Birth Order and Delinquency: Evidence from Denmark and Florida[*]

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Abstract

Birth order has been found to have a surprisingly large influence on educational attainment, yet much less is known about the role of birth order on delinquency outcomes such as disciplinary problems in school, juvenile delinquency, and adult crime: outcomes that carry significant negative externalities. This paper uses particularly rich datasets from Denmark and the state of Florida to examine these outcomes and explore potential mechanisms. Despite large differences in environments across the two areas, we find remarkably consistent results: in families with two or more children, second-born boys are on the order of 20 to 40 percent more likely to be disciplined in school and enter the criminal justice system compared to first-born boys even when we compare siblings. The data allow us to examine a range of potential mechanisms, and the evidence rules out differences in health at birth and the quality of schools chosen for children. We do find that parental time investment measured by time out of the labor force is higher for first borns at ages 2-4, suggesting that the arrival of a second born child extends early-childhood parental investments for first borns.

1 Introduction

Economists and policy makers have long been interested in the production function for human capital, with increasing attention paid to the development of non-cognitive skills (Cunha et al. (2010); Conti et al. (2016)). Delinquency is a welfare-relevant manifestation of non-cognitive skill formation. At young ages, disruptive peers have been shown to significantly impair learning (Carrell and Hoekstra (2010); Carrell et al. (2016); Kristoffersen et al. (2014)). At older ages, crime incurs direct harm on others as well as significant investments to deter and punish criminal activity (Nagin (2013)). A better understanding of the causes of crime would inform policies aimed at preventing delinquency in the first place.

The family environment plays a major role in the development of these non-cognitive skills and subsequent delinquency. Widom (1989) discusses a "cycle of violence" where delinquency among parents is passed on to children. The sheer amount of time children spend with their family and the influences each member has on one another imply that the family must have large effects. Estimating effects of parental investments and sibling influences can be confounded by endogeneity concerns, however.

This paper studies the effects of family environment on child delinquency outcomes through the lens of the influence of birth order across siblings. There is a long history of studying birth order in social psychology and economics (see, for example, Adler (1928) and Behrman and Taubman (1986)). The main recent empirical contributions stem from work by Black, Devereux and Salvanes (BDS). Their 2005 study employed large datasets from Norway for outcomes measured from 1986-2000, and they find large birth order effects that appear to dominate effects of family size on child outcomes. Using between and within-family variation in birth order, later-born children achieve a lower level of educational attainment and have worse labor-market outcomes. They also find a higher likelihood of teen births among women. Our work complements theirs by bringing to bear evidence on important outcomes rarely explored in the literature, with data from two very different countries.

In particular, this paper offers three main contributions. First, we provide some of the first estimates of the effects of birth order on delinquency behavior – disciplinary actions and truancy at school, juvenile delinquency, and adult imprisonment – that make use of large-scale data and facilitate sibling contrasts. A second innovation is that we study these relationships in two very different environments: Denmark and the state of Florida. Using the same empirical framework, variation in results (or lack thereof) across these environments provides insights into whether the effects stem from particular institutions or are more general in their nature. Third, using especially rich register data in Denmark and linked administrative data in Florida, we are able to investigate potential mechanisms for such differences. This includes measures of infant and childhood health, parental investments, school quality and sibling composition.

Across both of our locations, and across different estimation techniques, we find that second-born boys are substantially more likely to exhibit delinquency problems compared to their older sibling. In particular, juvenile crime is found to be 20 to 40 percent higher than the mean for first-born boys in both Denmark and Florida. Imprisonment by age 21 is also found to be 34 percent higher in

Denmark. These effects are particularly strong among more severe violent crimes (37 percent). In Florida, similarly large effects are found for suspensions in school (32 percent) but effects on truancy are much more moderate and heterogeneous. We find corroborative evidence when we consider a sample of young adolescents in Denmark where we can measure behavioral problems directly in the form of hyperactivity and measures of conduct problems by age 12.

In terms of mechanisms, we can rule out large classes of explanations. These include worse health at birth (second-born children appear healthier) or in childhood (second-born children have fewer disabilities), schooling decisions including the age of entry and the quality of schools chosen (second-born children attend no worse schools and are more likely to attend pre-kindergarten and daycare) as well as maternal employment (measured by maternity leave) in the first year of life. We do find that maternal employment and the use of daycare is higher for second borns in years 2-4 compared to older siblings. While it is well known that first borns have undivided attention until the arrival of the second born, these results show that the arrival of the second-born child has the potential to extend the early-childhood parental investment of the first-born child.

We also consider test score outcomes in both Denmark and Florida, and find that second-born boys in comparison to their older siblings score lower on reading and math assessments in Denmark but only on reading test in Florida.

2 Background

2.1 Previous evidence on birth order and delinquency

Previous work focusing on delinquency has employed survey data from the National Longitudinal Study of Adolescent Health (Argys et al. (2006); Averett et al. (2011); and Cundiff (2013)). They tend to find modest to no evidence of increased crime, along with substance use and sexual activity. For example, Cundiff (2013) uses Add Health data and finds that self-reported delinquency—a composite measure including marijuana use, non-violent crime, and binge drinking—is not related to birth order in regression models that include family fixed effects. Silles (2010) studies the National Child Development Study—a study of children born in one week in 1958 in the UK and followed afterward—and finds that first born (and last-born) children have improved non-cognitive test scores. Unfortunately, it is difficult to estimate family fixed-effects models with precision in these survey datasets. For example, Cundiff (2013) includes 655 families, and the odds ratio for delinquency is relatively imprecise (0.86 – 1.52 for middle-born compared to first-born). The current paper relies on much larger administrative datasets that provide more precision when using within-family variation in birth order to compare siblings.

2.2 Potential mechanisms

While birth order effects in education and labor market outcomes have been explored, the mechanisms behind the results have not been studied extensively. One potential explanation offered for such effects is different levels of parental investments across children. A standard economic model

that reconciles fertility and parental investment in children is the so-called "quantity-quality trade-off" proposed by Becker (1960), and further developed in Becker and Lewis (1973) and Becker and Tomes (1976). It is based on the premise of negative correlation between the number of children and income of the parents originating from rising marginal cost of quality with respect to quantity. In other words, with each additional child it is more expensive to maintain the same "quality" of children, and thus parents are going to invest less in human capital of higher birth order children Galor and Weil (2000)).[1] More recent literature has found mixed evidence on the "quantity-quality tradeoff" (Black et al. (2005); Angrist et al. (2010); Mogstad and Wiswall (2016)).

Empirically, parental time investments are found to be lower for later-born children, as the first-born has some undivided attention from parents until a younger sibling arrives Price (2008).[2] Averett et al. (2011) find that first-born children are supervised more and have fewer risky behaviors. Lehmann et al. (2014) also use NLSY data and show that birth order effects on parental-investment measures appear to be present at ages 0-2 and grow until ages 5-6 when schooling may mitigate such effects. Interestingly, the paper reports a broad shift in parenting for later-born children: parents are more likely to miss prenatal visits, less likely to abstain from alcohol during pregnancy and breastfeed, and parents provide less early-cognitive stimulation at home. Another direct measure of parental investment is in the form of financial transfers, and de Haan (2010) used the Wisconsin Longitudinal Study to show that such transfers are higher for earlier born children.

A second explanation is the influence that siblings have on one another: the quintessential peer effect. Later children will have older children as role models, unlike a first-born child (Zajonc and Markus (1975)). In addition, older siblings may benefit from teaching younger siblings and acting as such a role model Smith (1993)). These peer effects are difficult to isolate due to the simultaneity of influences, however (Manski (1995); Joensen and Nielsen (2015)). There is also a literature on the influence of sibling composition (brothers vs sisters) on educational attainment. Butcher and Case (1994) found that the presence of brothers increased educational attainment of women historically, although there is mixed empirical evidence for these effects with some studies finding no effects and others finding opposite effects (Hauser and Kuo (1998); Kaestner (1997); Conley (29); Deschenes (2002); Dayioglu et al. (2009); Chen et al. (2009)).

3 Data description

3.1 Denmark

For Denmark, the key data source is the Danish Birth Register, which includes information on individuals born in the period 1960-2010. For each child, the data includes information on exact date

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[1]An alternative model of the family that can explain birth-order differences is offered by Hotz and Pantano (2015) who argue that parental reputation concerns could lead to more intense monitoring and discipline among older children as a signal to later born children, and this could lead to direct effects on first-borns such as superior performance at school and better behavior.

[2]Price (2008)investigated American Time Use Survey and found that first-borns get 20-30 minutes more quality time each day compared to 2nd born in a similar family. This appears to be due to equalizing time after the second-born arrives even thought the first born had undivided attention when there was only one child in the household.

of birth and various birth outcomes. A unique identification number enables us to link generations, hence children can be linked to their parents and siblings. Given this structure of the data and access to the specific date of birth, we can measure each individual's birth order, the completed family size and the sex composition of children in the family.

The unique identifiers also allow us to match the birth records to rich data from various administrative registers. This provides us with demographic characteristics of the parents such as age, educational attainment, labor market status, earnings and immigrant status.

Our primary outcomes reflect risky behavior. To characterize risky behavior in the Danish context we exploit access to the Criminal Registers including criminal charges, convictions, date of crime and type of crime. In Denmark, from the age of 15 an individual is considered fully responsible for any criminal act, and we can observe all criminal charges and convictions from that age onward. Our main measure of risky behavior at the youngest age is an indicator of having any criminal convictions by age 16, and we also consider having any criminal convictions by age 21.[3] As a more severe measure of crime we also consider having ever been imprisoned by those ages. We explore effects at other ages, and across different types of crimes, as well.

To obtain a measure of school performance we study data from the School Registers. In Denmark the typical child enters first grade of compulsory schooling education the year they turn seven.[4] Compulsory school is completed with a ninth grade exit exam.[5] We measure school performance as ninth grade exit exam grades in reading and math. These exam results are based on assessments by the student's teacher and by an external reviewer. All grades are standardized to have zero mean and unit standard deviation within each cohort.

In addition to the delinquency, we explore potential mechanisms that can explain the birth order effects. One goal is to explore outcomes across a range of ages in an effort to determine when differences across siblings begin to occur. First, we consider conditions surrounding the birth of the child to measure the health endowed to the child which is partly due to prenatal investments. Specifically we consider birth weight and whether the mother experienced any complications during the pregnancy.

Second, we consider maternal investments early in a child's life. This includes information about days the mother spent on maternity leave along with information on maternal employment status 0-10 years after childbirth. From the Register of Daycare Institutions we obtain information about the populations' use of daycare facilities. Each year between 1995 and 2008 we have information about its type and place, and we create a measure of enrollment into out-of-home daycare at ages 1-3.

Next, we add a measure of school starting age to see if parents are treating second-born children differently at that stage of the life cycle. Then we use information from the Danish National Patient

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[3]We exclude all traffic offenses to focus on more serious offenses.

[4]A few children may be one year younger and a few may be one year older; we consider school starting age as an outcome below.

[5]In Denmark 9 years of school are compulsory. The Danish educational system is publicly provided from primary school throughout college. No tuition is charged and once the student turns 18 he or she is offered monthly financial aid from the government.

Registry and Danish Psychiatric Central Registry. From these data we have information about psychiatric diagnoses of all children diagnosed at a Danish general hospital. We consider two groups of diagnoses: disorders of psychological development and behavioral and emotional disorders, and we observe whether the child has received such a diagnosis by age 10.[6]

Finally, we are able to explore in detail measures of non-cognitive skills during childhood. Delinquency can be viewed as a behavioral outcome that is the consequence of lower levels of non-cognitive skill development, and there is evidence of birth order effects on non-cognitive skills (Black et al. (2015); Kaufmann and Messner (2015)); however, these studies evaluate non-cognitive skills later in life (at the time of the military draft or by parents), and are not able to measure changes in behaviors that could be related to later life crime such as emotional, hyperactivity and conduct problems. The Danish data, on the other hand, provide us with information gathered in the internationally-recognized Strengths and Difficulties Questionnaire (SDQ)[7], a behavioral screening questionnaire conducted when children are roughly 12 years old. These data were collected as part of the Danish two-teachers experiment.[8]

The SDQ contains 25 items within five dimensions. Four of the dimensions concerns difficulties covering conduct problems, emotional symptoms, hyperactivity and peer relationships. One dimension concerns strengths and covers prosocial behavior.[9] In line with past literature, we can use the four difficulty dimensions to generate the Total Difficulty Score reflecting the child's socio-emotional behavior. We follow the SDQ scoring rubric (Goodman et al. (2010)) and divide these scores into four categories: close to average, slightly raised, high and very high. We then estimate a separate regression for each component and for each category. Similarly we split the scores on the fifth dimension, prosocial behavior. These measures will allow us to investigate whether there are differences in psychological attributes or non-cognitive skills by birth order.

3.2 Florida

The Florida Departments of Education and Health merged together birth records for all children born in Florida between 1992 and 2002 with school records for the academic years 1995-96 through 2012-13 for the purposes of this research program. The Florida agencies matched children along three dimensions: first and last names, date of birth, and social security number. Rather than conducting probabilistic matching, the match was performed such that a child would be considered

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[6]Psychological development disorders cover diagnoses classified within the ICD10 codes F80-F89. Behavioral and emotional disorders cover diagnoses classified within the ICD10 codes F90-F98; one of the most frequent diagnoses within this category is ADHD.

[7]The Strengths and Difficulties Questionnaire was first developed by Goodman (1997) and later used in numerous studies (eg. Currie and Lin (2007); Kelly et al. (2009); Datta Gupta and Simonsen (2010); Berger and Spiess (2011); Kristoffersen et al. (2014)).

[8]The experiment was conducted in the 2012-13 school year and took place at the intermediate stage of primary school (6th grade). The sample consists of around 10,000 pupils from 231 public schools across 14 municipalities. If a school is part of the sample all its 6th graders were included. For more information about this data see "2L Rapport - Undersøgelse af effekten af tolærerordninger" by Andersen et al. (2014). The survey we are using was conducted before the two-teacher experiment began. Approximately 10,000 sixth grade pupils answered the questions in September 2012. Here they were around 12 years old.

[9]For a detailed list of questions see http://www.sdqinfo.com/.

matched so long as (1) there were no more than two instances of modest inconsistencies, and (2) there were no other children who could plausibly be matched using the same criteria. Common variables excluded from the match were used as checks of match quality. These checks confirmed a very high and clean match rate: In the overall match on the entire population, the sex recorded on birth records disagreed with the sex recorded in school records in about one-one thousandth of one percent of cases, suggesting that these differences are almost surely due to typos in the birth or school records.

Between 1992 and 2002, 2,047,663 births were recorded by the Florida Bureau of Vital Statistics; however, in the current project we can utilize only the 1994 to 2002 births as we are unable to match siblings for the 1992 and 1993 birth cohorts. There were 1,609,470 singleton births in Florida between 1994 and 2002, and of these 1,290,077 children were subsequently observed in Florida public school data, representing an 80.2 percent match rate. The match rate is almost identical to the percentage of children who are born in Florida, reside there until schooling age, and attend public school, as computed from data from the decennial Census and American Community Survey for years 2000 through 2009.[10] In the school districts representing the vast majority of Florida households, children are matched to households, and we link these anonymized school records back to the relevant students' birth records (via the birth-school link conducted by the Florida Departments of Education and Health) to determine birth order; this backward-matching also allows us to check the likelihood that the people we believe to be siblings are actually siblings (e.g., by comparing maternal characteristics such as date of birth).

Florida birth certificates enumerate demographic characteristics of the mother (including education, marital status and place of residence), demographic characteristics of the father if he appears on birth certificate, and health and demographic characteristics of the newborn.[11] In particular, we observe birth weight and indicators for any maternal health problems, whether or not they are related to the pregnancy.

Our primary delinquency outcomes are in-school suspensions and truancy. We obtain these measures from administrative school records that are available for the school years from 2002-03 through 2011-12. We measure suspensions as an indicator variable whether the child was ever suspended in a given school year, while we measure truancy based on the reported absence rate, defined as number of days present in school to total number of days that the child was enrolled in a given school year. Both variables are multiplied by 100 to obtain percent values.[12] This results in repeated observations for each student, which will allow us to trace effects across different grades, as described in more detail below.

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[10]Figlio et al. (2013) provide extensive validity checks on the matching procedure.

[11]In a very small number of cases (fewer than 100 sibling pairs) where the race or ethnicity of the mother on sibling's birth certificates do not match, we assign the race and ethnicity associated with the birth certificate of the firstborn child.

[12]The Florida records also include information on disciplinary referrals that do not result in suspensions, but the statewide referral data only include the most serious disciplinary infractions and therefore include just a subset of all disciplinary incidents; 93 percent of the disciplinary incidents reported in the state records result in suspension. Because we are not entirely certain about the rules governing which non-suspension referrals are included in the data, we concentrate exclusively on disciplinary referrals that result in suspension.

In addition, the Florida Education Data Warehouse provides us with a wide array of additional outcomes that we use to investigate the mechanisms beyond the identified birth order effects. Our measures of academic performance are based on Florida Comprehensive Assessment Test (FCAT) in mathematics and reading, a state-wide standardized yearly assessment of all students in Florida conducted in grades three through ten. In this paper we focus on test scores in grades three through eight, because curriculum differences make interpersonal test score comparisons relatively difficult in high school (e.g., one tenth grader is taking algebra while the other is enrolled in calculus). Therefore, each child in the sample can contribute up to six observations, one for each grade observation.

Unlike in Denmark, we cannot match children to their medical records in Florida. However, the Florida school records also provide an opportunity to observe poor health outcomes in childhood and adolescence. Specifically, we observe whether each child receives special education services for physical (e.g., orthopedic impairments, sensory impairments, speech pathologies), intellectual, or emotional disabilities. These measures are high-quality indicators of some elements of child health as they are linked to school finances and monitored by Florida Department of Education.

While we have limited ability to measure investment in human capital, we can at least measure one element of school quality, as defined by the state of Florida via their school accountability system. Since 1999, the Florida Department of Education has awarded each of its public schools a letter grade ranging from A (best) to F (worst). Initially, the grading system was based mainly on average proficiency rates on the FCAT standardized exam. Beginning in 2002, grades were based on a combination of average FCAT proficiency rates and average student level FCAT test score gains from year to year; other quality indicators, such as science performance, were subsequently added.[13] We utilize this information to construct contemporaneous school quality measure. For ease of implementation, we measure the school letter grades numerically, with A schools receiving 4 points and F schools receiving 0 points. As additional measures of parental investment in children, we also investigate if the second born is less likely to attend pre-kindergarten and whether parents hold back the child a year at the start of schooling.

To measure interactions with the juvenile justice system, one large anonymous Florida school district reports whether children have been incarcerated in juvenile detention centers.[14] Between the 1989-90 academic year and the 2004-05 academic year, the school district retained a code in its student master records for whether the student was in a juvenile detention center, and maintained records for that student as long as the student remains registered for school in the district. Florida children are required to remain in school until their sixteenth birthday, so this variable is most complete for children under the age of sixteen. Given the ending date of the records for the juvenile detention code, we can measure juvenile detention through the end of the mandatory school attendance period for children born on or before August 31, 1989.[15] For the purpose of this

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[13]See Rouse et al. (2013) for a detailed description of the over-time changes to Florida's school accountability system.

[14]School districts in Florida are county-level. We are unable to link the Florida statewide school records to juvenile crime data, and the children in the matched birth-schools data are too young to measure juvenile crime for many sibling pairs in any event.

[15]September 1 is the typical cutoff for school attendance in any given year.

juvenile-delinquency analysis, we measure whether children are siblings based on whether they are coresident and have the same last name; since we can begin to measure residential addresses in this county in the 1989-90 academic year, we feel most comfortable about our ability to measure birth order for children born on or after September 1, 1979.[16] Limiting ourselves to first and second-borns who were born between September 1, 1979 and August 31, 1989 leaves us with 24,928 children in 12,464 families. In this school district, we cannot measure variables observed on birth certificates, but we are able to observe whether a child is limited English proficient, receives subsidized meals, or lives in a low-income micro-neighborhood.[17]

3.3 Sample construction

We construct the analysis samples for both locations in the same way, to the extent possible. As in the previous literature, we exclude twins from the sample due to the problem of correctly assigning birth order of twins – and, of course, all of the mechanisms for birth order effects that we postulate involve the children being born some time apart from one another. Our main analysis will focus on the first two children of families with two or more children, as the previous literature has found birth order effects begin particularly salient for the first two children in a family. Further, given our emphasis on delinquency outcomes we focus on families where the second-born child is a boy. We present results for second-born girls as a separate investigation later in the paper. The sample is also restricted to full biological siblings meaning that all the children have the same mother and father so that we can exploit variation within these stable families by comparing outcomes across siblings.[18]

Table 1 reports summary statistics for all families, all families with two or more children where the first two children are full biological siblings, and our main analysis sample. In Denmark, the family characteristics are very similar across these samples, with the age at first birth moderately lower for families with 2 or more children compared to all families. In Florida, families with 2 or more children have higher educated mothers, come from higher income ZIP codes, and are more likely to be white. These differences are largely due to the restriction that siblings have the same father. For example, if we study all mothers with two or more children irrespectively of the father status then the fraction of African American mothers increases to 22 percent.

One of the main contributions of the paper is that we can compare birth order effects using the same types of model specifications and similar outcome measures across two very different environments. Table 1 shows that there are clear differences in the observables between Denmark and Florida. The average age at first birth in Denmark is lower than in Florida by about one year.

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[16]With this restriction, we will only miscode birth order for families with more than a six year gap between older siblings and the oldest-observed children enrolled in school in 1989-90.

[17]The school district divides the county into approximately one thousand micro-neighborhoods for the purposes of school assignment and school transportation planning. These micro-neighborhoods tend to include between 50 and 200 students at any given time, so they are smaller than Census block groups.

[18]In Denmark we observe complete information on fathers in 98 percent of sibling population and father is the same in 92 percent of families with first two born siblings. In Florida we observe complete information on fathers in 84 percent of sibling population and father is the same in 88 percent of families with first two born siblings.

Within the sample of two or more children the spacing between first and second born is bigger in Denmark than in Florida. The education systems are different, but in Denmark, 33 percent of mothers have a basic education that ends after 9 years and 22 percent have a college degree, whereas in Florida 10 percent of mothers in our analysis sample are high school dropouts and 32 percent have a college degree.[19]

Florida has much more racial-ethnic variation than Denmark, and although race or ethnicity are not reported in the Danish Registers, national statistics reveal that 8.9 percent of people living in Denmark are immigrants, and of these 58 percent originate from non-western countries. There is a negligible fraction of immigrants of Hispanic origin. In contrast 22 percent of mothers in Florida are African American and 24 percent are of Hispanic origin. Finally, the fraction of immigrants in twice as high in Florida as it is in Denmark, and furthermore the sources of immigration differ. In Denmark immigrants come mostly from Turkey, Iraq, Bosnia-Herzegovina, Iran, and Pakistan. In Florida the most frequently-occurring countries are Cuba, Mexico, Colombia, Venezuela, and the Dominican Republic.

4   Empirical model

The main estimating equations for person i born in cohort $c(i)$ in family $f(i)$ are of the form:

$$Y_i \quad = \quad \beta_0 + \beta_1 \text{Second}_i + \beta_2 \text{Girl}_i + \beta_3 X_i + \delta_{c(i)} + \mu_{f(i)} + \varepsilon_i \tag{1}$$

where β_1 compares second-born boys to their older sibling, β_2 is an intercept shift for girls in girl-boy families, X contains controls described below, δ_c are cohort effects included to control for the fact that later-born children benefit from general progress over time, and μ_f are family fixed effects to exploit within-family variation. The fixed effects are appealing because they control for factors that are invariant within families, and we are particularly interested in comparing siblings. In practice, previous work suggests that family fixed effects do not have a large impact on estimates (Black et al. (2005); Bagger et al. (2013), Härkönen (2014)). A cost of within-family estimation is that standard errors can increase, but with our large samples precision is not particularly problematic. We report results with and without family fixed effects, and when we exclude them our vector of β_3 contains estimates on mother and father age at birth and education, marital status and immigrant status indicators as well as regional controls (ZIP codes – 1,472 in total – for Florida and municipalities - 275 in total - for Denmark). In Denmark we further include maternal and paternal employment, family income and number of children until 2011 as a measure of completed family size, while in Florida we include race and ethnicity indicators.[20] We cluster standard errors at the family level.

In the Florida school records we observe individual students multiple times between grades

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[19]In about 10% of cases we do not observe maternal and paternal education in Denmark. Similarly we do not observe maternal and paternal employment in 9% of cases. In OLS regressions where we use these variables as controls we create an indicator variable for missing education and/or employment.

[20]Our fixed effects results hold also when we include time varying family controls such as mother's age, education and marital status as well as zip code of residence. These results are reported in Table A2.

one (three) and eight. Since we want to observe children longitudinally as they age, we impose a longitudinal component into the observed grades. Namely, we start with observations in grade one and then assign children to subsequent "imputed grade levels" with each school year, which allows us to account for grade repeaters. In the main results we pool all the student observations together and in Figures 2, 3 and 5 we present estimates as children progress through schooling scaling the estimates, except for test scores, by the baseline mean for each imputed grade.[21]

In the Florida juvenile-delinquency data, we can include an indicator for (first observed) limited English proficiency, subsidized school meal status (a common measure of socio-economic status), and average school meal status in student micro-neighborhood. This latter variable is possible because the school district divides the county into over 1,000 micro-neighborhoods for the purposes of school assignment and school bus routing and scheduling. While the neighborhoods vary in size, on average between 50 and 200 students live in a neighborhood at any given time.[22]

One estimation concern is that family structure can have its own effects on a family other than direct birth order effects. Bagger et al. (2013) note that birth order and family size are jointly determined. That is, one cannot manipulate family size, holding within-family distribution of birth orders constant. Another example is that families with same-sex children among their first-borns are more likely to have additional births—a measure that is often used as an instrument for family size (Angrist et al. (2010); Conley and Glauber (2006)). Black et al. (2005) also use this instrument in their analysis of family size, but they note that same-sex siblings may have an independent effect on child outcomes. To address these issues, we will show results with and without controls for completed family size. We will also report results for different sex compositions, which has been found to have an effect on family size as both a robustness check and an exploration of sibling influences under the assumption that same-sex siblings have more influence on one another compared to mixed-sex siblings.

Another issue is that last-born children may have worse outcomes if families decide not to continue having children if they have one that is particularly costly (e.g. has health problems) (Ejrnæs and Portner (2004)). Our main analysis includes families with two or more children, and we also examine results in families with three or more children so that the second born is not the last born.

5 Main results

This section reports results first for delinquency outcomes (Table 2), which is then followed with the analysis of different types of criminal activity in Denmark (Table 3). Table 4 presents short-run cognitive outcomes at age 12 in Denmark while Table 5 investigates early childhood mechanisms. We then present short-run cognitive outcomes, namely test scores in Table 6. Subsequent tables further examine potential mechanisms and heterogeneity focusing on spacing between siblings (Table 7),

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[21]In Florida we observe test scores for grades three through eight, and thus in Table 6 we restrict our attention to these grades only.

[22]Specific numbers are not provided here in order to preserve the anonymity of the school district in question.

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maternal education (Table 8), contrast between native born and immigrant parents (Table 9), and finally for Florida on racial and ethnic contrasts (Table 10).

5.1   Delinquency

Table 2 reports our main results for delinquency. Panels A and B show results for Denmark, where second-born boys are more likely to have criminal-justice involvement and serve time in prison both by age 16 and 21. In models with family fixed effects, second-born boys are 1.5 percentage-points more likely to have been found to commit a crime when aged 15 or 16 compared to first-borns. This is 42 percent higher than first-born boys. By age 21, the estimate suggests a 3.5 percentage-point increase, or 22 percent higher than the mean for first-born boys. These results are fairly stable in OLS models both with and without extensive controls, and in models with family fixed effects without a systematic effect of adding controls. The early-age result grows somewhat in magnitude when we include family fixed effects. The larger effect (compared to the mean) at younger ages when crime is less common is consistent with birth order effects having particularly strong influences for the extremes of the behavioral distribution. We document this phenomenon in left panel of Figure 1, which depict elevated effects on criminal activity for ages 16 and 17 that subsequently stabilize at about 20 percent.

When we look at more serious crimes—those that end in prison—the mean of the dependent variable for first-born boys is 0.7 percent by age 16 and 6.7 percent by age 21. Second-born boys are found to be 0.8 and 2.3 percentage points more likely to have spent time in prison at these ages, respectively, which implies over 100 percent and nearly 35 percent effects. The right panel of Figure 1 documents consequently elevated effects for the teenage years that flatten at the level of 40 percent when boys enter adulthood. These are very large effects given that we are using within-family variation: comparing siblings from the same family where one just happens to be born after the other.

Panel C of Table 2 provides analogous results for juvenile-delinquency by age 16 in a single, large unnamed county in Florida. In the OLS model without family fixed effects but with a wider set of controls, second-born boys are 0.5 percentage-points more likely to become involved with the juvenile justice system, which is approximately 20 percent higher than the mean for first-born boys. When we focus on within-family comparisons by adding family fixed effects, the estimate increases to 1.1 percentage points, or 42 percent. Notably, even though as documented in Table 1 the state of Florida is very different from Denmark in terms of observable socio-demographic characteristics as well as the judicial systems, the estimated effects of being born second to the mother are remarkably similar across the two locations.

Another measure of behavioral issues can be found in the Florida schooling data in the form of suspensions and absences. We define these as an indicator for being ever suspended and the absence rate in a given school year multiplied by 100. Remarkably, we find similar results suspensions as well. They are found to be 1.8-4.5 percentage points higher (or 32-80 percent higher than the mean). For absences, we find point estimates of -0.01 to 0.25 percentage points more absences from school,

or 0 to 6.5 percent higher. For suspensions, similar to the criminal activity results, we document moderately larger second-born effects earlier in life, namely in elementary school in comparison to middle school (left panel of Figure 2). This pattern is not confirmed for absence rates (right panel of Figure 2), however, where we observe fewer absences for the youngest grades, and more absences among second-borns in grades 4, 5 and 8.[23] This could be explained by the fact that in early schooling years absenteeism is much more about health and acclimatization to education processes than intentionally missing classes: a sign of misconduct in later grades that corroborates the delinquency findings.[24][25]

For the delinquency outcomes measured in Florida schooling data, adding family fixed effects reduces the point estimates. One explanation is that the set of controls varies across Panels C and D due to data availability. Given that there are meaningful controls at our disposal in both panels, however, the fact that they increase point estimates for some outcomes but decrease point estimates for others helps to rule out straightforward explanations that the results are due to omitted variable bias that operates in a similar way across outcomes. This is further confirmed by the heterogeneous results discussed in footnote 24. In any event, we favor the within-family comparison including family fixed effects to absorb time-invariant characteristics of families and we proceed with it throughout the subsequent sections of the paper.

The uniqueness of Danish registry data allows us to investigate different types of crime. If our working hypothesis about decreased non-cognitive abilities that affect particularly extreme parts of the distribution is correct then we should see larger birth order effects for more severe rather than petty crimes. Table 3 reports the results for violent crime (e.g. manslaughter, rape or death threats), property crime (e.g. forgery, arson or burglary) and special crime (e.g. drug offenses, illegal weapon possession or human trafficking). First as expected, crime rate is highest for property crimes, followed by special crimes and lowest for violent crimes. However, the second-born effects are the largest among the latter group which is supportive of our hypothesis on particularly strong influences for the extreme outcomes.

5.2 Non-cognitive measures

In addition to measures of delinquency, we are able to study the relationships between birth order and measures of non-cognitive skills observed as part of the Strengths and Difficulties Questionnaire (SDQ), measured at approximately age twelve for a subset of the Danish population of children. One

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[23]Approximately zero effects estimates in Table 2 are driven by this heterogeneity over time as the negative early schooling coefficients cancel out with positive coefficients is grades 3,4 and 8.

[24]The early grades results are less negative and the later grades results are more positive for absences when we estimate OLS regressions with or without controls, and thus in Table 2 in columns (4) and (5) of panel D we estimate positive and significant coefficients. This discrepancy supports the need for within and across families comparison rather than just across families comparison.

[25]Even though at each grade we compare individuals from the same family, across grades we have a repeated cross-section of families i.e. not all pairs utilized in grade one comparisons are old enough to make it to grade eight comparisons. Due to data restriction we are underpowered to run this panel analysis however when we restrict the sample to grades one to six then our results are qualitatively consistent with the repeated-cross section estimates for these grades.

limitation of our data is that we cannot implement family fixed effects strategy due to observations on only three cohorts in selected schools. Therefore, we present OLS estimates with rich set of controls including child birth year dummies, mother age at first birth, mother age, father age, municipality dummies, maternal and paternal education, maternal and paternal employment, family income, immigrant dummy, number of children in family.

Tables 4 and A7 present the results. Panel A of Table 4 presents total difficulties score, and we show its sub-components - emotional, conducts, hyperactivity and peer problems - in panels A to D of Table A7. In panel B of Table 4 we present a positive outcome, namely prosociality score.

Second-born boys are 5 percent less likely to be categorized as close to average in comparison to their older siblings and although insignificant we find positive coefficients on all the remaining categories of total difficulty score. Investigation of the sub-components of the total score reveals that second-born boys are particularly adversely affected in terms of hyperactivity. They are 4.9 percentage points less likely to score "close to average" on the hyperactivity component. At the same time, we do not find any statistically significant effects for emotional problems, conduct problems,peer problems and prosocial behavior. Relating this to Heckman (2000) findings of non-cognitive skills being important determinants of success, these increased hyperactivity problems may be precursors to criminal-justice involvement later in life (Heller et al. (2015)).

5.3   Mechanisms: Early-life measures

Our first set of potential mechanisms investigates what happens to these children prior to attending school, and we present the effects of birth order on maternal, infant and childhood health as well as probing into several parental investment channels including differential labor supply responses or school choices. If we find meaningful effects at these younger ages, this provides some insights into the timing of when differences begin to appear.

Table 5 presents the results. Columns (1) and (2) consider birth weight and complications in pregnancy as measures of the health endowment at birth and proxy for maternal health during pregnancy. Here we find that second-borns weigh 3.7 percent more on average in Denmark and 2.5 percent more in Florida. Similarly, second borns have fewer complications during pregnancy compared to first borns (20 percent lower in Denmark, 12 percent lower in Florida). These differences are not explained by the fact that mothers are older for second-born births.[26] This result suggests that second-borns are not starting out in worse health compared to their older sibling, ruling out one potential mechanism.

Next we consider parental time investment in the form of daycare/preschool and maternal employment. We find that daycare at age 1 is 17 percentage points lower in Denmark for second-born

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[26]There is a positive relationship between maternal age and birth weight when we regress log birth weight on maternal age even if we include family fixed effects, however the main results do not change when we add controls for maternal age at birth. In fact in the fixed effects specification the coefficient on maternal age is negative, small and insignificant. We have also investigated several other birth outcomes, and we find positive effects for birth weight in levels, one and five minutes Apgar scores; negative effects for probability of being low birth weight and being preterm; and no significant effect for abnormal conditions at birth or congenital anomalies. These results are qualitatively similar in both Denmark and Florida.

boys (Table A6). However by age 2 and 3 second-born boys are 3.4 and 10.8 percentage points more likely to be enrolled in out-of-home daycare (5 percent and 14 percent higher than the mean for first born boys). This finding corresponds well with maternal employment effects, which we depict in Figure 4 for 0 to 10 years after child birth. It shows that 2-4 years after birth mothers of second-born boys are significantly more likely to be employed compared to mothers of first-borns. The net effect of substituting maternal care with institutional care is ambiguous, however, and in fact earlier return to the labor market may be harmful for boys (Fan et al. (2015)). We additionally document that maternity leave is shorter for second-born boys compared to the first-borns – 8.6 fewer days of maternity leave compared to a mean of 150 days for first-born boys yields about 6 percent effect. It thus appears that the addition of a second-born child results in mothers spending more of a first-born's early childhood out of the of labor force: maternity leave upon the arrival of a second born adds time that mothers spend with first borns in addition to the undivided attention received by first borns in their first year of life.

In Florida we cannot observe maternal employment or maternity leave uptake but we do observe pre-kindergarten participation, which can begin as early as age two. We define our outcome variable as either parents declaring pre-kindergarten attendance of their children at the time of kindergarten enrollment or actually observing children being enrolled in public pre-kindergarten. We find nearly 7 percentage points higher participation rate among second-born boys, which is equivalent to 12 percent effect. This could be a reduction in direct parental investment in favor of institutionalized care but pre-kindergarten participation is generally viewed in the literature as a positive investment in human capital (Havnes and Mogstad (2011)).

In terms of school starting age, we see a 3.5 percent decrease in age at first grade in Denmark, however we do not document any elevated probability of being held back in first grade in Florida. Given that the evidence on school starting age and age at test are mixed, we view our estimates as rather not supporting the lower investment in second-born children.[27] In fact, it seems that second-born boys in Florida are attending higher quality primary schools in comparison to their older siblings. About 66 percent of first-born boys (among those for whom we can match siblings) attend first grade in A-rated schools in the state of Florida but this number is 4.4 percent higher (2.9 percentage points) for their younger brothers. The school quality gradient changes as children progress through schooling, and in subsequent grades we observe a mix of positive and negative coefficients generally oscillating around zero (Figure 5). Thus, lower quality schools located in less-affluent neighborhoods should not explain our delinquency results.

Both data sets allow us to also investigate childhood health as measured by various disabilities. About 18 percent of school age children in Florida are diagnosed with some form of disability, and in our sibling sample we observe 6.8 percent and 7 percent of first-born boys having been diagnosed with cognitive and behavioral disability, respectively. The incidence of disability diagnoses in Denmark

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[27]Black et al. (2011)document small positive effects of starting school younger but much larger negative effects of age at test. On the other hand, they also document that boys starting schooling younger have higher incidence of mental health problems at age 18. The school starting age effects are generally relatively small and thus should not be the main drivers of our birth order effects in Denmark.

in far lower with about 2.5 percent on average. Columns (7) and (8) in Table 5 document no birth order gradient in either developmental or behavioral disabilities for both locations, and if anything, we actually see a decreased probability of second-born being diagnosed with cognitive disability in Florida.[28]

One innovation in the current paper is that we are able to explore a wide range of potential alternative mechanisms, including health endowments at birth, parental investment in the form of maternal employment and the use of daycare, as well as school choice. While we do not find the primary mechanisms that result in the higher delinquency outcomes later in life, we do find relatively precise zero results on some of these measures. On others we find decreased direct parental investment in the form of time spent with parents in favor of indirect investment in the form of formal childcare arrangements. Whether and how these differences could affect observed later life differences is an open research question. This leaves us with parental investments within the home (as opposed to time out of the home and in the labor force) and sibling influences as our leading explanations for the birth order results.

5.4   Test scores

Our next set of results considers childhood test scores. These are of interest in their own right as educational outcomes, and indeed have been studied in the previous literature. We are also interested in them to test whether the behavioral outcomes in our main results are also evident in these measures that are more traditionally though to as measures of cognitive skills. In Denmark, we observe them for 9th grade, so slightly younger than our crime by age 16 results, and in Florida we have results for younger children - grades 3-8 - so as early as age 8. If we find effects at these younger ages, this provides some insights into the timing of when differences begin to appear, and also whether they grow or shrink as children age.

Table 6 shows that in Denmark, second-born boys have lower test scores: 0.11 and 0.14 standard deviations for math and reading, respectively. In Florida, we do not find a birth-order effect for math scores, but we do find that reading scores are 0.08 standard deviations lower for second-born boys. When we look at each grade separately (Figure 3), we find that the positive but insignificant estimate for mathematics is driven by early grades. In fact, for grades three and four we find positive and statistically significant effects of being the second born. This would be consistent with the higher early investment into human capital of second born boys through sending them to pre-kindergarten and better schools (Autor et al. (2016)) that fades out over time allowing the non-cognitive aspects to dominate. For reading we observe negative estimates in all studied grades that, except for grade 8, are relatively constant over time.

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[28]In the case of Denmark we have also investigated addiction related hospitalizations by either age 16 or 21, which include poisoning by narcotics or psychodysleptics or toxic effects of alcohol. We do not find any birth order gaps in these outcomes. Similarly we do not find differences between second-born boys and their older siblings in the probability of dying by either 16 or 21. Finally, we looked at the number of emergency room visits by age 5 and 10. For both of these outcomes we find that second-born boys have about 10 percent more visits than their older siblings, however, we are unable to distinguish if these are due to poorer underlying health or more accidents related with e.g. increased hyperactivity documented in Table A7.

5.5   Heterogeneous delinquency effects

We have documented very similar effects of birth order on delinquency in both Denmark and Florida; however, the richness of the data in both locations allows us to investigate heterogeneity of these effects in much more detail. We divide this analysis into two parts. First, we continue to consider potential mechanisms through spacing and sex composition of the sibship. Investigation of distance between siblings in terms of age and sex could provide us with some clues about implicit differential investment related to the nature of family arrangements. Second, we investigate if the birth order effects are different in more versus less affluent or advantaged families – this is proxied by education, maternal employment (only Denmark), nativity as well as race and ethnicity (only Florida).

We begin by presenting in Table 7 the differential effects of birth order by spacing between first and second born children in our data. We divide families into those that had the second birth up to two years after the first one and those where the distance in age between siblings is three years or more.[29] We find that in both countries delinquency is higher among families where the children are closer in age. That said, there are differences in the relative magnitudes of the birth order effects by spacing groups in Denmark versus Florida. In Denmark we find larger birth order effects for the closer spaced siblings while in Florida we find that sibling pairs with longer spacing durations have relatively larger birth order effects. We are underpowered to detect statistically significant birth order effects by spacing in the unnamed Florida county where we observe juvenile justice system interactions, but the (imprecisely estimated) results are larger for siblings spaced further apart akin to what we found for suspensions. In Denmark the results at age 16 are weaker and we do not have precise estimates for crime, yet the effect for prison by age 16 is about 20 percent higher for families where the siblings are closely spaced. Our results are more precise at age 21 where we see both higher criminal activity and incarceration for the second-borns born up to two years after their older sibling.

The results for Denmark are broadly consistent with the idea that resources and parental attention are diluted more in families where the children are born closer to one another. If boys require more attention from parents (Bertrand and Pan (2013); Autor et al. (2015)) then this could help to explain why more closely-spaced sibling pairs have greater incidence of delinquency. It's not entirely clear why the birth order effect is greater in Denmark for more closely spaced siblings while the opposite is true for Florida. One possibility could involve different practices regarding maternity leave following pregnancy. As we observed in Section 5.3, a potential mechanism for birth order effects, at least in Denmark, where we observe maternal labor market outcomes, is that the first-born child experiences extra maternal attention when very young and again when the second-born child is born; if maternal attention is differentially important during very early childhood, then this could generate the finding that the birth order effect is particularly pronounced in Denmark when children are closely spaced. In Florida, maternity leave policies are not as generous, so one might imagine

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[29]We define spacing in months based on date of birth, then convert it to years and round to the nearest integer. For example, if the first born birth date is November 1994 and the second born birth date is September 1997 then they are separated by 34 months or 2.8 years, and we assign them spacing of 3 years. Our results are invariant to various ways of measuring spacing.

that the role of the "double-dose" of extra maternal attention would be attenuated, thereby putting more weight on the time at home without siblings explanation, which privileges first-born children the longer the birth spacing. These explanations, of course, are only speculative.

Our identification for the second-born boy effect comes from the comparison of birth order in boy-boy and girl-boy pairs. If there is gender antagonism between siblings then it is plausible that the second-born effects would be larger among the girl-boy families. On the other hand, if there is gender complementarity in delinquency behavior (e.g., it is higher among individuals of the same sex due to peer pressure) we might expect to observe higher estimates among the boy-boy pairs. We present these results in Table A3, and they unanimously support the former hypothesis. Boys in both Denmark and Florida fare orders of magnitude worse if they have an older sister in comparison to the having an older brother. As expected, the estimates for the latter group are somewhat more modest that our main results in Table 2.

Given that we have showed a gradient in the estimates by spacing between siblings, it is not unreasonable to ask whether this gradient interacts with gender composition of sibship. In particular, one can imagine that the gender antagonism between brother and his older sister would be particularly aggravated among closely spaced siblings. We present these results in appendix Table A4. Among boy-boy families we confirm the pattern observed in Table 7 for Florida, namely that second-borns are doing worse in families where the boys are spaced further apart. In Denmark, however, the results are somewhat different in comparison to Table 7. First, we actually find negative effects for second born boys in comparison to their older brothers for criminal behavior by age 16. Second, we do not find any birth order gaps for prison outcomes or crime by age 16 in families where brothers are spaced further apart. Third, we find similar gaps irrespectively of spacing for criminal activity by age 21. The results are clearer when we compare second-born boys to their older sisters, where in Denmark, younger brothers are doing much worse in families where the age difference is less than three years in comparison to families where the difference is larger. This is suggestive of a direct negative spillover of having an older sister on their brothers. Interestingly, the results are comparable in the two samples for the outcomes in Florida albeit consistently with Table A3 larger for girl-boy pairs than boy-boy pairs.

So far we have provided suggestive evidence that the negative effects of being second-born boy are larger for families that need to share the resources between siblings for a longer period of their childhood (spacing) and where the children might require higher levels of management and oversight (opposite sex). If these hypotheses about resources in the form of either financial resources or attention are correct, then it makes sense to investigate heterogeneity by socio-economic status.

In Table 8 we divide families into those with mothers having less than 12 years of formal education (equivalent of high school dropout in the United States) and those who have 12 or more years of schooling. The more educated families tend to have more resources, live in more affluent and safer neighborhoods, and are able to send their children to higher-rated schools. It is also the case that delinquency rates are more than twice as high in the less educated sample for virtually all our measures. That said, the estimates for Denmark suggest very similar second-born effects among

both high and low educated parents. The estimates are larger among the families where mother has less education, but this is offset by the higher baseline delinquency rate among children raised in these households.

A similar resource availability story can be examined looking at maternal employment, tough here the expected sign of the effect is not so clear. On the one hand, employed mothers provide additional income and resources, but on the other hand this means that children are send to day care or overseen by unrelated adults. If quality of maternal time outweighs the benefits of what can be purchased with the additional income then we could actually see second-born boys doing worse off in families where the mother works, especially during early childhood (Fan et al. (2015)). Our results, reported in appendix Table A1, document that delinquency is on average higher in households where mom is not employed one year after birth in case of both children. The point estimates are also higher for the non-employed samples but the effect sizes are comparable for both outcomes by the age of 21, however, these scaled estimates are much larger for crime and imprisonment by the age of 16 suggesting that income effect may dominate maternal time effect for these more extreme outcomes.

There exists ample evidence that children with immigrant backgrounds fare worse in terms of many later life outcomes (Borjas (2006); Abramitzky and Boustan (2016)) though the differences vary for schooling outcomes, with Aslund et al. (2011) documenting relative disadvantage in Sweden while Figlio and Ozek (2016) show superior educational outcomes for the children of immigrants in the United States. Very little is known about the birth order effects in these families. We document the gradient between second-born boys and their older siblings for immigrant and native families in Table 9. First, it is worth noting that the children of immigrants in Denmark have higher crime and incarceration rates, but the children of immigrants in Florida have lower rates of suspensions and absences in comparison to the children of native-born people. In both locations, however, we find larger second-born effects among the children of immigrants relative to the children of native-born residents.

Although Denmark is fairly racially and ethnically homogeneous, in Florida about 20 percent of the population is African American and another 18 percent is Hispanic. It is also the case that African Americans and Hispanics have one average lower socio-economic status and their children fare worse in schooling outcomes. Thus, we present results separately for African Americans, non-African Americans, Hispanics and non-Hispanics in Table 10. Absenteeism is lower among these two minorities in comparison to the rest of the population, but the suspension rate for African Americans is more than twice as high as for non-African Americans. The second-born effects are similar among Hispanics and non-Hispanics for both outcomes. When comparing African Americans to non-African Americans, however, the effects for both outcomes are larger among the more advantaged – on average – non-African Americans. They are, in fact, negative for African Americans in the case of truancy.

5.6 Robustness checks

Given the very large magnitude of these differences between first and second-born children, we check the robustness of the results in a number of ways. In the main set of results our fixed effects specification controls only for cohort effects but it is possible that our estimates are still biased because we do not account for mother time varying characteristics like marital status and education or place of residence. These characteristics could change across births and influence the second-born either positively (e.g. mother improving her education) or negatively (e.g. family moving to a poorer neighborhood due to reduced resources). When we control for maternal age at birth, maternal education, maternal marital status and location at the time of birth in the fixed effects models our estimates are similar (panel A in Table A2), and in fact four out of six remain exactly identical.

In Table 5 we have documented that second-borns are moderately healthier at the time of birth in comparison to their older siblings, and thus, if there is a causal effect of health at birth on delinquency then the main results could be mediated through improved health. When we control for birth outcomes in our preferred specification in panel B of Table A2, however, the results do not change which suggests that better health in infancy does not moderate the effects on delinquency. At the same time, because health at birth has a causal effect on cognitive development (Figlio et al. (2014)) our second-born estimates for test scores increase marginally in magnitude when we control for birth weight.

One explanation for our main results pertains to potential stopping rules that parents use when determining family size. In our preferred sample we focus on the first two births among families with two or more children, but it is possible that issues associated with the second-born child might induce some families to cease their fertility following the second-born child. To address this issue, we drop from the sample all families for whom we observe exactly two children (panel C in Table A2). This cuts our sample by about 60 and 85 percent in Denmark and Florida, respectively. In Denmark this is almost entirely due to families stopping their fertility at parity two, while in Florida we lose even more observations because of the nature of the data – since we only observe births over 9 years, it is particularly possible that the families which we drop now as having exactly two children will continue their fertility beyond the year where we can observe them. First, it is worth noting that in these larger families the average delinquency rates for the first born boys are higher than in the preferred sample which could be related with the lower socioeconomic status of families with higher fertility. Nonetheless, our results are very stable whether we include exact parity two families or not.

5.7 Effects for girls

Boys and girls have much different delinquency rates, they go through puberty at different ages, and they perform better in certain subjects in comparison to others. Therefore, in order to facilitate an "apples to apples" comparison in our estimation strategy we have thus far focused on the comparison of second-born boys to their older siblings – whether for both brothers and sisters in the main

sample or for only older brothers in panel A of appendix Table A3. But the birth order gradient in delinquency for girls is also of interest, and we therefore present the estimates for the sample of girl-girl and boy-girl comparisons in panels C and D of appendix Table A3.

In general, we do not observe substantially increased birth order effects for the group of families with second-born girls with respect to the more serious delinquency outcomes involving the judiciary system. Indeed, in Denmark we observe a negative estimated second-born effect for the prison outcomes, though this result is driven by the boy-girl comparison rather than the girl-girl comparison.[30] At the same time, we do find positive effects of being a second girl in the girl-girl family on the rates suspensions in Florida. These are similar in magnitude to second-born boy effect. As visible in Figure A2, the positive suspension effects are driven by middle school grades where second-born girls have higher estimates than second-born boys. On the other hand, they experience zero or imprecisely estimated negative effects in primary schooling. We observe similar to Figure 2 patterns with regard to absenteeism, however there is no elevated absenteeism in grades 4 and 5.[31]

We also investigate the degree to which any differences in birth order effects by second-born gender is possibly due to different mechanisms affecting girls versus boys. For instance, it may be the case that second-born girls are in better health, or that parents invest more in early human capital if the second-born child is female. As can be seen in appendix Table A8, in contrast to the parallel second-born boy mechanisms presented in Table 5, most of the potential mechanisms that we explored (e.g., neonatal health, pre-kindergarten participation, and school quality) are remarkably similar between second-born boys and second-born girls. The same conclusion applies to maternal labor market activity after birth depicted in Figures 4 and A4.[32] This general pattern of findings leads us to believe that the mechanisms we explored do not account for any boy-girl differences in birth order effects on delinquency.

6 Conclusions

The literature has paid considerable attention to identifying the effects of birth order on a range of "cognitive" outcomes such as test scores, educational attainment, and wages. We contribute to this literature by studying a set of more extreme outcomes relating to delinquency. In order to gauge the degree to which birth order is really at play in determining delinquent behavior, we perform, to the extent practicable, parallel analyses in two rich but otherwise considerably different societies – Denmark and the United States (Florida). These societies have much different approaches to crime

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[30]We present delinquency estimates over time for Denmark in Figure A1.

[31]We find fairly similar effects for second-born girls as for second-born boys in terms of reading, and for second-born girls the estimates for math are u-shaped. We present these results in Figure A3. In Figure A5 we further present evidence on quality of schools attended by second-born girls in these girl-girl and boy-girl families. Akin to estimates for second-born boys we find elevated probability of attending better quality school in first grade that then diminishes and oscillates around zero with some small negative and statistically significant estimates.

[32]For completeness in Table A5 we present the analysis of spacing for girl-girl and boy-girl families. We do not find many differences in girl-girl families for Denmark except for negative effect on criminal activity by age 16 for closer spaced sisters. The results for Florida are larger for sisters spaced further apart which is similar to findings in boy-boy families. In boy-girl families second-born girls do unanimously better in families where their brother is born within two years.

and punishment and are demographically very different, but our sets of findings are fundamentally quite similar.

We find, consistently across both countries, that second-born boys are substantially more likely to exhibit delinquency problems compared to their older sibling. Second-born boys have substantially higher rates of juvenile crime, particularly severe violent crime, and imprisonment than do their older siblings. We observe antecedents for these patterns in terms of early delinquency problems (especially disciplinary behavior that results in suspensions but also in middle school truancy) as well as in terms of direct measures of conduct problems and hyperactivity at age 12. The patterns of delinquency differ, however, across countries when we look at second-born girls.

We explore a wide variety of early-life outcomes in order to understand the mechanisms through which birth order effects are occurring. We are able to rule out broad classes of explanations: We find no evidence that second-born children are less healthy, and indeed second-born children appear to be healthier at birth and have lower rates of disability in childhood. We also find no evidence that parents invest less in second-born children's education: second-born children attend better schools. Second-born children are more likely to attend pre-kindergarten later in childhood, which could be interpreted either positively or negatively as differential investment. We consider differences in parental attention to be a more likely explanation for the differences in delinquency across the birth order. Second-born children tend to have less maternal attention than do their older siblings because first-born children experience their mother's maternity leaves and temporarily reduced labor market participation both following their own births as well as following the birth of the second-born. Therefore, in addition to the fact that first-borns experience undivided attention until the arrival of the second born, we discovered that the arrival of the second-born child has the potential to extend the early-childhood parental investment of the first-born child.

These new results have important implications for social policy. Crime, delinquency, and incarceration have enormous social costs and are associated with major losses in human potential. Our findings that birth order appears to influence the likelihood of delinquency among boys, and that differences begin to appear early, suggests potentially fruitful avenues for monitoring and intervention. Our findings regarding systematically different dosages of early-childhood parental attention as a plausible mechanism also points the way toward more research needed on this question.

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Figures and Tables

Table 1: Descriptive Statistics

	Denmark			Florida		
	All	All 2+ families	2+ Boy-Boy and Girl-Boy families	All	All 2+ families	2+ Boy-Boy and Girl-Boy families
	(1)	(2)	(3)	(4)	(5)	(6)
Parental controls - Mother						
Age mother – first-born	25.23	25.04	25.04	-	25.97	26.04
Education						
Basic	0.33	0.32	0.32	0.20	0.10	0.09
High school or vocational	0.35	0.34	0.34	0.59	0.58	0.58
College	0.22	0.23	0.23	0.21	0.32	0.32
Employed	0.75	0.74	0.74	-	-	-
Parental controls - Father						
Age father – first-born	28.26	28.14	28.11	-	28.70	28.77
Education						
Basic	0.24	0.24	0.24	0.15	0.10	0.10
High school or vocational	0.45	0.44	0.44	0.60	0.60	0.60
College	0.20	0.21	0.21	0.26	0.30	0.30
Employed	0.84	0.84	0.84	-	-	-
Family controls						
Income						
Low	0.23	0.24	0.23	0.25	0.15	0.15
Low-Medium	0.29	0.31	0.29	0.25	0.22	0.22
Medium-High	0.26	0.26	0.26	0.25	0.29	0.29
High	0.22	0.19	0.22	0.25	0.33	0.34
Mother immigrant	0.13	0.13	0.13	0.24	0.20	0.20
Father immigrant	0.12	0.12	0.12	-	-	-
Mother African American	-	-	-	0.22	0.11	0.11
Mother Hispanic	-	-	-	0.24	0.22	0.22
Spacing (firstborn to second-born)	-	3.03	3.03	-	2.65	2.66
Completed family size	2.34	2.59	2.59	-	-	-
Number of children	448,979	235,720	121,100	1,592,342	186,388	95,442

Note: Sample is column (1) is based on all singleton births between 1981 and 1990 in Denmark. Sample in column (4) is based on all singleton births between 1994 and 2002 in the state if Florida. We are unable to provide maternal age at first birth for this sample since we do not know older and younger siblings for the full population of births. We also do not observe education for fathers who do not appear on the birth certificate and the sample size for paternal education is 1,277,106. Columns (2) and (5) are based on the sample of families with two or more children. We can link siblings only in about 70 percent of counties of Florida and only if both births occurred in the state of Florida between 1994 and 2002. We can link all siblings in Denmark. Columns (3) and (6) present the subsample of interest with second-born boys. Employment in Denmark is measured in the year before birth. All other controls are measured at the time of child's birth. Individual level income in Denmark and ZIP code of birth median income based on 2000 Census for Florida. Spacing refers to distance in years between first and second birth.

Table 2: Main results

	(1) OLS	(2) OLS with controls	(3) Fixed effects	(4) OLS	(5) OLS with controls	(6) Fixed effects
	Panel A. Denmark: Birth cohorts 1981-1990					
	Crime by age 16			*Crime by age 21*		
Second-born	0.005***	0.012***	0.015***	0.021***	0.038***	0.035***
	(0.001)	(0.002)	(0.003)	(0.003)	(0.004)	(0.005)
Girl	-0.023***	-0.023***	-0.019***	-0.117***	-0.117***	-0.116***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.004)
Mean of Y for first born boy	0.036			0.158		
Number of children/families	121,100/60,550			121,100/60,550		
	Panel B. Denmark: Birth cohorts 1981-1990					
	Prison by age 16			*Prison by age 21*		
Second-born	0.003***	0.006***	0.008***	0.009***	0.022***	0.023***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.003)
Girl	-0.006***	-0.006***	-0.003***	-0.060***	-0.059***	-0.059***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Mean of Y for first born boy	0.007			0.067		
Number of children/families	121,100/60,550			121,100/60,550		
	Panel C. Large FL County: Children born Sept 1979-Aug 1989					
	In juvenile justice system by 16th birthday					
Second-born	0.005**	0.005*	0.011**			
	(0.003)	(0.003)	(0.006)			
Girl	-0.015***	-0.015***	-0.013**			
	(0.002)	(0.002)	(0.005)			
Mean of Y for first born boy	0.026					
Number of children/families	24,928/12,464					
	Panel D. Florida: Birth cohorts 1994-2002					
	Suspensions			*Absences*		
Second-born	3.929***	4.500***	1.795***	0.245***	0.150***	-0.012
	(0.143)	(0.201)	(0.215)	(0.029)	(0.039)	(0.030)
Girl	-3.719***	-3.757***	-4.054***	0.062*	0.047	-0.030
	(0.119)	(0.114)	(0.168)	(0.033)	(0.031)	(0.024)
Mean of Y for first born boy	5.603			3.770		
Number of observations/children/families	372,646/72,734/36,367			371,104/72,602/36,301		

Note: Standard errors clustered at mother level. OLS and FE regressions in columns (1), (3), (4) and (6) include only child birth year dummies. Controls in column (2) and (5) in Panels A and B include child birth year dummies, mother age at first birth, mother age, father age, municipality dummies, maternal and paternal education, maternal and paternal employment, family income, immigrant dummy, number of children in family. Controls in column (2) in Panel C include first observed limited English proficiency, subsidized school meal status, and average school meal status in student micro-neighborhood. Controls in column (2) and (5) in Panel D include child birth year dummies, mother age at first birth, mother age, father age, ZIP code of birth dummies, mother and father education dummies as well as indicator variables for race, ethnicity, immigrant status and marital status at the time of birth.

Table 3: Types of crime by age 21: Denmark birth cohorts 1981-1990

	(1)	(2)	(3)
	Violen Crime	Property Crime	Special Crime
Second-born	0.016***	0.021***	0.018***
	(0.003)	(0.004)	(0.004)
Girl	-0.039***	-0.071***	-0.057**
	(0.002)	(0.003)	(0.003)
Mean of Y for first-born boy	0.043	0.104	0.063
Number of children/families		121,100/60,550	

Note: Standard errors clustered at mother level. All estimates come from fixed effects regressions controlling for child birth year dummies. Special crime includes for example drug offenses and illegal weapon possession.

Table 4: Short-run non-cognitive outcomes: Denmark birth cohorts 1999-2000

	(1)	(2)	(3)	(4)
	Close to average	Slightly raised	High	Very high
	Panel A: Total difficulties score			
Second-born	-0.041*	0.021	0.006	0.014
	(0.023)	(0.018)	(0.011)	(0.013)
Girl	0.009	-0.033**	0.009	0.015
	(0.019)	(0.014)	(0.010)	(0.011)
Mean of Y for first born boy	0.829	0.094	0.034	0.043
	Panel B: Prosocial score			
Second-born	-0.024	0.020	0.002	0.003
	(0.027)	(0.021)	(0.017)	(0.014)
Girl	0.138***	-0.062***	-0.041***	-0.035***
	(0.021)	(0.017)	(0.013)	(0.010)
Mean of Y for first born boy	0.695	0.155	0.090	0.059
Number of children		3,370		

Note: Standard errors clustered at mother level. OLS regressions in columns (1)-(4) include the following controls: child birth year dummies, mother age at first birth, mother age, father age, municipality dummies, maternal and paternal education, maternal and paternal employment, family income, immigrant dummy, number of children in family. The questionnaire was answered by 6th grade students from birth cohorts 1998-2000. Panel A is a combination of emotional problems score, conduct problems score, hyperactivity score and peer effects problems score. We present the results for these scores separately in Table A7.

Table 5: Mechanisms: neonatal and childhood health, parental investment and school quality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Ln(birth weight)	Complications in pregnancy	Days of maternity leave	Maternal employment one year after birth	Out of home daycare at age 2	School starting age (1st grade)	Disorders of psychological development	Behavioural and emotional disorders
	Panel A. Denmark: Birth cohorts 1981-1990							
Second-born	0.037***	-0.053***	-8.574***	-0.005	0.039***	-0.235***	-0.000	-0.002
	(0.002)	(0.005)	(0.692)	(0.004)	(0.006)	(0.006)	(0.003)	(0.003)
Girl	-0.040***	-0.002	-0.232	-0.006*	-0.006	-0.107	-0.015***	-0.021***
	(0.001)	(0.004)	(0.538)	(0.003)	(0.004)	(0.005)	(0.002)	(0.002)
Mean of Y for first born boy	8.141	0.264	149.873	0.767	0.667	6.760	0.018	0.030
Number of children	172,642	172,934	98,576	175,686	89,262	174,724	85,258	85,258
Number of families	86,467	86,467	49,288	87,843	44,631	87,362	42,629	42,629
	Ln(birth weight)	Complications in pregnancy	Pre-kindergarten participation	Held back a year	Attending A quality school in first grade	School quality (0-4) in first grade	Cognitive disability	Behavioral disability
	Panel B. Florida: Birth cohorts 1994-2002							
Second-born	0.025***	-0.027***	0.067***	-0.006	0.029***	0.060***	-0.010**	0.001
	(0.003)	(0.007)	(0.008)	(0.004)	(0.007)	(0.011)	(0.004)	(0.004)
Girl	-0.040***	0.004	-0.030***	-0.040***	0.000	0.005	-0.036***	-0.034***
	(0.002)	(0.005)	(0.006)	(0.003)	(0.005)	(0.009)	(0.003)	(0.003)
Mean of Y for first born boy	8.115	0.221	0.544	0.067	0.664	3.478	0.068	0.070
Number of children	72,734	72,734	72,734	72,734	69,434	69,434	72,734	72,734
Number of families	36,367	36,367	36,367	36,367	34,717	34,717	36,367	36,367

Note: Standard errors clustered at mother level. All estimates come from fixed effects regressions controlling for child birth year dummies.

Table 6: Short-run cognitive outcomes

	(1)	(2)	(3)	(4)
	Denmark: Birth cohorts 1986-1997		Florida: Birth cohorts 1994-2002	
	Math	Reading	Math	Reading
Second-born	-0.109***	-0.137***	0.010	-0.078***
	(0.010)	(0.012)	(0.012)	(0.012)
Girl	-0.084***	0.347***	-0.036***	0.081***
	(0.007)	(0.009)	(0.009)	(0.009)
Mean of Y for first born boy	0.278	-0.044	0.461	0.388
Number of observations	144,906	144,906	285,604	288,858
Number of children	144,906	144,906	67,644	67,768
Number of families	72,453	72,453	33,822	33,884

Note: Standard errors clustered at mother level. All estimates come from fixed effects regressions controlling for child birth year dummies.

Table 7: Heterogeneity effects by spacing between first- and second-born child

	(1)	(2)	(3)	(4)
	Spaced 1-2 years apart	Spaced 3+ years apart	Spaced 1-2 years apart	Spaced 3+ years apart
Panel A. Denmark: Birth cohorts 1981-1990				
	Crime by age 16		*Crime by age 21*	
Second-born	0.002	0.003	0.041***	0.016**
	(0.006)	(0.004)	(0.011)	(0.008)
Girl	-0.019***	-0.019***	-0.129***	-0.108***
	(0.003)	(0.002)	(0.006)	(0.004)
Mean of Y for first born boy	0.040	0.030	0.157	0.128
Number of children	48,552	72,548	48,552	72,548
Number of families	24,276	36,274	24,276	36,274
Panel B. Denmark: Birth cohorts 1981-1990				
	Prison by age 16		*Prison by age 21*	
Second-born	0.007**	0.003	0.039***	0.007
	(0.004)	(0.002)	(0.008)	(0.005)
Girl	-0.005***	-0.002*	-0.067***	-0.055***
	(0.002)	(0.001)	(0.004)	(0.003)
Mean of Y for first born boy	0.011	0.007	0.067	0.050
Number of children	48,552	72,548	48,552	72,548
Number of families	24,276	36,274	24,276	36,274
Panel C. Large FL County: Children born Sept 1979-Aug 1989				
	In juvenile justice system by 16th birthday			
Second-born	0.005	0.009		
	(0.008)	(0.015)		
Girl	-0.014**	-0.009		
	(0.006)	(0.009)		
Mean of Y for first born boy	0.025	0.027		
Number of children	16,958	7,970		
Number of families	8,479	3,985		
Panel D. Florida: Birth cohorts 1994-2002				
	Suspensions		*Absences*	
Second-born	1.832***	2.822***	-0.001	-0.005
	(0.410)	(0.409)	(0.050)	(0.073)
Girl	-4.529***	-3.433***	-0.036	-0.021
	(0.239)	(0.231)	(0.030)	(0.038)
Mean of Y for first born boy	6.440	4.508	3.829	3.694
Number of observations	209,746	162,900	208,804	162,300
Number of children	38,758	33,976	38,684	33,918
Number of families	19,379	16,988	19,342	16,959

Note: Standard errors clustered at mother level. All estimates come from fixed effects regressions controlling for child birth year dummies.

Table 8: Heterogeneity effects by maternal education at birth

	(1)	(2)	(3)	(4)
	< 12 years	12+ years	< 12 years	12+ years
	Panel A. Denmark: Birth cohorts 1981-1990			
	Crime by age 16		*Crime by age 21*	
Second-born	0.013**	0.007**	0.044***	0.021***
	(0.006)	(0.003)	(0.009)	(0.006)
Girl	-0.024***	-0.010***	-0.158***	-0.083***
	(0.004)	(0.002)	(0.007)	(0.004)
Mean of Y for first born boy	0.052	0.021	0.218	0.108
Number of children	39,386	68,234	39,386	68,234
Number of families	19,693	34,117	19,693	34,117
	Panel B. Denmark: Birth cohorts 1981-1990			
	Prison by age 16		*Prison by age 21*	
Second-born	0.010***	0.002*	0.028***	0.012***
	(0.003)	(0.001)	(0.007)	(0.004)
Girl	-0.003	-0.001	-0.082***	-0.034***
	(0.002)	(0.001)	(0.005)	(0.003)
Mean of Y for first born boy	0.010	0.003	0.101	0.037
Number of children	39,386	68,234	39,386	68,234
Number of families	19,693	34,117	19,693	34,117
	Panel C. Florida: Birth cohorts 1994-2002			
	Suspensions		*Absences*	
Second-born	3.247***	1.447***	-0.154	0.015
	(0.794)	(0.215)	(0.115)	(0.029)
Girl	-7.077***	-3.638***	0.019	-0.037
	(0.668)	(0.168)	(0.096)	(0.024)
Mean of Y for first born boy	11.778	4.804	5.519	3.545
Number of observations	43,414	329,232	43,202	327,902
Number of children	8,436	64,298	8,420	64,182
Number of families	4,218	32,149	4,210	32,091

Note: Standard errors clustered at mother level. All estimates come from fixed effects regressions controlling for child birth year dummies.

Table 9: Heterogeneity effects by immigration origin

| | (1) | (2) | (3) | (4) |
	Native-born	Immigrants	Native-born	Immigrants
	Panel A. Denmark: Birth cohorts 1981-1990			
	Crime by age 16		*Crime by age 21*	
Second-born	0.008***	0.035***	0.025***	0.065***
	(0.003)	(0.008)	(0.005)	(0.012)
Girl	-0.014***	-0.045***	-0.108***	-0.161***
	(0.002)	(0.007)	(0.004)	(0.010)
Mean of Y for first born boy	0.030	0.065	0.143	0.214
Number of children	102,266	18,834	102,266	18,834
Number of families	51,133	9,417	51,133	9,417
	Panel B. Denmark: Birth cohorts 1981-1990			
	Prison by age 16		*Prison by age 21*	
Second-born	0.004***	0.019***	0.015***	0.043***
	(0.001)	(0.005)	(0.004)	(0.009)
Girl	-0.001	-0.015***	-0.049***	-0.117***
	(0.001)	(0.004)	(0.002)	(0.008)
Mean of Y for first born boy	0.005	0.021	0.058	0.103
Number of children	102,266	18,834	102,266	18,834
Number of families	51,133	9,417	51,133	9,417
	Panel C. Florida: Birth cohorts 1994-2002			
	Suspensions		*Absences*	
Second-born	1.813***	1.684***	-0.042	0.087
	(0.253)	(0.378)	(0.035)	(0.054)
Girl	-4.319***	-3.033***	-0.020	-0.073
	(0.194)	(0.325)	(0.028)	(0.046)
Mean of Y for first born boy	5.942	4.260	3.939	3.106
Number of observations	297,156	75,490	295,854	75,250
Number of children	57,990	14,744	57,884	14,718
Number of families	28,995	7,372	28,942	7,359

Note: Standard errors clustered at mother level. All estimates come from fixed effects regressions controlling for child birth year dummies. We define natives as individuals born in Denmark and Florida, respectively. We define immigrants in Florida based on the fact that mother was born outside of the US while in Denmark if either of the parents were born outside of Denmark.

Table 10: Heterogeneity effects by race and ethnicity: Florida birth cohorts 1994-2002

|	(1)	(2)	(3)	(4)
	Suspensions		*Absences*	
	Panel A. Race			
	African American	Not African American	African American	Not African American
Second-born	2.586***	1.618***	-0.209***	0.016
	(0.828)	(0.214)	(0.076)	(0.032)
Girl	-8.311***	-3.550***	-0.193***	-0.011
	(0.745)	(0.165)	(0.070)	(0.025)
Mean of Y for first born boy	11.617	4.888	3.456	3.808
Number of observations	39,388	333,258	39,226	331,878
Number of children	7,874	64,860	7,858	64,744
Number of families	3,937	32,430	3,929	32,372
	Panel B. Ethnicity			
	Hispanic	Non-Hispanic	Hispanic	Non-Hispanic
Second-born	1.506***	1.897***	0.066	-0.039
	(0.380)	(0.257)	(0.052)	(0.035)
Girl	-3.638***	-4.169***	-0.049	-0.025
	(0.332)	(0.194)	(0.044)	(0.028)
Mean of Y for first born boy	4.964	5.792	3.562	3.832
Number of observations	84,212	288,434	83,936	287,168
Number of children	16,520	56,214	16,496	56,106
Number of families	8,260	28,107	8,248	28,053

Note: Standard errors clustered at mother level. All estimates come from fixed effects regressions controlling for child birth year dummies. We define race and ethnicity based on maternal information at birth.

Figure 1: Birth order effects on criminal activity in early adulthood among boys: Estimates by age in Denmark
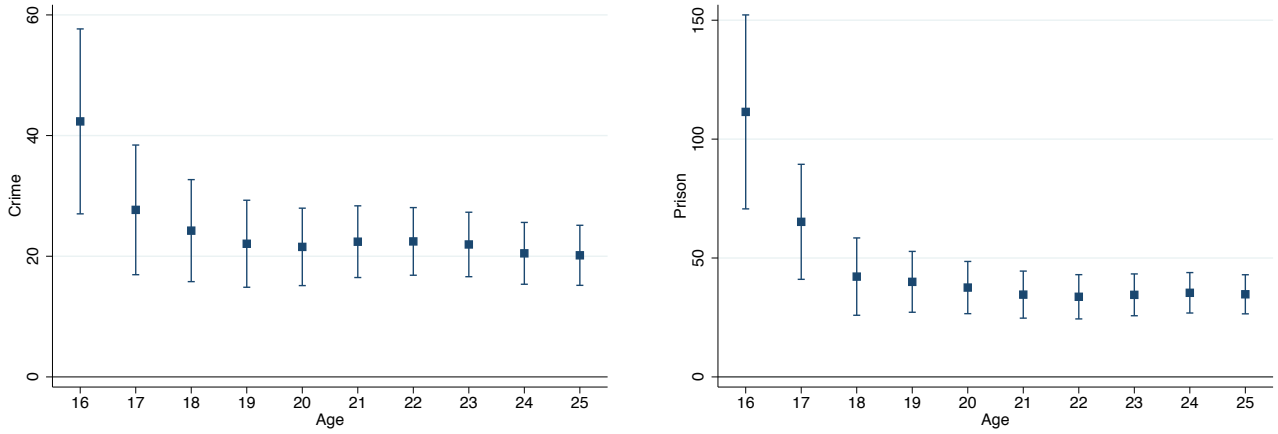
Note: Left hand side plot presents results for crime and right hand side plot presents results for incarceration. All estimates come from fixed effects regressions controlling for child birth year dummies and are scaled by means of dependent variable in a given group. Dependent variables is delinquency by given age or in given grade. Standard errors clustered at mother level. Estimates based on boy-boy and girl-boy sample.

Figure 2: Birth order effects on delinquency in childhood among boys: Estimates by grade in Florida
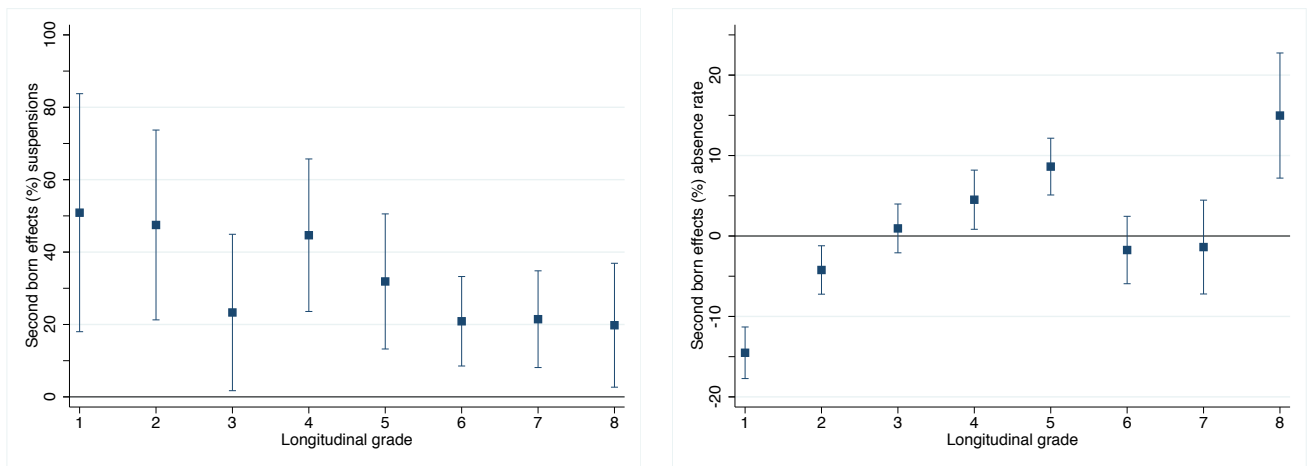
Note: Left hand side plot presents results for suspensions and right hand side plot presents results for absence rate. Estimates based on boy-boy and girl-boy sample. For further details see notes in Figure 1.

Figure 3: Birth order effects on cognitive development in childhood among boys: Estimates by grade in Florida
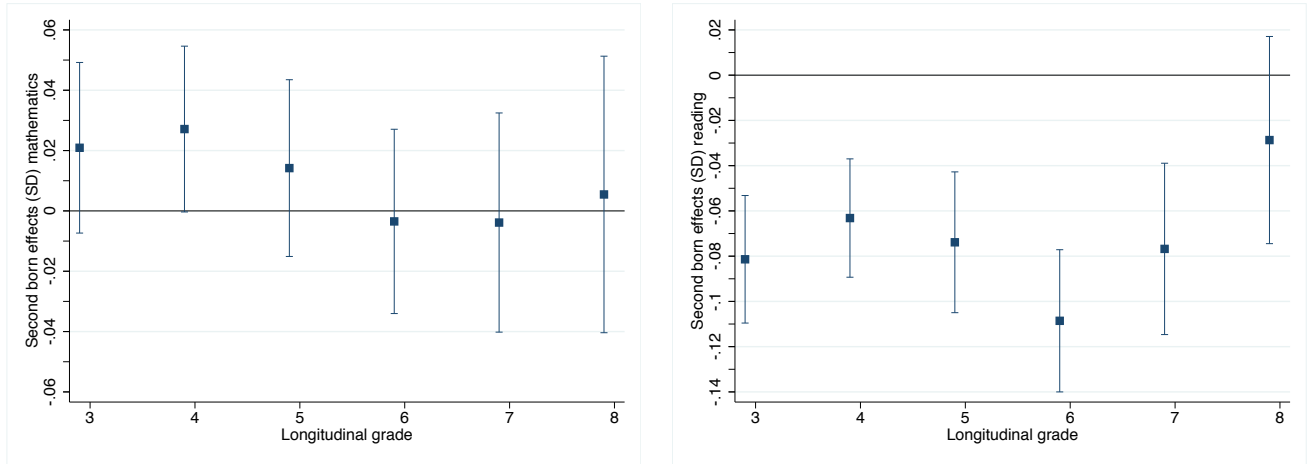
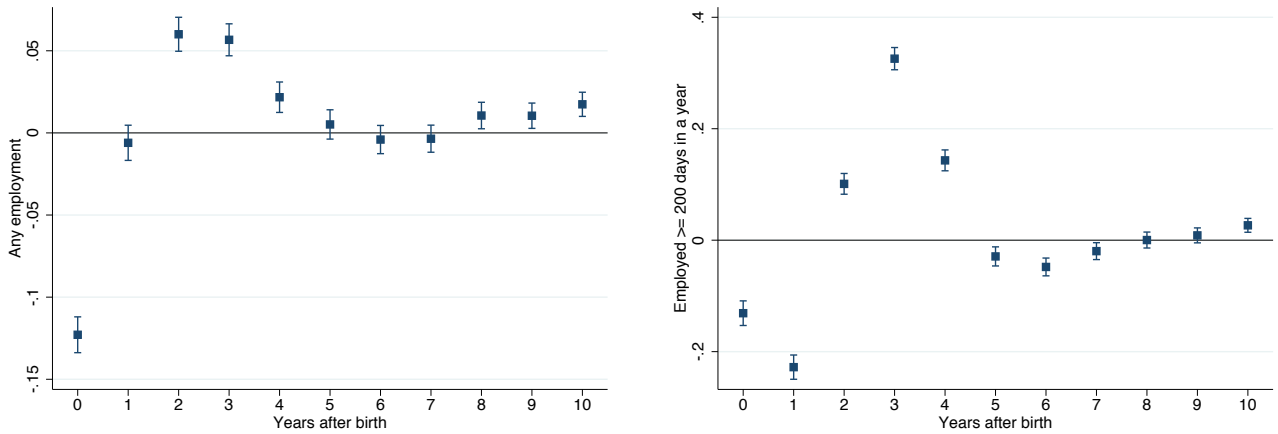

Note: Left hand side plot presents results for math test scores and right hand side plot presents results for reading test scores. Estimates based on boy-boy and girl-boy sample. For further details see notes in Figure 1.

Figure 4: Maternal labor market activity after birth among boys: Estimates for Denmark

Note: Left hand side plot presents results for any maternal employment and right hand side plot presents results for full time maternal employment. All estimates come from fixed effects regressions controlling for child birth year dummies and are scaled by means of dependent variable in a given group. Dependent variables is maternal employment in a given year after child birth i.e. being employed 1st year after birth, 2nd year after birth etc. Standard errors clustered at mother level. Estimates based on boy-boy and girl-boy sample.

Figure 5: Birth order effects on attended school quality among boys: Estimates by grade in Florida
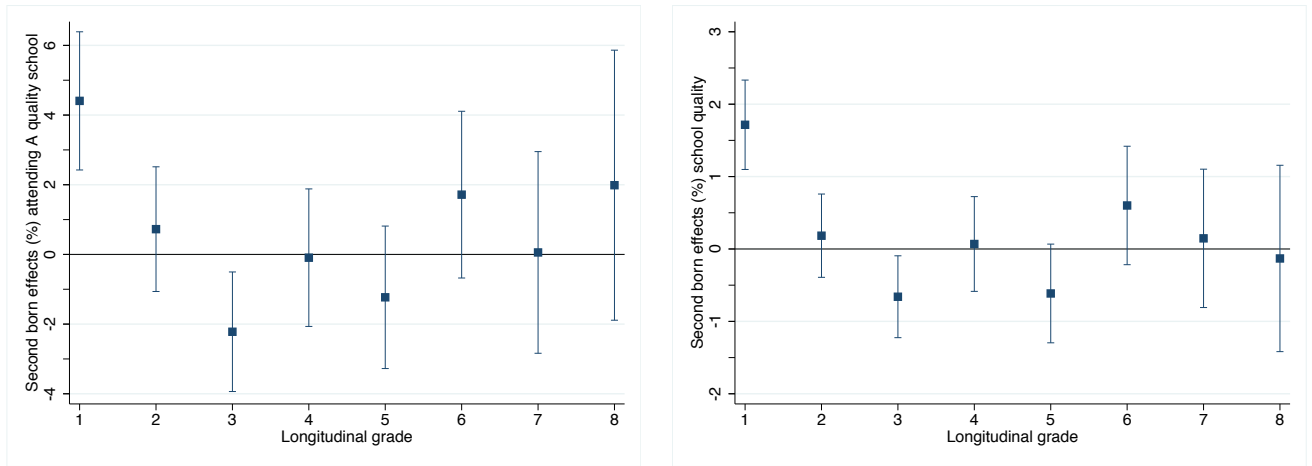
Note: Left hand side plot presents results for probability of attending A quality school and right hand side plot presents results for school quality on 0-4 scale. Estimates based on boy-boy and girl-boy sample. For further details see notes in Figure 1.

Appendix Tables

Table A1: Heterogeneity effects by maternal employment: Denmark birth cohorts 1981-1990

	(1)	(2)	(3)	(4)
	Non-employed	Employed	Non-employed	Employed
	Crime by age 16		*Crime by age 21*	
Second-born	0.023**	0.007**	0.036**	0.029***
	(0.010)	(0.003)	(0.017)	(0.006)
Girl	-0.015**	-0.015***	-0.144***	-0.107***
	(0.007)	(0.002)	(0.012)	(0.004)
Mean of Y for first born boy	0.046	0.030	0.213	0.139
Number of observations	11,426	80,286	11,426	80,286
Number of families	5,713	40,143	5,713	40,143
	Prison by age 16		*Prison by age 21*	
Second-born	0.016***	0.002	0.030**	0.017***
	(0.005)	(0.002)	(0.012)	(0.004)
Girl	-0.002	-0.003**	-0.068***	-0.048***
	(0.004)	(0.001)	(0.009)	(0.003)
Mean of Y for first born boy	0.010	0.006	0.097	0.055
Number of observations	11,426	80,286	11,426	80,286
Number of families	5,713	40,143	5,713	40,143

Note: Maternal employment is defines a mother working full or part time one year after birth. Standard errors clustered at mother level. All estimates come from fixed effects regressions controlling for child birth year dummies.

Table A2: Main results - robustness of fixed effects models

	(1)	(2)	(3)	(4)	(5)	(6)
	Denmark				Florida	
	Crime		Prison			
	By age 16	By age 21	By age 16	By age 21	Suspensions	Absence rate
Panel A: Additional maternal/household controls						
Second-born	0.015***	0.034***	0.008***	0.023***	1.667***	-0.012
	(0.003)	(0.005)	(0.001)	(0.003)	(0.217)	(0.030)
Girl	-0.019***	-0.116***	-0.003***	-0.059***	-4.054***	-0.032
	(0.002)	(0.004)	(0.001)	(0.002)	(0.168)	(0.024)
Mean of Y for first born boy	0.036	0.158	0.007	0.067	5.603	3.770
# children/families	121,100/60,550				72,734/36,367	72,602/36,301
Panel B: Controlling for birth outcomes						
Second-born	0.015***	0.035***	0.008***	0.022***	1.769***	-0.009
	(0.003)	(0.005)	(0.001)	(0.003)	(0.216)	(0.030)
Girl	-0.018***	-0.115***	-0.003***	-0.058***	-4.019***	-0.037
	(0.002)	(0.004)	(0.001)	(0.002)	(0.170)	(0.024)
Mean of Y for first born boy	0.036	0.158	0.007	0.067	5.603	3.770
# children/families	121,100/60,550				72,734/36,367	72,602/36,301
Panel C: Dropping families of size two						
Second-born	0.017***	0.049***	0.009***	0.031***	2.158***	-0.068
	(0.005)	(0.008)	(0.003)	(0.006)	(0.620)	(0.077)
Girl	-0.022***	-0.136***	-0.004**	-0.078***	-5.932***	0.109*
	(0.003)	(0.006)	(0.002)	(0.004)	(0.503)	(0.064)
Mean of Y for first born boy	0.043	0.168	0.012	0.074	7.938	3.961
# children/families	49,688/24,844				10,512/5,256	10,510/5,255

Note: Standard errors clustered at mother level. All estimates come from fixed effects regressions controlling for child birth year dummies. Additional controls in panel A include mother's age at birth, education, marital status and ZIP code of residence in the case of Florida. In Denmark controls include municipality dummies, mother's age at birth, anternal and paternal education, maternal and paternal employment as well as family income. Additional controls in panel B include log birth weight, maternal pregnancy complications and gestational length. Panel C drops families that have exactly two children. Birth cohorts for Denmark: 1981-1990; birth cohorts unnamed county in Florida (column (5)): September 1979 to August 1989; birth cohorts for the state of Florida: 1994-2002.

Table A3: Main results by gender composition

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Denmark					Florida	
	Crime		Prison		Juvenile justice system by age 16	Suspensions	Absence rate
	By age 16	By age 21	By age 16	By age 21			
Panel A: Boy-Boy families							
Second-born	0.014***	0.027***	0.005**	0.013***	0.013*	1.241***	-0.018
	(0.004)	(0.006)	(0.002)	(0.005)	(0.008)	(0.283)	(0.038)
Mean of Y for first born boy	0.036	0.158	0.007	0.067	0.026	5.603	3.770
# children/families	62,420/31,210				13,050/6,525	37,830/18,915	37,768/18,884
Panel B: Girl-Boy families							
Second-born	0.035***	0.161***	0.015***	0.093***	0.022***	6.413***	0.024
	(0.003)	(0.006)	(0.002)	(0.004)	(0.007)	(0.286)	(0.041)
Mean of Y for first born girl	0.012	0.040	0.001	0.007	0.011	1.895	3.834
# children/families	58,680/29,340				11,916/5,958	34,904/17,452	34,834/17,417
Panel C: Girl-Girl families							
Second-born	-0.000	0.005	-0.000	0.007***	-0.002	0.799***	-0.038
	(0.002)	(0.004)	(0.001)	(0.002)	(0.006)	(0.178)	(0.039)
Mean of Y for first born girl	0.012	0.042	0.001	0.007	0.012	1.807	3.864
# children/families	55,756/27,878				11,696/5,848	33,580/16,790	33,512/16,756
Panel D: Boy-Girl families							
Second-born	-0.023***	-0.123***	-0.008***	-0.068***	-0.015**	-4.182***	-0.199***
	(0.003)	(0.006)	(0.001)	(0.004)	(0.007)	(0.261)	(0.039)
Mean of Y for first born boy	0.032	0.152	0.006	0.061	0.025	5.955	3.865
# children/families	58,864/29,432				11,992/5,996	36,270/18,135	36,210/18,105

Note: Standard errors clustered at mother level. All estimates come from fixed effects regressions controlling for child birth year dummies. Birth cohorts for Denmark: 1981-1990; birth cohorts unnamed county in Florida (column (5)): September 1979 to August 1989; birth cohorts for the state of Florida: 1994-2002.

Table A4: Main results by gender composition and spacing: Second-born boy effects

	(1)	(2)	(3)	(4)	(5)	(6)
		Denmark			Florida	
	Crime		Prison		Suspensions	Absence rate
	By age 16	By age 21	By age 16	By age 21		
Panel A1: Boy-Boy families and siblings 1-2 years apart						
Second-born	-0.017*	0.018	-0.004	0.019*	1.333**	0.005
	(0.009)	(0.015)	(0.005)	(0.011)	(0.540)	(0.067)
Mean of Y for first born boy	0.039	0.175	0.010	0.076	6.440	3.829
# children/families		25,150/12,575			20,358/10,179	20,326/10,163
Panel A2: Boy-Boy families and siblings 3 or more years apart						
Second-born	0.006	0.021*	0.000	-0.001	2.472***	-0.028
	(0.006)	(0.011)	(0.003)	(0.008)	(0.575)	(0.099)
Mean of Y for first born boy	0.033	0.146	0.005	0.061	4.508	3.694
# children/families		37,270/18,635			17,472/8,736	17,442/8,721
Panel B1: Girl-Boy families and siblings 1-2 years apart						
Second-born	0.040***	0.193***	0.024***	0.127***	6.798***	0.028
	(0.008)	(0.014)	(0.004)	(0.010)	(0.575)	(0.071)
Mean of Y for first born girl	0.013	0.046	0.001	0.009	2.383	3.882
# children/families		23,402/11,701			18,400/9,200	18,358/9,179
Panel B2: Girl-Boy families and siblings 3 or more years apart						
Second-born	0.018***	0.119***	0.008***	0.070***	6.682***	0.038
	(0.005)	(0.010)	(0.002)	(0.006)	(0.544)	(0.103)
Mean of Y for first born girl	0.012	0.037	0.001	0.006	1.277	3.773
# children/families		35,278/17,639			16,504/8,252	16,476/8,238

Note: Standard errors clustered at mother level. All estimates come from fixed effects regressions controlling for child birth year dummies. Birth cohorts for Denmark: 1981-1990; birth cohorts unnamed county in Florida (column (5)): September 1979 to August 1989; birth cohorts for the state of Florida: 1994-2002.

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Table A5: Main results by gender composition and spacing: Second-born girl effects

	(1)	(2)	(3)	(4)	(5)	(6)
		Denmark			Florida	
	Crime		Prison			
	By age 16	By age 21	By age 16	By age 21	Suspensions	Absence rate
			Panel A1: Girl-Girl families and siblings 1-2 years apart			
Second-born	-0.011**	0.002	0.000	0.007	0.812**	-0.050
	(0.005)	(0.009)	(0.002)	(0.005)	(0.360)	(0.066)
Mean of Y for first born girl	0.014	0.046	0.001	0.009	2.160	3.913
# children/families		22,080/11,040			18,020/9,010	17,982/8,991
			Panel A2: Girl-Girl families and siblings 3 or more years apart			
Second-born	-0.000	0.002	-0.002	0.003	0.783**	0.220**
	(0.004)	(0.007)	(0.001)	(0.003)	(0.342)	(0.096)
Mean of Y for first born girl	0.011	0.038	0.001	0.006	1.344	3.799
# children/families		33,676/16,838			15,560/7,780	15,530/7,765
			Panel B1: Boy-Girl families and siblings 1-2 years apart			
Second-born	-0.033***	-0.152***	-0.012***	-0.093***	-5.425***	-0.196***
	(0.007)	(0.014)	(0.003)	(0.009)	(0.504)	(0.065)
Mean of Y for first born boy	0.037	0.168	0.008	0.074	6.571	3.899
# children/families		23,622/11,811			19,600/9,800	19,562/9,781
			Panel B2: Boy-Girl families and siblings 3 or more years apart			
Second-born	-0.025***	-0.116***	-0.005***	-0.051***	-3.694***	-0.141
	(0.005)	(0.010)	(0.002)	(0.006)	(0.527)	(0.097)
Mean of Y for first born boy	0.029	0.142	0.004	0.053	5.137	3.820
# children/families		35,242/17,621			16,670/8,335	16,648/8,324

Note: Standard errors clustered at mother level. All estimates come from fixed effects regressions controlling for child birth year dummies. Birth cohorts for Denmark: 1981-1990; birth cohorts unnamed county in Florida (column (5)): September 1979 to August 1989; birth cohorts for the state of Florida: 1994-2002.

Table A6: Daycare by age of the child: Denmark birth cohorts 1993-2000

	(1)	(2)	(3)
	At age 1	At age 2	At age 3
Second-born	-0.172***	0.034***	0.108***
	(0.007)	(0.006)	(0.006)
Girl	-0.002	-0.007	-0.011***
	(0.005)	(0.004)	(0.004)
Mean of Y for first born boy	0.160	0.667	0.764
Number of observations		87,442	
Number of families		43,721	

Note: Standard errors clustered at mother level. All estimates come from fixed effects regressions controlling for child birth year dummies.

Table A7: Short-run non-cognitive outcomes: Denmark birth cohorts 1999-2000

	(1)	(2)	(3)	(4)
	Close to average	Slightly raised	High	Very high
	Panel A: Emotional problems score			
Second-born	-0.002	0.008	-0.013	0.006
	(0.020)	(0.014)	(0.010)	(0.011)
Girl	-0.114***	0.031**	0.011	0.071***
	(0.019)	(0.014)	(0.011)	(0.012)
Mean of Y for first born boy	0.878	0.059	0.041	0.022
	Panel B: Conduct problems score			
Second-born	-0.013	-0.002	-0.000	0.016
	(0.021)	(0.016)	(0.012)	(0.010)
Girl	0.051***	-0.016	-0.029***	-0.006
	(0.017)	(0.013)	(0.010)	(0.008)
Mean of Y for first born boy	0.847	0.079	0.051	0.023
	Panel C: Hyperactivity score			
Second-born	-0.049**	-0.005	0.029**	0.024
	(0.023)	(0.017)	(0.012)	(0.015)
Girl	0.041**	-0.016	-0.007	-0.019
	(0.019)	(0.013)	(0.010)	(0.011)
Mean of Y for first born boy	0.820	0.080	0.040	0.061
	Panel D: Peer problems score			
Second-born	-0.013	-0.024	0.023	0.013
	(0.029)	(0.022)	(0.019)	(0.018)
Girl	0.079***	-0.052***	-0.024*	-0.003
	(0.024)	(0.018)	(0.014)	(0.015)
Mean of Y for first born boy	0.638	0.170	0.097	0.095
Number of children		3,370		

Note: Standard errors clustered at mother level. OLS regressions in columns (1)-(4) include the following controls: child birth year dummies, mother age at first birth, mother age, father age, municipality dummies, maternal and paternal education, maternal and paternal employment, family income, immigrant dummy, number of children in family. The questionnaire was answered by 6th grade students from birth cohorts 1998-2000. These are sub-scores for the results reported in panel A of Table 4.

Table A8: Mechanisms: neonatal and childhood health, parental investment and school quality: Second-born girl effects

Panel A. Denmark: Birth cohorts 1981-1990

	(1) Ln(birth weight)	(2) Complications in pregnancy	(3) Days of maternity leave	(4) Maternal employment one year after birth	(5) Out of home daycare at age 2	(6) School starting age (1st grade)	(7) Disorders of psychological development	(8) Behavioural and emotional disorders
Second-born	0.036***	-0.051***	-8.341***	-0.002	0.042***	-0.257***	-0.004*	-0.001
	(0.002)	(0.005)	(0.720)	(0.004)	(0.007)	(0.007)	(0.002)	(0.003)
Girl	-0.036***	0.001	0.395	-0.004	0.007	-0.095***	-0.017***	-0.021***
	(0.001)	(0.004)	(0.551)	(0.003)	(0.005)	(0.005)	(0.001)	(0.002)
Mean of Y for first born boy	8.107	0.259	148.939	0.762	0.653	6.665	0.004	0.010
Number of children	161,814	161,814	92,992	164,476	84,072	165,012	80,558	80,558
Number of families	80,907	80,907	46,496	82,238	42,036	82,506	40,279	40,279

Panel B. Florida: Birth cohorts 1994-2002

	(1) Ln(birth weight)	(2) Complications in pregnancy	(3) Pre-kindergarten participation	(4) Held back a year	(5) Attending A quality school in first grade	(6) School quality (0-4) in first grade	(7) Cognitive disability	(8) Behavioral disability
Second-born	0.028***	-0.040***	0.054***	-0.007**	0.035***	0.062***	-0.012***	0.006
	(0.003)	(0.007)	(0.008)	(0.003)	(0.007)	(0.012)	(0.003)	(0.004)
Girl	-0.034***	0.007	-0.029***	-0.033***	-0.006	-0.016*	-0.036***	-0.036***
	(0.002)	(0.006)	(0.006)	(0.003)	(0.005)	(0.009)	(0.003)	(0.003)
Mean of Y for first born boy	8.081	0.223	0.518	0.032	0.659	3.469	0.032	0.037
Number of children	69,850	69,849	69,850	69,850	66,708	66,708	69,850	69,850
Number of families	34,925	34,925	34,925	34,925	33,354	33,354	34,925	34,925

Note: Standard errors clustered at mother level. All estimates come from fixed effects regressions controlling for child birth year dummies.

Appendix Figures

Figure A1: Birth order effects on criminal activity in early adulthood among girls: Estimates by age in Denmark
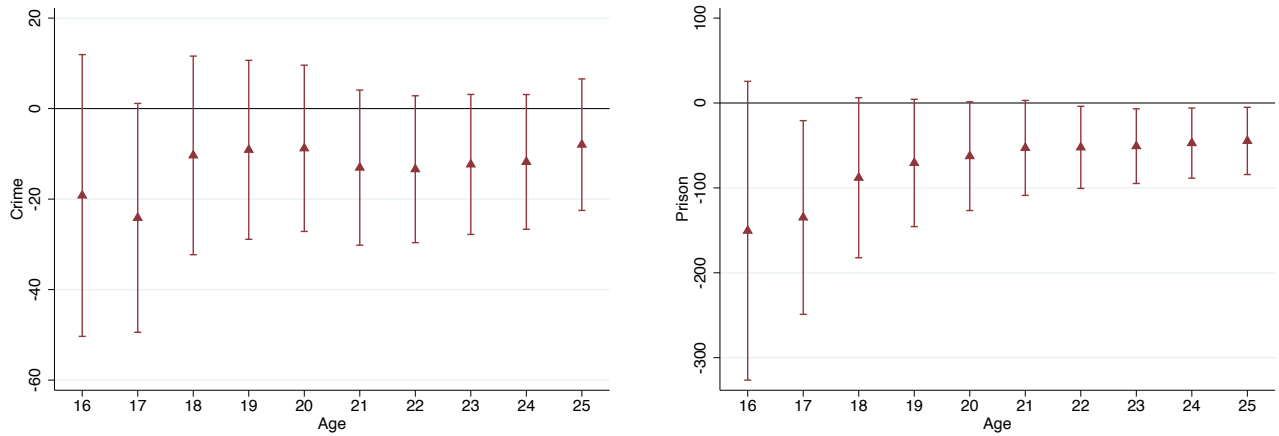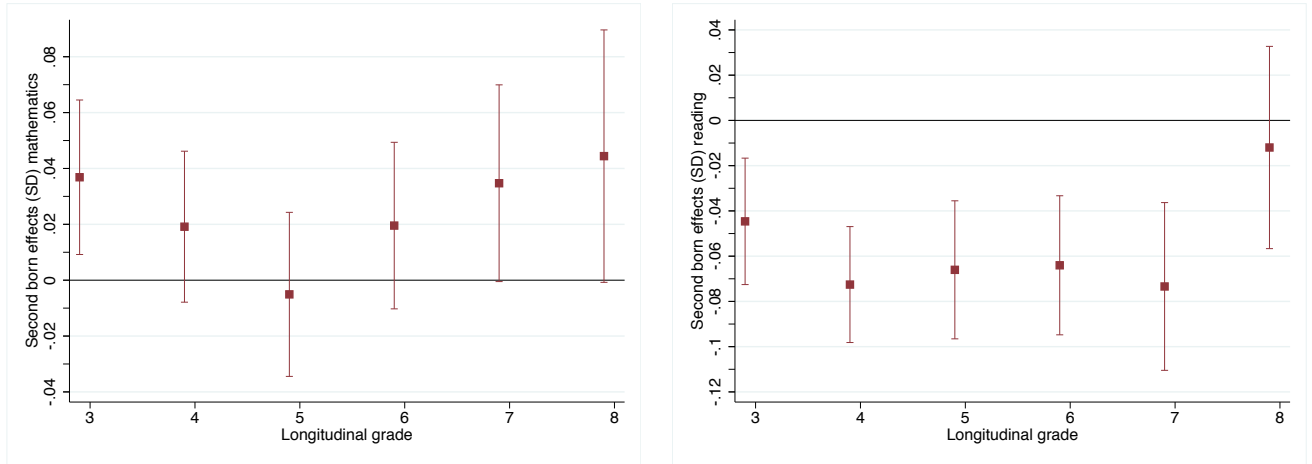

Note: Left hand side plot presents results for crime and right hand side plot presents results for incarceration. All estimates come from fixed effects regressions controlling for child birth year dummies and are scaled by means of dependent variable in a given group. Dependent variables is delinquency by given age or in given grade. Standard errors clustered at mother level. Estimates based on girl-girl and boy-girl sample.

Figure A2: Birth order effects on delinquency in childhood among girls: Estimates by grade in Florida
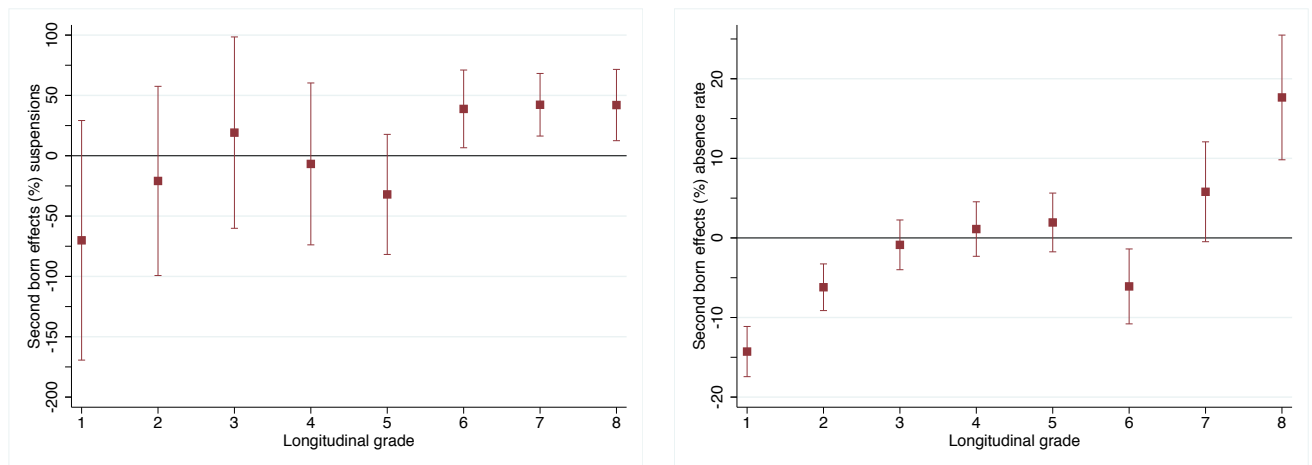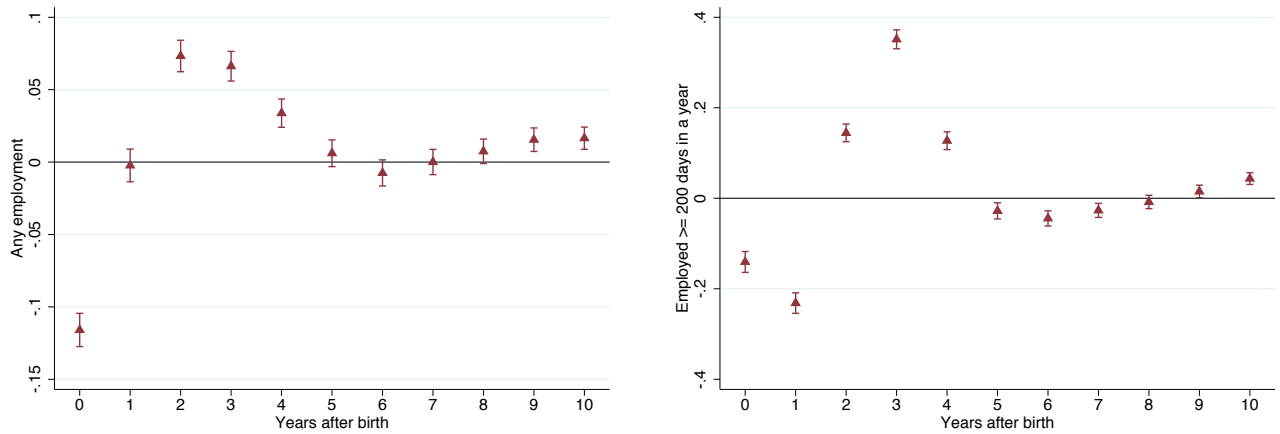

Note: Left hand side plot presents results for suspensions and right hand side plot presents results for absence rate. Estimates based on girl-girl and boy-girl sample. For further details see notes in Figure 1.

Figure A3: Birth order effects on cognitive development in childhood among girls: Estimates by grade in Florida
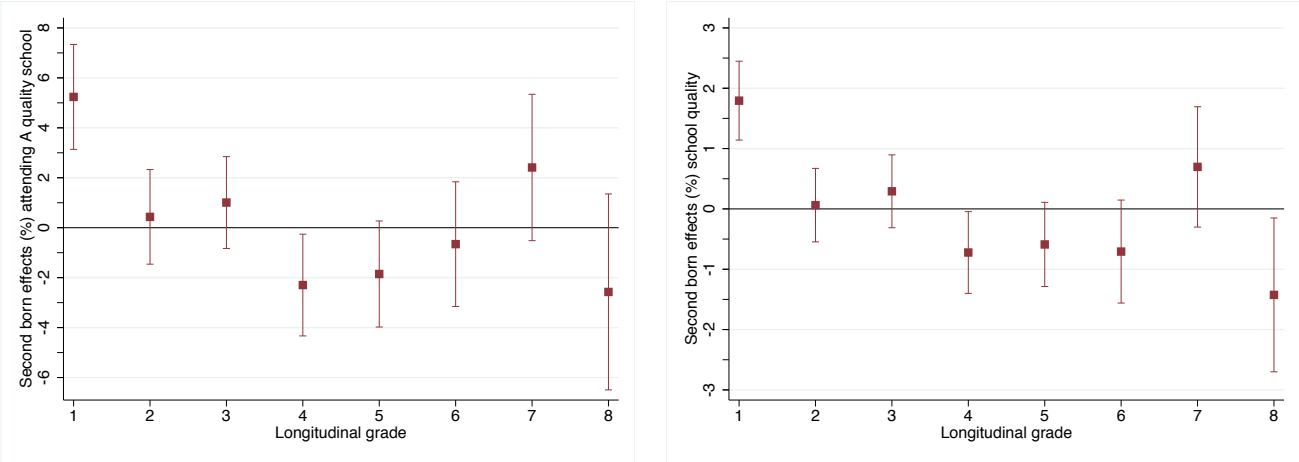

Note: Left hand side plot presents results for math test scores and right hand side plot presents results for reading test scores. Estimates based on girl-girl and boy-girl sample. For further details see notes in Figure 1.

Figure A4: Maternal labor market activity after birth among girls: Estimates for Denmark

Note: Left hand side plot presents results for any maternal employment and right hand side plot presents results for full time maternal employment. All estimates come from fixed effects regressions controlling for child birth year dummies and are scaled by means of dependent variable in a given group. Dependent variables is maternal employment in a given year after child birth i.e. being employed 1st year after birth, 2nd year after birth etc. Standard errors clustered at mother level. Estimates based on girl-girl and boy-girl sample.

Figure A5: Birth order effects on attended school quality among girls: Estimates by grade in Florida

Note: Left hand side plot presents results for probability of attending A quality school and right hand side plot presents results for school quality on 0-4 scale. Estimates based on girl-girl and boy-girl sample. For further details see notes in Figure 1.