less *Total time*, 3.3 hours less *Quality time*, and 2 hours less *Quality Engaged time* per week. In 3-children families second-borns receive about 2.5 hours *Total time*, 2 hours *Quality time*, and 1.5 hours *Quality Engaged time* less than first-borns do, while the time loss suffered by the third-borns is about 5 hours *Total time*, 4 hours *Quality time*, and 3 hours *Quality Engaged time*.

Comparing the magnitudes of the losses by the last-born children (2nd-born of 2-children families and 3rd-born of 3-children families), we see a bigger loss in maternal total and quality time, but a bigger loss in paternal quality engaged time.

These birth order effects are generally consistent with the evidence in Price (2008) - children with higher birth order positions receive less maternal time at each age, and signal the presence of inequality in the intrahousehold allocation of resources.

However, it can be observed that in the FE columns of Tables 4 and 5, most birth order coefficients lose their significance. Here, we control for family unobserved heterogeneity, which amounts to looking at what happens within the family. This suggests that OLS effects are confounded by family unobserved characteristics that are positively correlated

[9]Note that the 'timing' of the variables follow the pattern in the model described above. Lagged time input is regressed on lagged characteristics.

with family size across the sample, and exert a negative effect on the time that parents devote to their children. Within the family, on the contrary, we observe very little variation of parental time allocation to children of different birth order positions at the same age. Interestingly, while the birth order coefficients for mother's time are hardly different from zero with using a FE estimation, some significant birth order effects are detected for father's *Quality* and *Quality Engaged time* when the children are between ages 5 to 18. Second-borns of 2-sibling families receive from their fathers about 1.2 hours less *Quality Engaged time* per week with respect to their first-born counterparts at the same age. In 3-children families, the loss with respect to first-borns is 2.4 hours *Quality time* for the second, and 4.6 hours for the third-born. More research is needed to corroborate this finding, pointing to a different time resource allocation behaviour of mothers and fathers when children are not in their early childhood period. However, the general evidence we find does not support the view that time allocation of parents is the channel through which birth order effects on children outcomes are established.

5 Conclusions

Children of higher birth order positions are found to have poorer outcomes. Literature suggests that these inequalities could be due to differences in resources received by children of different birth order positions. This paper focuses on the role of a particular resource received from parents - time. It investigates whether birth order effects in child outcomes are due to differences in time received, considering total time and two alternative definitions of quality time.

Using a sample of data of children aged 5 to 18 from the Child Development Supplement of the Panel Study of Income Dynamics, we find the usual negative relationship between birth order and the available verbal ability test scores, conditional to family size. Mathematical skills, on the contrary, appear not to differ significantly across children of different birth order positions. A negative relationship is also found between birth order and both maternal and paternal time, which is partly consistent with Price (2008). We show that this negative relationship is mostly driven by between families variation in OLS estimation, since we detect that birth order effects in parental time are generally diminished when we resort to family fixed effects. Interestingly, when we control for family unobserved heterogeneity, we find some birth order patterns only in quality time devoted by fathers when their children are between 5 to 18 years old.

Overall, our results suggest that parental time is not the pushing factor behind birth order effects: to the extent that birth order effects are the outcome of the mechanism of intrahousehold allocation of resources, they must be explained by other resources differently allocated to each offspring.

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Table 1

Hourly Averages of Maternal and Paternal Time

	Lagged Time (Age 0 to 12)			Current Time (Age 5 to 18)		
	Weekday	Weekend	Week	Weekday	Weekend	Week
Total maternal time	5.478	8.653	44.697	4.090	7.123	34.695
	(3.249)	(3.460)	(19.041)	(2.780)	(4.188)	(18.274)
Maternal quality time	2.968	4.506	23.854	1.516	2.930	13.438
	(2.325)	(2.725)	(14.805)	(1.367)	(2.536)	(9.626)
Maternal quality engaged time	1.446	2.321	11.872	0.646	1.423	6.074
	(1.433)	(1.984)	(9.367)	(0.714)	(1.610)	(5.428)
Total paternal time	2.747	6.714	27.162	2.768	5.987	25.814
	(2.412)	(4.102)	(15.611)	(2.623)	(4.293)	(17.954)
Paternal quality time	1.497	3.480	14.443	1.048	2.467	10.173
	(1.532)	(2.743)	(10.286)	(1.240)	(2.427)	(8.794)
Paternal quality engaged time	0.800	1.736	7.471	0.456	1.191	4.665
	(1.001)	(1.785)	(6.797)	(0.722)	(1.550)	(5.243)

Table 2
Descriptive Statistics

Variables	Mean	Std. Dev
Child's age in years	11.703	3.211
Child's gender (1=Male)	0.471	0.499
Child's race (1=Black)	0.129	0.335
Child's birth weight in pounds	7.119	1.308
Mother's age at childbirth	28.335	5.104
Mother's education in years	13.432	2.717
Mother was employed when child was 0-12 years old	0.604	0.489
Mother is employed when child is 5-18 years old	0.689	0.463
Father's education in years	13.500	2.766
Father was employed when child was 0-12 years old	0.967	0.178
Father is employed when child is 5-18 years old	0.934	0.248
Family income when child was 0-12 years old	66656.13	52314.6
Family income when child is 5-18 years old	95926.96	106682
First-born of 2-children family=1	0.227	0.419
Second-born of 2-children family=1	0.227	0.419
First-born of 3-children family=1	0.124	0.329
Second-born of 3-children family=1	0.173	0.378
Third-born of 3-children family=1	0.107	0.310
First-born of 4- to-5 children family=1	0.033	0.178
Second-born of 4- to-5 children family=1	0.037	0.188
Third-born of 4- to-5 children family=1	0.037	0.188
Fourth- and Fifth-born of 4- to-5 children family=1)	0.035	0.185
Birth order position dummy variable (1st-born=1)	0.384	0.487
Birth order position dummy variable (2nd-born=1)	0.437	0.496
Birth order position dummy variable (3rd-born=1)	0.144	0.351
Birth order position dummy variable (4th- and 5th-born=1)	0.035	0.185
Family size	2.687	0.706
Family size dummy variable (2 children=1)	0.455	0.498
Family size dummy variable (3 children=1)	0.404	0.491
Family size dummy variable (4 and 5 children=1)	0.141	0.349
Year 2007	0.283	0.451
Letter Word Standardized Score	108.283	16.890
Passage Comprehension Standardized Score	106.509	15.095
Applied Problem Standardized Score	108.501	15.827
Number of families	396	
Number of children	792	

Table 3

Birth Order Differences in Standardized Test Scores

	Letter Word		Passage Comprehension		Applied Problem	
	OLS	FE	OLS	FE	OLS	FE
Age	-0.801***	-0.297	-1.099***	0.188	-0.806***	-0.454
	(0.235)	(1.309)	(0.203)	(1.275)	(0.187)	(1.234)
Male	-3.515**	-1.026	-2.545**	-1.609	2.653**	2.916**
	(1.095)	(1.171)	(0.908)	(1.094)	(0.911)	(1.083)
Birth weight, pounds	0.087	0.285	-0.121	0.408	0.392	0.758
	(0.498)	(0.622)	(0.375)	(0.709)	(0.373)	(0.775)
2nd-born of 2-children	-4.428***	-3.659*	-2.349*	-2.603	-0.792	-0.780
	(1.301)	(1.767)	(1.186)	(1.645)	(1.255)	(1.890)
2nd-born of 3-children	-2.789	-0.501	-2.608	-4.331*	-2.254†	-2.285
	(1.900)	(2.183)	(1.602)	(1.964)	(1.332)	(2.192)
3rd-born of 3-children	-6.406**	-3.746	-6.682***	-6.268†	-2.649	-2.846
	(2.203)	(3.342)	(1.963)	(3.260)	(2.066)	(3.964)
2nd-born of 4-5 children	-1.662	-3.620	-2.944	-2.084	0.322	0.856
	(2.222)	(3.276)	(2.399)	(2.902)	(2.608)	(3.813)
3rd-born of 4-5 children	-1.178	-2.542	1.760	-0.251	0.958	3.706
	(2.515)	(4.868)	(3.210)	(4.111)	(2.564)	(5.660)
4th-5th born of 4-5 children	-7.338†	-2.986	-2.819	-1.308	-0.385	4.814
	(3.961)	(6.449)	(3.593)	(5.693)	(2.487)	(6.618)
Observations	792	792	792	792	792	792
R-squared	0.175	0.029	0.223	0.053	0.315	0.069
Number of families		396		396		396

Robust standard errors in parentheses. † $p<0.10$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$
Controls include: mothers's age at childbirth, mothers's marital status at childbirth (never married=1), mother's education (dummy variables indicating high school graduate, college, college graduate), father's education, dummy variable for black race, log of family income (lagged and current), dummy variable to indicate year 2007 as period of observation.

Table 4

Birth Order Differences in Maternal Time

Panel A	Total		Quality		Quality Engaged	
Current Time (Age 5-18)	OLS	FE	OLS	FE	OLS	FE
2nd-born of 2-children	-2.238	-0.193	-1.549†	-0.796	-0.379	-0.660
	(1.578)	(1.699)	(0.900)	(1.009)	(0.505)	(0.584)
2nd-born of 3-children	-3.182†	-1.641	-1.649†	-2.369*	-1.143*	-0.519
	(1.863)	(2.101)	(0.940)	(1.172)	(0.490)	(0.512)
3rd-born of 3-children	-4.729†	-0.325	-3.337*	-3.001	-1.428*	-0.914
	(2.650)	(3.481)	(1.415)	(1.929)	(0.698)	(0.943)
2nd-born of 4-5 children	-3.084	-1.015	-0.642	-1.252	0.231	-0.673
	(3.623)	(3.344)	(2.070)	(1.468)	(1.060)	(0.766)
3rd-born of 4-5 children	-4.223	-6.055	1.171	-1.536	-0.086	-2.105*
	(3.137)	(5.249)	(1.675)	(2.362)	(1.053)	(1.050)
4th-5th born of 4-5 children	-13.001***	-9.401	-4.002*	-4.214	-1.305	-3.122*
	(3.614)	(6.684)	(1.742)	(3.069)	(1.212)	(1.442)
Observations	792	792	792	792	792	792
R-squared	0.117	0.046	0.136	0.048	0.101	0.067
Number of families		396		396		396
Panel B	Total		Quality		Quality Engaged	
Lagged Time (Age 0-12)	OLS	FE	OLS	FE	OLS	FE
2nd-born of 2-children	-2.898†	0.013	-3.510***	-0.477	-1.511*	0.010
	(1.511)	(1.740)	(1.032)	(1.374)	(0.683)	(0.994)
2nd-born of 3-children	-2.247	2.349	-1.588	1.113	-0.772	-0.152
	(1.566)	(2.133)	(1.120)	(1.599)	(0.738)	(1.051)
3rd-born of 3-children	-6.254*	2.721	-4.535**	0.786	-1.863†	-0.321
	(2.448)	(3.316)	(1.620)	(2.538)	(1.055)	(1.857)
2nd-born of 4-5 children	-0.379	2.726	2.808	3.285	1.453	2.793
	(3.080)	(2.776)	(2.541)	(2.015)	(1.790)	(1.803)
3rd-born of 4-5 children	-2.514	2.871	2.554	5.282	1.046	4.369
	(3.286)	(4.939)	(2.307)	(3.582)	(1.760)	(2.902)
4th-5th born of 4-5 children	-2.647	13.653*	-1.977	5.200	1.192	6.413
	(4.079)	(6.573)	(2.443)	(5.157)	(1.795)	(4.174)
Observations	792	792	792	792	792	792
R-squared	0.242	0.147	0.401	0.231	0.331	0.228
Number of families		396		396		396

Robust standard errors in parentheses. † $p<0.10$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Controls include: Child's age, gender, birth weight in pounds, mothers's age at childbirth, mothers's marital status at childbirth (never married=1), mother's education (dummy variables indicating high school graduate, college, college graduate), dummy variable for black race, log of family income, dummy variable to indicate year 2007 as period of observation.

Table 5
Birth Order Differences in Paternal Time

Panel A	Total		Quality		Quality Engaged	
Current Time (Age 5-18)	OLS	FE	OLS	FE	OLS	FE
2nd-born of 2-children	-0.658	-2.059	-1.038	-1.657	-0.321	-1.219*
	(1.448)	(1.598)	(0.816)	(1.041)	(0.449)	(0.601)
2nd-born of 3-children	1.483	-0.355	-0.503	-2.442*	0.012	-0.511
	(1.903)	(1.872)	(0.924)	(1.212)	(0.566)	(0.569)
3rd-born of 3-children	-2.257	-4.302	-2.458†	-4.614*	-0.517	-1.676†
	(2.735)	(2.891)	(1.284)	(1.911)	(0.772)	(0.884)
2nd-born of 4-5 children	-1.704	-1.441	-0.477	-1.390	0.908	-1.277†
	(3.011)	(3.107)	(1.395)	(1.430)	(1.007)	(0.731)
3rd-born of 4-5 children	-2.849	-3.501	0.400	-2.517	1.272	-2.330†
	(3.543)	(4.424)	(1.425)	(2.086)	(1.185)	(1.262)
4th-5th born of 4-5 children	-5.643	-2.642	-3.148†	-4.977†	0.027	-3.422*
	(3.973)	(5.054)	(1.698)	(2.638)	(1.215)	(1.563)
Observations	792	792	792	792	792	792
R-squared	0.056	0.049	0.082	0.049	0.061	0.058
Number of families		396		396		396
Panel B	Total		Quality		Quality Engaged	
Lagged Time (Age 0-12)	OLS	FE	OLS	FE	OLS	FE
2nd-born of 2-children	-3.536**	-0.859	-3.349***	-1.093	-2.097***	-0.771
	(1.349)	(1.280)	(0.895)	(0.907)	(0.631)	(0.598)
2nd-born of 3-children	-2.468†	0.190	-2.043*	-0.459	-1.417*	-0.239
	(1.468)	(1.395)	(0.919)	(0.971)	(0.562)	(0.617)
3rd-born of 3-children	-4.899*	-0.401	-3.737**	-0.667	-3.378***	-0.903
	(2.163)	(2.103)	(1.326)	(1.536)	(0.801)	(1.021)
2nd-born of 4-5 children	0.049	-0.374	0.488	0.051	-0.625	-0.526
	(2.840)	(1.882)	(1.669)	(1.256)	(1.367)	(0.846)
3rd-born of 4-5 children	-1.999	1.912	-0.470	2.284	-1.925	-0.217
	(2.635)	(2.817)	(1.794)	(2.189)	(1.405)	(1.527)
4th-5th born of 4-5 children	-4.751	2.759	-2.887	0.129	-1.927	-0.421
	(2.941)	(4.103)	(2.115)	(3.190)	(1.541)	(1.860)
Observations	792	792	792	792	792	792
R-squared	0.070	0.021	0.161	0.052	0.143	0.032
Number of families		396		396		396

Robust standard errors in parentheses. † p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Controls include: Child's age, gender, birth weight in pounds, mothers's age at childbirth, mothers's marital status at childbirth (never married=1), father's education (dummy variables indicating high school graduate, college, college graduate), dummy variable for black race, log of family income, dummy variable to indicate year 2007 as period of observation.

Figure 1
Distribution of Ages by Birth Order Position

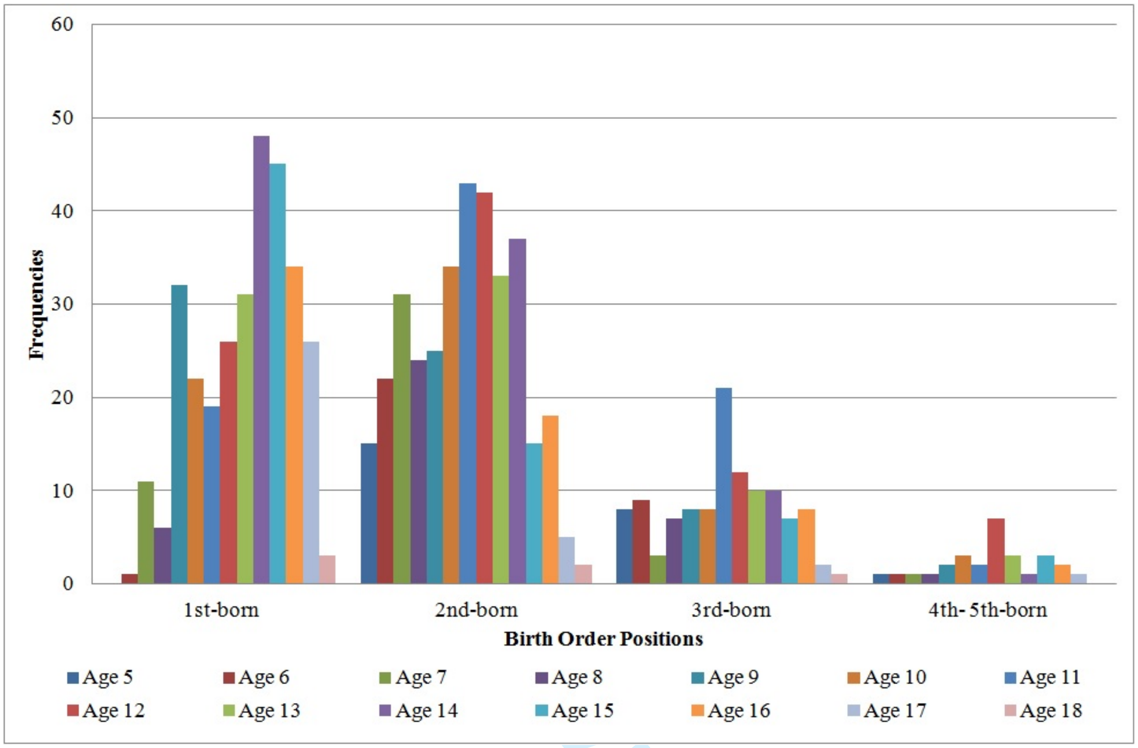

Figure 2
Average Standardized Test Scores by Birth Order Positions