Birth Order Differences in Early Inputs and Outcomes*

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Abstract

We examine within-family differences in key prenatal and early childhood inputs in an effort shed light on the possible early origins of birth order differences in adult labor and education outcomes. Taking advantage of the rich information on *in utero* and early childhood conditions in the Children of the NLSY 1979, we find that, mothers are less likely to seek prompt prenatal care, breastfeed, and provide a high quality home environment for their later-born children. This negative relationship between birth order and early inputs is reflected in children's early motor and social development scores, with children of higher birth order scoring up to 0.3 standard deviations lower than their older siblings. We find that birth order differences in early inputs and outcomes are most prominent in white families and among children of mothers with low AFQT scores.

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1 Introduction

A substantial body of recent research shows that pre- and post-natal conditions are key determinants of adult outcomes (Heckman, Stixrud and Urzua 2006). In particular, the fetal origins literature presents evidence that in utero nutrition, stress, and exposure to toxins have a lasting impact on adult health and labor market outcomes (Almond and Currie 2011). Moreover, both theoretical and empirical studies on the formation of skills over the life cycle demonstrates that inputs during early childhood are critical for facilitating the productivity of later investments (Cunha, Heckman, Lochner and Masterov 2006).

In this paper, we explore within-family differences in crucial prenatal and early childhood inputs as a potential explanation for the "birth order effect" – significant differences in adult outcomes by birth order across siblings or individuals from observably similar households. Although several studies have found a negative relation between birth order and educational attainment and adult earnings (Kantarevic and Mechoulan 2006) and IQ (Black, Devereux and Salvanes 2007), research examining the possible causes of the birth order effect has been less successful. For example, Monfardini and See (2011) investigate the role of parental time investment and find that although parents do spend less quality time with children of higher birth order at any given age, birth order differences in cognitive assessments are not explained by measures of maternal quality time. Similarly, the negative relationship between IQ and birth order found in Black et al. (2007) is robust to controlling for several birth endowments such as birthweight, gestational period, and head size.

We take advantage of the rich information on early childhood inputs and outcomes available in the National Longitudinal Survey of Youth 1979 (NLSY79) and the Children of the NLSY79 (CNLSY79) to test whether there are birth order differences in a wide range of prenatal and early postnatal inputs, including alcohol use and smoking during pregnancy, prenatal medical care, breastfeeding patterns, and the quality of the home environment. We then analyze whether birth order differences in the children's motor and social development (MSD) during their first three years depend on variations in these early inputs. Our results show that mothers are less likely to seek prompt prenatal care, breastfeed, and provide a high quality home environment for their later-born children. This negative relationship between the quality of early inputs and birth order is mirrored in children's early MSD scores, with children of higher birth order scoring up to 0.3 standard deviations lower than their older siblings. However, while early home environment is significantly associated with MSD scores at ages 0 to 1, both the statistical significance and the magnitude of the birth order differences in motor and social development remain robust to accounting for early inputs. Furthermore, we find that these birth order differences in early inputs and outcomes are most prominent in white families and among children of mothers with low Armed Forces Qualifying Test (AFQT) scores.

Our paper makes a number of key contributions to the birth order literature. First, despite growing evidence of the importance of early childhood investments on later outcomes, no other study thus far has assessed whether early inputs other than parental time can help explain the lower achievement of later-born children. Second, our findings shed light on an unexplored aspect of the birth order effect by assessing how the magnitudes and patterns of the birth order effect differ by the mother's cognitive ability and race.

2 Data and Empirical Strategy

Our analysis relies on the children of the female respondents of the NLSY79, a nationally representative sample of 12,686 individuals who were between 14 and 21 years old when they were first interviewed in 1979. Periodic surveys have been conducted since then, collecting rich socio-economic data and information on health and non-cognitive/cognitive inputs and outcomes of every child of the women of the NLSY79. We examine birth order differences in various measures of early maternal behavior and child outcomes: alcohol consumption and smoking during pregnancy, patterns of prenatal medical visits, birth outcomes including gestational length, birth weight and height, breastfeeding, quality of the home environment, and motor and social development during the child's first three years of life.

The Home Observation Measurement of the Environment (HOME) measures the quality of the child's cognitive stimulation and emotional support as represented by parental interactions and access to learning resources and activities. We focus on the total HOME score as well as on the two cognitive and emotional sub-scores separately. The MSD score is based on the mother's answer to fifteen or sixteen age-appropriate questions about her child's social, motor, and cognitive development and has been shown to be strongly associated with later cognitive test scores (Mott, Baker, Ball, Keck and Lenhart 1998).

We exploit the linked mother-child data structure of the CNLSY79 to measure the effect of birth order on early inputs and outcomes as follows:

$$Y_{if} = \alpha + \beta \text{Birth Order}_{if} + \gamma X_i + \upsilon_f + \varepsilon_{if}$$

where i denotes child, f family, and Y_{if} the variable of interest. We additionally control for child-specific characteristics X_i that can affect mother's choices and children's outcomes: gender, age of the mother at birth, and birth cohort and region indicators.[1] υ_f are family (mother) fixed effects. For the most concise presentation of our results, we estimate a linear birth order effect in lieu of a model that separately identifies the effect on each later-born children relative to the first-born. Alternative models including birth order dummies reveal a monotonically decreasing relation between birth order and the quality of early inputs and outcomes. Therefore, β can be interpreted as the average difference in the variable of interest of a child with that of his/her older sibling born just before him/her. Because siblings observations are likely to be correlated, standard errors are clustered at the family level.

To report results for a consistent and comparable sample across our variables of interest,

[1]Because time-varying family level-variables are at risk of being outcome variables, our preferred specification does not include them as controls. Nevertheless, our results are robust to controlling for income, welfare recipiency, and mother's labor force participation, both contemporaneous and lagged, or to including father's presence at birth, age differences between siblings, or the gender of the first-born child in the family.

Table 1: Early Inputs

	Month of first prenatal care (1)	Ever breastfed (2)	Weeks breastfed (3)	HOME (Total) (4)	HOME (Cognitive) (5)	HOME (Emotional) (6)
Birth order	0.367***	-0.058**	2.210	-3.649**	-3.124***	-0.134
	(0.098)	(0.029)	(2.394)	(1.652)	(1.142)	(0.984)
Birth order × AFQT	-0.104**	-0.014	-1.306	-0.841	-0.481	-0.456
	(0.050)	(0.016)	(1.050)	(1.002)	(0.663)	(0.625)
Birth order × Black	-0.064	0.044	-2.928	2.338	1.368	0.337
	(0.103)	(0.032)	(2.442)	(2.003)	(1.510)	(1.388)
Birth order × Hisp.	-0.163	-0.022	-1.921	0.477	1.422	-1.180
	(0.104)	(0.037)	(2.766)	(2.194)	(1.300)	(1.606)
N	3,332	3,332	1,643	3,332	3,332	3,332
F-stat	1.311	1.712	2.550	3.342	6.086	2.251

Notes: All regressions are weighted to correct for overrepresentation of minorities and include family fixed effects. Robust standard errors clustered at the family level are in parentheses. All specifications control for regional dummies, maternal age and age squared, and the child's gender and birth cohort dummies. Month of first prenatal visit is defined for women who sought prenatal care within the first trimester of pregnancy. AFQT is age-standardized to have a mean of 0 and standard deviation of 1. Weeks breastfed is defined for only those children who were ever breastfed. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

we restrict our sample to children for whom we have complete information on the early inputs of interest and excludes families with twin births.[2] However, our results are robust to the exclusion of these sample restrictions.

3 Results

Table 1 presents the results on a selected subset of prenatal and early childhood investments. We find weak to mixed evidence of birth order differences in prenatal investments. We observe no differences in alcohol consumption during pregnancy by birth order and only weak evidence of a lower reduction of smoking for higher-order children among prior smokers.[3] However, conditional on having sought prenatal care within the first trimester, mothers sig-

[2]Twin births have been used as the source of exogenous variation in family size in studies examining the impact of family size on children's outcomes. We exclude families with twins, because we do not want to confound the birth order effect with that of an unexpected increase in family size.

[3]We find an 11 percentage point decrease in the probability of reducing smoking, but no evidence of a reduction in the number of cigarettes smoked per day in later pregnancies (results not shown).

nificantly delay their first visit to the doctor for their later pregnancies. White mothers with an average AFQT delay their first prenatal visit by about 1.5 weeks with each subsequent pregnancy.[4] The delay is smaller for those women with higher AFQT scores and among racial minorities, with the birth order effect becoming statistically insignificant for children of high AFQT minority women.

Despite some evidence that higher birth order children experience lower quality of in utero care, we find that differences in these conditions are not reflected in their birth outcomes – specifically, their birth weight, height, and gestational length (results not shown). We find that children of higher birth order are actually less likely to be premature and to suffer from low weight at birth. However, this finding is consistent with the biology literature showing a positive relationship between birth order and weight (Wilcox, Chang and Johnson 1996).

We find the most consistent birth order differences in postnatal investments. First, a growing body of the literature has established the beneficial effects of breastfeeding when compared to formula feeding (Belfield and Kelly 2010, Borra, Iacovou and Sevilla 2012).[5] A child of a white mother is about 6 percentage points less likely to be breastfed than his/her older sibling. The mother's cognitive ability has a negligible impact on this gap. However, interestingly, we do not find birth order differences in breastfeeding patterns among black families. Conditional on the mother's choice to breastfeed, there are no statistically significant differences in the number of weeks children of varying birth order are breastfed or both white and non-white children.

Finally, the quality of the home environment – especially the cognitive environment – is severely affected by the child's birth order. HOME scores have been shown to be significant predictors of later cognitive achievement and health (Todd and Wolpin 2007). Children with a white mother experience 0.15 to 0.2 standard deviations worse home environment than

[4]Smith-Conway and Deb (2005) report that for normal pregnancies, a one week delay in the first prenatal visit is associated with a decrease of 1 to 1.2 ounces in birth weight, while others, such as Currie and Grogger (2002), only find a weak impact.

[5]For instance, Borra et al. (2012) find that breastfeeding for four weeks is associated with an increase in later cognitive test scores by around one tenth of a standard deviation and positively linked to increases in non-cognitive skills for children of low educated mothers.

Table 2: Motor and Social Development

	Ages 0 and 1		Ages 2 and 3	
	(1)	(2)	(3)	(4)
Birth order	-0.339***	-0.362***	-0.205*	-0.215*
	(0.110)	(0.110)	(0.113)	(0.118)
Birth order × AFQT	0.117**	0.148**	0.029	0.040
	(0.058)	(0.060)	(0.055)	(0.057)
Birth order × Black	0.209	0.254	0.274**	0.291**
	(0.156)	(0.158)	(0.114)	(0.123)
Birth order × Hisp.	0.020	0.028	-0.024	0.013
	(0.132)	(0.134)	(0.140)	(0.151)
N	2,330	2,330	2,330	2,330
F-stat	2.767	2.877	3.405	2.492
Prenatal	N/A	1.17	N/A	0.97
Birth Outcome	N/A	1.69	N/A	1.48
Breastfeeding	N/A	0.55	N/A	0.75
Home	N/A	2.11**	N/A	0.68

Notes: All regressions are weighted to correct for overrepresentation of minorities and include family fixed effects. Robust standard errors clustered at the family level in parentheses. All specifications control for regional dummies, maternal age and age squared, and the child's gender, birth year, and age (in months) at the time of the interview. Motor and social development scores and AFQT have been normalized to a mean of 0 and standard deviation of 1. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

their older sibling born just before him/her. Similar to the breastfeeding patterns, while the mother's AFQT has negligible effect on these differences, race has as significant impact. Younger children in African-American families do not appear to experience a lower quality home environment than their older siblings.

Next, we turn to measures of child development in the time frame of these inputs to assess whether birth order differences are also evident in the earliest measures of cognitive and non-cognitive outcomes and whether prenatal and early postnatal inputs explain any differences in development by birth order. Table 2 presents results for the Motor and Social Development scores at each of the two periods during which the children were assessed.[6] We find a strong birth order effect even at the very start of the child's life, but again, only

[6] We restrict the sample to those children for whom we have scores at both assessments.

in white families. At ages between 0 and 3, white children of higher birth order score 0.2 to 0.3 standard deviations lower in their MSD assessment than their older siblings, while birth order differences are not present among black children. The magnitude of the negative relationship between MSD score and birth order is somewhat mitigated among children of high ability (AFQT) mothers. Furthermore, the size of the birth order effect on MSD does not appear to grow over the first years of life, suggesting that very early investments are key to determining the birth order effect in later outcomes.[7]

To assess whether these differences in MSD scores can be attributed to lower early investments, columns (2) and (4) control for prenatal investments, birth outcomes, breastfeeding patterns, and HOME scores. Although the patterns of birth order differences in early inputs across race and AFQT are mirrored in MSD scores, controlling for these early childhood investments does not change the significance or the general magnitude of the birth order coefficients.[8]

4 Discussion

In light of the importance of early childhood inputs on future outcomes, we test for birth order differences in various prenatal conditions and in early childhood investments and outcomes. We find significant birth order differences in some early inputs, namely in the promptness of prenatal care, breastfeeding rates, and the quality of the cognitive home environment, with latter-born children experiencing worse inputs than their older siblings. Children's development is significantly correlated with birth order as early as the first year of life. The negative relationship between birth order and early inputs and outcomes is predominantly present in white families and in children of low ability mothers.

Despite the similarity in the pattern of early inputs and MSD scores, birth order differences in motor and social development are robust to controlling for variations in pre- and

[7]Lehmann, Nuevo-Chiquero and Vidal-Fernandez (2012) report a similar pattern for cognitive and non-cognitive outcomes during childhood and adolescence.

[8]Nevertheless, HOME scores are significantly correlated with MSD scores at least at ages 0 to 1.

postnatal investments. Nevertheless, since consistent patterns of birth order effects appear even within the first year of life, our findings lend support to the early origins of the birth order differences in adult outcomes. We suspect our conservative estimation strategy that relies on family-fixed effects takes away most of the variation in early investments across children and reduces the statistical power of these variables.

Our finding that there are little or no birth order differences in early inputs and outcomes in African-American families is robust to more flexible specifications and to race subsample analysis. The ability of our estimates to capture the birth order effect, as measured by within-family variation in inputs and outcomes, is not significantly different between white and black families, implying that the absence of birth order effects among African-American families cannot simply be attributed to a lack of variation. Furthermore, because race is correlated with other socio-economic characteristics, we explore whether the lack of birth order effects among blacks is the result of limited financial resources. First, we check that the level of within-family variation in our income-related controls are comparable across race. Second, we estimate various alternative specifications in which we interact birth order with race and welfare status, grandparents' education/income, or mother's AFQT and find that our results are robust to their inclusion. Moreover, we find that the nature of the interaction between birth order and race and AFQT remains strong and robust in later outcomes such as educational attainment or high school graduation rates.

Although our data do not allow us to do a direct test, we believe the lack of a birth order effect for blacks may reflect racial differences in preferences for redistribution as found in Alesina and La Ferrara (2005). Further work is required to more carefully characterize the relationship among birth order, race, and inequality aversion.

References

Alesina, Alberto and Eliana La Ferrara (2005) “Preferences for Redistribution in the Land of Opportunities,” *Journal of Public Economics*, Vol. 89, No. 5, pp. 897–931.

Almond, Douglas and Janet Currie (2011) “Killing me Softly: The Fetal Origins Hypothesis,” *The Journal of Economic Perspectives*, Vol. 25, No. 3, pp. 153–172.

Belfield, Clive R. and Inas Rashasd Kelly (2010) “The Benefits of Breastfeeding Across the Early Years of Childhood,” NBER Working Papers 16496, National Bureau of Economic Research.

Black, Sandra E., Paul J. Devereux, and Kjell G. Salvanes (2007) “Older and Wiser? Birth Order and IQ of Young Men,” *NBER Working Paper #13237*.

Borra, Cristina, Maria Iacovou, and Almudena Sevilla (2012) “The Effect of Breastfeeding on Children’s Cognitive and Noncognitive Development,” *Labour Economics*, Vol. 19, No. 4, pp. 496 – 515.

Cunha, Flavio, James J. Heckman, Lance J. Lochner, and Dimitriy V. Masterov (2006) “Interpreting the evidence on life cycle skill formation,” in E. Hanushek and F. Welch eds. *Handbook of the Economics of Education*, Amsterdam: North Holland, Chap. 12, pp. 697–812.

Currie, Janet and Jeffrey Grogger (2002) “Medicaid Expansions and Welfare Contractions: Offsetting Effects on Prenatal Care and Infant Health?” *Journal of Health Economics*, Vol. 21, No. 2, pp. 313–335.

Heckman, James J., Jora Stixrud, and Sergio Urzua (2006) “The Effects of Cognitive and Noncognitive Abilities on Labor Market Outcomes and Social Behavior,” *Journal of Labor Economics*, Vol. 24, No. 3, pp. 411–482.

Kantarevic, Jasmin and Stéphane Mechoulan (2006) "Birth Order, Educational Attainment, and Earnings," *Journal of Human Resources*, Vol. 41, No. 4, pp. 755–777.

Lehmann, Jee-Yeon K., Ana Nuevo-Chiquero, and Marian Vidal-Fernandez (2012) "Explaining the Birth Order Effect: The Role of Prenatal and Early Childhood Investments," *IZA Discussion Paper No. 6755.*

Monfardini, Chiara and Sarah Grace See (2011) "Birth Order and Child Outcomes: Does Maternal Quality Time Matter?" *Unpublished Manuscript.*

Mott, Frank, Paula C. Baker, David E. Ball, Canada K. Keck, and Steven M. Lenhart (1998) *The NLSY Children, 1992: Description and Evaluation*: Center for Human Resource Research, Ohio State University.

Smith-Conway, Karen and Partha Deb (2005) "Is Prenatal Care Really Ineffective? Or, Is the 'Devil' the Distribution?" *Journal of Health Economics*, Vol. 24, No. 3, pp. 489–513.

Todd, Petra E. and Kenneth I. Wolpin (2007) "The Production of Cognitive Achievement in Children: Home, School, and Racial Test Score Gaps," *Journal of Human capital*, Vol. 1, No. 1, pp. 91–136.

Wilcox, Mark A., Allan M.Z. Chang, and Ian R. Johnson (1996) "The Effects of Parity on Birthweight Using Successive Pregnancies," *Acta Obstetricia et Gynecologica Scandinavica*, Vol. 75, No. 5, pp. 459–463.