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As Published: 10.1086/704497

Publisher: University of Chicago Press

Persistent URL: https://hdl.handle.net/1721.1/136518

Version: Final published version: final published article, as it appeared in a journal, conference proceedings, or other formally published context

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Birth Order and Delinquency: Evidence from Denmark and Florida

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Little is known about the role birth order plays in delinquency and adult crime outcomes that carry significant externalities. We use rich data sets from Denmark and Florida to examine these outcomes and explore potential mechanisms. Despite large environmental differences between the areas, we find remarkably consistent results: in families with two or more children, secondborn boys are 20%–40% more likely to be disciplined in school and enter the criminal justice system than are their firstborn male siblings. We rule out health at birth and school quality as mechanisms but find evidence for the role of parental time investment.

I. Introduction

Economists and policy makers have long been interested in the production function for human capital, with increasing attention paid to the development

We thank Paul Bingley, Dalton Conley, John Donohue, Jens Ludwig, Justin McCrary, Joe Price, and numerous seminar participants at the Danish Institute for

[*Journal of Labor Economics*, 2020, vol. 38, no. 1]
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Submitted November 21, 2017; Accepted October 5, 2018; Electronically published November 4, 2019

of noncognitive skills (Cunha, Heckman, and Schennach 2010; Conti, Heckman, and Pinto 2016). Delinquency is a welfare-relevant manifestation of lower-level acquisition of noncognitive skills. At young ages, disruptive peers have been shown to significantly impair learning (Carrell and Hoekstra 2010; Kristoffersen et al. 2015; Carrell, Hoekstra, and Kuka 2018). At older ages, crime incurs direct harm on others and leads to 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 noncognitive 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; however, estimating effects of parental investments and sibling influences can be confounded by endogeneity concerns.

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, e.g., Adler 1928; Behrman and Taubman 1986; Sulloway 1996). The main recent empirical contributions stem from work by Black, Devereux, and Salvanes. Their 2005 study employed large data sets from Norway for outcomes measured from 1986 to 2000, and they find large birth order effects on child outcomes that appear to dominate those associated with family size. Using between- and within-family variation in birth order, laterborn 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 settings.

Local and Regional Government Research, the National Bureau of Economic Research (NBER) Summer Institute Economics of Crime Workshop, the CESifo Economics of Education Group Conference, the University of Essex, and the University of Notre Dame. We are grateful to the Florida Departments of Education and Health for providing the deidentified matched data used in this analysis. Sanni Breining gratefully acknowledges financial support from the Centre for Integrated Register-Based Research at Aarhus University (CIRRAU) and the Danish Council for Independent Research. David N. Figlio appreciates funding from the US Department of Education, the National Institutes of Health, and the Bill and Melinda Gates Foundation. The conclusions expressed in this paper are those of the authors and do not represent the positions of the Florida Departments of Education and Health or those of our funders. All errors are our own. Contact the corresponding author, David N. Figlio, at figlio@northwestern.edu. Information concerning access to the data used in this paper is available as supplemental material online.

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 crime and imprisonment—using large-scale data sets that 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 registry data in Denmark and linked administrative data in Florida, we are able to investigate potential mechanisms for such differences. This information 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 secondborn boys are substantially more likely to exhibit delinquency problems than their older sibling. In particular, involvement with the juvenile justice system is found to be on the order of 30%–40% higher compared with the mean level of involvement among firstborn boys in both Denmark and Florida. For example, 7.2% of firstborn boys in Denmark are sentenced to prison by the age of 21, and we estimate that secondborn boys have a rate that is 2.4 percentage points higher: a 33% difference when comparing brothers in the same household. These effects are particularly strong among more severe violent crimes (36%). In Florida, similarly large effects are found for suspensions in school (29%), 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 (secondborn children appear healthier) or in childhood (secondborn children have fewer disabilities); schooling decisions, including the age of entry and the quality of schools chosen (secondborn children attend no worse schools and are more likely to attend prekindergarten and day care); and maternal employment (measured by maternity leave) in the first year of life. We do find that maternal employment and the use of day care is higher for secondborns in years 2–4 compared with older siblings. While it is often noted that firstborns have undivided attention until the arrival of the secondborn, our results show that the arrival of the secondborn child has the potential to extend the early-childhood parental investment in the firstborn child that may compound the natural bifurcation of parental attention between first- and secondborn children. We also consider test score outcomes in both Denmark and Florida and find that secondborn boys score lower on reading and math assessments in Denmark but only on reading tests in Florida, in comparison to their older siblings.

This achievement gap may be a signal and a contributor the delinquency results that we find later in life.

The remainder of the paper is organized as follows. Section II provides a brief background on the previous literature with an emphasis on the areas where our results represent a contribution. Section III describes the data. Section IV presents the empirical framework. Section V reports the main results, mechanisms, heterogeneity, and robustness checks. Section VI concludes.

II. Background

A. Previous Evidence on Birth Order and Delinquency

Previous work focusing on delinquency has relied on survey data at a smaller scale and self-reported measures (Argys et al. 2006; Averett, Argys, and Rees 2011; Cundiff 2013). These studies tend to find modest to no evidence of increased delinquency associated with birth order, along with substance use and sexual activity. However, none of these studies investigate objectively measured and arguably more socially costly criminal outcomes, such as convictions or incarceration. Cundiff (2013) uses Add Health data to study self-reported delinquency—a composite measure including marijuana use, nonviolent crime, and binge drinking—finding a relatively imprecise null effect of birth order when using family fixed effects. Averett, Argys, and Rees (2011) also use Add Health data and confirm birth order differences in risky behavior that cannot be explained by differential parental supervision. Meanwhile, Argys et al. (2006) use National Longitudinal Survey of Youth 1997 (NLSY97) data investigating smoking, drinking, marijuana use, sexual intercourse, and criminal activity. Although they find birth order differences in substance use and sexual activity, their results on self-declared crime are much weaker and inconclusive. Silles (2010) studies the National Child Development Study—a study of children born in one week in 1958 in the United Kingdom and followed afterward—and finds that first-born (and last-born) children have improved noncognitive test scores.

Unfortunately, it is difficult to estimate family fixed effects models with precision in these survey data sets. For example, Cundiff (2013) includes 655 families, and the odds ratio for delinquency is relatively imprecise (0.86–1.52 for middle-born compared with firstborn children). The current paper relies on much larger administrative data sets that provide more precision when using within-family variation in birth order to compare siblings. Furthermore, we focus on outcomes that carry significant costs to child development (e.g., suspensions and the related outcome of disruptive peers) as well as society (e.g., incarceration), and we are able to investigate the mechanisms in much more detail, including those that relate to formal investments in human capital as opposed to pure home supervision. Finally, we are the first to document, albeit across two different data sets, developmental trajectory in delinquent behavior.

B. Potential Mechanisms

While birth order effects in education and labor market outcomes have been explored, the mechanisms behind these 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 trade-off (Black, Devereux, and Salvanes 2005; Rosenzweig and Zhang 2009; Angrist, Lavy, and Schlosser 2010; Mogstad and Wiswall 2016) that varies depending on the parity examined and outcome. In this line of research it is particularly hard to uncover the causal effects of being a single child, which is an interesting baseline case for our paper, as birth order differences do not occur in such families. Perhaps the best evidence to date on singleton families comes from China's one-child policy and suggests that firstborn children may benefit cognitively (Qian 2009) and behaviorally (Cameron et al. 2013) from having siblings. To the extent that these results generalize to contemporary United States or Denmark, it would suggest that firstborns gain not only from undivided attention and resources early in life but also potentially from positive peer effects later.

Empirically, parental time investments are mostly found to be lower for later-born children, as the firstborn has some undivided attention from parents until a younger sibling arrives (Price 2008).[2] Averett, Argys, and Rees (2011) find that firstborn children are supervised more and have fewer risky behaviors. Pavan (2016) confirms that parents in the United States dedicate more resources to firstborns, and using structural estimation suggests that differences in parental investments across siblings can account for more than

[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 firstborns, such as superior performance at school and better behavior. Sulloway (1996) presents a related argument, that firstborn children may be more likely to identify with their parents and therefore to emulate and obey their parents in order to gain parental attention.

[2] Price (2008) investigated the American Time Use Survey and found that firstborns get 20–30 minutes more quality time each day than do secondborns in a similar family. This appears to be due to equalizing time after the secondborn arrives even thought the firstborn had undivided attention when there was only one child in the household.

50% of observed birth order gap in cognitive ability. Lehmann, Nuevo-Chiquero, and Vidal-Fernandez (2018) 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 and less likely to abstain from alcohol during pregnancy and breastfeeding, 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. In the Swedish context, Ginja, Jans, and Karimi (2017) study a plausibly exogenous increase in parental leave benefits with the arrival of later-born children and find that the resulting increase in parental leave and financial resources leads to improved outcomes for earlier- but not later-born children—an improvement that could be responsible for as much as a third of the gap in cognitive ability between first- and secondborn children. Meanwhile, evidence from Ecuador suggests that if parents invest more in the later-born children, the birth order effects can be reversed (de Haan, Plug, and Rosero 2014). In this particular setting, firstborns in lower-income families are found to receive less quality time with mothers and are less likely to be breastfed followed by lower human capital accumulation. This result suggests that perhaps birth order per se is not important, but rather it is context-specific behavior of parents that can explain differences between children in longer-run outcomes.

A second explanation is the influence that siblings have on one another: the quintessential peer effect. Later-born children, unlike firstborns, will have older siblings as role models (Zajonc and Markus 1975). In addition, older siblings may also 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 (Manski 1995; Black et al. 2016; Joensen and Nielsen 2018; Qureshi 2018). 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 historically increased educational attainment of women, although there is mixed empirical evidence for these effects, with some studies finding no effects and others finding opposite effects (Kaestner 1997; Hauser and Kuo 1998; Conley 2000; Deschenes 2007; Chen, Chen, and Liu 2009; Dayioglu, Kirdar, and Tansel 2009).

Finally, it could be the case that the differential inputs or peer effects described above lead not only to changes in cognitive ability but also to differences in personality, and low levels of noncognitive skills are correlated with increased delinquency (Hill et al. 2011). Such differences have been proposed in the early work by psychologists (e.g., Adler 1928) and more recently explored in large-scale data (e.g., Black, Gronqvist, and Ockert 2018);

however, the evidence is less uniform in this domain, which is likely due to power and measurement error issues (Ernst and Angst 1983). The best evidence to date on this topic, based on the population of Swedish-born males, suggests that firstborn children indeed have advantages across a variety of personality traits, including conscientiousness and emotional stability. These children are also more likely to invest in their own development (e.g., read books or spend time on homework) and be controlled by their parents (Black, Gronqvist, and Ockert 2018).

C. Data Description

A. Denmark

For Denmark, the key data source is the Danish Birth Registry, which includes information on all individuals born in the period 1960–2010, and our main outcomes focus on a subset of children born between 1981 and 1990. For each child, the data set includes information on exact date 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 date of birth, we can measure each individual's birth order, the completed family size, and the sex composition of children in the family.[3] 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 delinquency behavior. To characterize such behavior in the Danish context we exploit access to the criminal registers, which include convictions, suspended prison sentences and incarceration, and date of crime as well as 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 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. As a more severe measure of crime, we also consider having ever been issued suspended or implemented imprisonment sentence by those ages. All outcome variables are multiplied by 100 to obtain percent values. Our data also allow us to explore effects at other ages and across different types of crimes.

In addition, we are able to explore measures of noncognitive skills during childhood. Delinquency can be viewed as a behavioral outcome that is the consequence of lower levels of noncognitive skills development, and there is evidence of birth order effects on noncognitive skills (Black, Gronqvist, and

[3] We can measure completed family size to the extent that subsequent children in a family with first- and secondborns born from 1981 to 1990 are born before December of 2010.

Ockert 2018); however, they evaluate noncognitive skills later in life (at the time of the military draft) and are not able to measure behaviors that could be related to later-life crime, such as emotional, hyperactivity, and conduct problems.[4] The Danish data, on the other hand, provide us with information gathered in the internationally recognized Strengths and Difficulties Questionnaire (SDQ),[5] a behavioral screening questionnaire conducted when children are roughly 12 years old. These data were collected as part of the Danish two-teachers experiment.[6]

The SDQ contains 25 items within five dimensions. Four of the dimensions concern difficulties covering conduct problems, emotional symptoms, hyperactivity, and peer relationships. One dimension concerns strengths and covers prosocial behavior.[7] In line with past literature, we can use the four difficulty dimensions to generate the total difficulty score reflecting the child's socioemotional behavior. We follow the SDQ scoring rubric (Goodman, Rowe, and Gan 2010) and divide these scores into four categories: close to average, slightly raised, high, and very high.[8] Each of these categories will constitute an outcome that we will study in the analysis below. 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 noncognitive skills by birth order in early adolescence.

One of the innovations in the paper is our ability to explore potential mechanisms that can explain the birth order effects. The 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.

[4] On the other hand, Rohrer, Egloff, and Schmukle (2015) find no evidence for birth order effects on extraversion, agreeableness, conscientiousness, or imagination.

[5] The SDQ was first developed by Goodman (1997) and later used in numerous studies (e.g., Currie and Lin 2007; Kelly et al. 2009; Berger and Spiess 2011; Datta Gupta and Simonsen 2012; Kristoffersen et al. 2015).

[6] The experiment was conducted in the 2012–13 school year and took place at the intermediate stage of primary school (sixth 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 of its sixth graders were included. For more information about this data, see 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 of 2012. Here they were around 12 years old.

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

[8] Each of the scales of the SDQ is scored from 0 to 10, and we follow the psychology literature in forming the index and discretizing it: we add up the four scores to calculate a total difficulty score (range, 0–40) and then categorize them such that 80% of children score "close to average," 10% are "slightly raised," 5% are "high," and 5% are "very high."

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 day-care institutions we obtain information about the populations' use of day-care 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 day care at ages 1–3.

Next, we add a measure of school-starting age to see whether parents are treating secondborn children differently at that stage of the life cycle. Then we use information from the Danish National Patient Registry and Danish Psychiatric Central Registry. From these data we have information about psychiatric and behavioral diagnoses of all children diagnosed in Denmark (inpatient, outpatient, or emergency department). We consider two groups of diagnoses—disorders of psychological development as well as behavioral and emotional disorders—and we observe whether the child has received such a diagnosis by age 10.[9]

To obtain a measure of performance in school, we study data from the school registers. In Denmark, the typical child enters the first grade of compulsory schooling education the year they turn 7.[10] Compulsory school is completed with a ninth-grade exit exam.[11] We measure performance in school 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.

B. Florida

The Florida Departments of Education and Health merged 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 purpose of this research. 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 matched so long as (1) there were no more than two instances of modest inconsistencies and (2) there were no other children

[9] 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 attention-deficit/hyperactivity disorder (ADHD).

[10] A few children may be 1 year younger, and a few may be 1 year older; we also consider school starting age as an outcome.

[11] The Danish educational system is publicly funded 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.

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 1% 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 1994–2002 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% 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 using data from the decennial census and American Community Survey for the years 2000–2009.[12] 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 students we believe to be siblings are actually siblings (e.g., by comparing maternal characteristics, such as date of birth).[13]

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 the birth certificate, and health and demographic characteristics of the newborn.[14] In particular, we observe birth weight and indicators for any maternal health problems, regardless of whether they are related to the pregnancy.

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

[13] We can observe births and match siblings only among those born between 1994 and 2002. This means that we do not observe siblings born outside this data window and thus cannot compute completed family size in the case of Florida. However, because of the match to birth records, we know the exact birth order as enumerated on the birth certificate. Based on this information, we select first births to the mother, which means that no firstborn in our empirical sample can have an older sibling; however, both children can have younger siblings born after 2002 that we do not observe in the data. Given that our results are insensitive to controlling or not controlling for completed family size (we can observe this information in Denmark and in a large Florida county), which is also consistent with the prior literature, we do not believe that this constraint in Florida statewide data is a major limitation.

[14] 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.

Our primary in-school delinquency outcomes are suspensions and truancy. We obtain these measures from administrative school records that are available for the school years from 2002–3 through 2011–12. We measure suspensions as an indicator variable for whether the child was ever temporarily removed from school in a given school year, while we measure truancy based on the reported absence rate, defined as the number of days absent (net of suspended days) in school to total number of days that the child was enrolled in a given school year.[15] Both variables are multiplied by 100 to obtain percent values.[16] We have repeated observations for each student, which will allow us to trace effects across different grades.[17]

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 the Florida Comprehensive Assessment Test (FCAT) in mathematics and reading, a statewide standardized yearly assessment of all students in Florida conducted in grades 3–10. In this paper, we focus on test scores in grades 3–8 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 disabilities, such as orthopedic impairments, sensory impairments, and speech pathologies, as well as intellectual and 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.

[15] Florida law defines a "habitual truant" as a "student who has 15 or more unexcused absences within 90 calendar days with or without the knowledge or consent of the student's parent or guardian." We focus on days absent from school as an indicator of a proclivity toward truancy.

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

[17] We base our analysis on longitudinal "imputed grades" in which we assign students to grade they would have been in had they progressed one grade per year from the first time we observe them in first grade, regardless of whether they were promoted to the next grade. Our results are similar if we focus on actual grades rather than imputed grades.

While we have limited ability to measure investment in human capital, we can measure one of its components, namely, school quality as defined by the state of Florida via its 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 competency in science, were subsequently added.[18] 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 whether the secondborn is less likely to attend prekindergarten 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.[19] Between the 1989–90 academic year and the 2004–5 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 remained 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 16. 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.[20] For the purpose of this juvenile delinquency analysis, we determine whether children are siblings on the basis of whether they are coresident and have the same last name;[21] 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

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

[19] 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.

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

[21] We have also relaxed this definition of sibship to look at consistently coresident children with different last names and continue to find similar results, but we prefer the same-name definition because we are most confident there that the children are full siblings.

September 1, 1979.[22] Limiting ourselves to first- and secondborns 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 microneighborhood.

C. 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 because all of the mechanisms for birth order effects that we postulate involve the children being the product of successive pregnancies. Our main analysis employs a sample of the first two children born in families with two or more children, as the previous literature has found that birth order effects are particularly salient for the first two children in a family. Furthermore, given our emphasis on delinquency outcomes we focus on families where the secondborn child is a boy, that is, boy-boy and girl-boy pairs. The main analysis sample is also restricted to full biological siblings, meaning that all of the children have the same mother and father so that we can exploit variation within these stable families by comparing outcomes across siblings.[23] We present results for secondborn girls and for other types of families as separate investigations later in the paper.

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 mother's age at first birth moderately lower for families with two or more children compared with that for all families. In Florida, families with two 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 irrespective of the father status, then the fraction of African American mothers increases to 22%.

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.

[22] With this restriction, we will miscode birth order only for families with more than a 6-year gap between older siblings and the oldest-observed children enrolled in school in 1989–90.

[23] In Denmark we observe complete information on fathers in 98% of the sibling population, and the father is the same in 92% of families across the first two births. In Florida we observe complete information on fathers in 79% of the sibling population, and the father is the same in 70% of families across the first two births.

Table 1
Descriptive Statistics

	Denmark			Florida		
	All (1)	All ≥2 Families (2)	≥2 Boy-Boy and Girl-Boy Families (3)	All (4)	All ≥2 Families (5)	≥2 Boy-Boy and Girl-Boy Families (6)
	A. Parental Controls: Mother					
Age mother—firstborn	25.23	25.04	25.04		25.82	25.88
Education:						
Basic	32.52	31.86	31.69	20.30	10.45	10.15
High school or vocational	34.98	34.42	34.42	58.60	59.25	59.27
College	22.08	22.89	23.02	21.10	30.30	30.58
Employed	75.36	74.38	74.37			
	B. Parental Controls: Father					
Age father—firstborn	28.26	28.14	28.11		28.55	28.61
Education:						
Basic	23.85	23.70	23.54	14.83	10.86	10.69
High school or vocational	44.57	43.85	43.61	59.59	60.90	60.85
College	20.22	21.02	21.26	25.59	28.23	28.47
Employed	83.99	84.19	84.12			
	C. Family Controls					
Income:						
Low	22.54	22.84	22.92	25.02	15.79	15.53
Low/medium	27.61	28.79	28.84	25.06	22.75	22.81

Medium/high	26.25	26.27	26.17	25.19	28.72	28.67
High	23.60	22.10	22.08	24.73	32.74	32.99
Mother immigrant	11.94	12.78	12.87	24.03	20.58	20.37
Father immigrant	10.62	11.52	11.66			
Mother African American				21.89	11.24	10.89
Mother Hispanic				23.94	22.94	22.74
Spacing (firstborn to secondborn)		3.03	3.03		2.65	2.65
Completed family size	2.34	2.59	2.59			
			D. Outcomes			
Convicted by age 16	3.26	3.27	4.29			
Convicted by age 21	10.93	11.01	14.39			
Sentenced to prison by age 16	.78	.83	1.24			
Sentenced to prison by age 21	4.22	4.36	6.12			
Incarcerated by age 16	.11	.12	.18			
Incarcerated by age 21	1.40	1.48	2.18			
Suspended in school					4.51	5.61
Absence rate in school					3.83	3.84
Number of children	448,979	235,720	121,100	1,592,342	148,788	75,914

NOTE.—Sample in col. 1 is based on all singleton births with complete data between 1981 and 1990 in Denmark. Sample in col. 4 is based on all singleton births with complete data between 1994 and 2002 in the state of 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 and the same father. We can link siblings only in about 70% 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 secondborn boys. Employment and income in Denmark are 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. Binary variables are multiplied by 100, giving percent values.

The average age at first birth in Denmark is lower than that in Florida by about 1 year. Within the sample of two or more children, the spacing between the first- and the secondborn is bigger in Denmark than in Florida. The education systems are different, but in Denmark 32% of mothers have a basic education that ends after 9 years and 23% have a college degree, whereas in Florida 10% of mothers in our analysis sample are high school dropouts and 31% have a college degree.[24]

Florida has much more racial and ethnic variation than Denmark, and although race or ethnicity are not reported in the Danish registers, national statistics reveal that 8.9% of people living in Denmark are immigrants, and of these 58% originate from non-Western countries. There is a negligible fraction of immigrants of Hispanic origin. In contrast, 22% of mothers in Florida are African American, and 24% are of Hispanic origin. Finally, the fraction of immigrants is twice as high in Florida as in Denmark, and furthermore the sources of immigration differ. In Denmark, immigrants mostly come from Turkey, Iraq, Bosnia-Herzegovina, Iran, and Pakistan. In Florida, the most frequently occurring countries of origin are Cuba, Mexico, Colombia, Venezuela, and the Dominican Republic, but in addition, 44% of immigrants to Florida come from non-Hispanic countries in the Caribbean, Europe, Asia, and Africa.

The last panel of table 1 reports means for the outcome variables. Interactions with justice system are not uncommon, and in Denmark by age 21 nearly 11% of individuals have a conviction, 4.2% are given suspended prison sentences, and 1.4% are actually incarcerated.[25] When we focus on boy-boy and girl-boy families, these rates are somewhat higher. In Florida, 5.6% of our analysis sample is suspended in a given year, and the absence rate is 3.8%.

IV. Empirical Model

The main estimating equations based on boy-boy and girl-boy pairs for person i born in cohort $c(i)$ in family $f(i)$ are of the form

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

[24] 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 impute mean values and create an indicator variable for missing education and/or employment.

[25] We exclude all traffic offenses to focus on more serious offenses. Our data on convictions are very similar to national statistics (DST 2014). Our means are between 12% and 20% below the national rate of suspended and implemented incarceration sentences measured in this cumulative way (by age 16 and by age 21). This undercounting is likely driven by the selected sample of families that we include in our final analysis.

where β_1 compares secondborn 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 possibility that secular trends in population-level student performance might confound birth order estimates, 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, Devereux, and Salvanes 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 family fixed effects our vector X contains 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).[26] In Denmark, we further include characteristics at the first birth, such as 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.[27] We cluster standard errors at the family level.

In the Florida school records we observe individual students multiple times between grades 1 or 3 and 8. 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 1 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 of the student observations together, and in figures 2, 4, and A1 (fig. A1 is available online) we present estimates as children progress through schooling, scaling the estimates (except for test scores) by the baseline firstborn boy mean for each imputed grade.[28]

[26] In these models, the introduction of birth cohort indicators helps avoiding omitted variable bias due to differences in outcomes across cohorts; however, it also introduces an imbalance in maternal age at first birth across first- and secondborn children in the same cohort. We control for mother's age at first birth and mother's age at the child's birth, so the model relies on different spacing across families to identify the different effects. In the end we emphasize the family fixed effects models, which avoid the discussed issue, and birth order embeds effects of being reared by parents who are slightly older for secondborns compared with firstborns.

[27] In Denmark, maternal and paternal employment as well as family income are measured in the year before birth. Our fixed effects results also hold when we include time-varying family controls, such as mother's age, education, and marital status as well as zip code/municipality of residence.

[28] In Florida, we observe test scores for grades 3–8, and thus in table A3 we restrict our attention to these grades only. We observe suspensions and truancy in grades 1–8 for birth cohorts 1994–2000 and grades 3–8 for birth cohorts 2001

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 socioeconomic status [SES]), and average school meal status in student microneighborhood. This latter variable is possible because the school district divides the county into more than 1,000 microneighborhoods 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 microneighborhood at any given time.[29]

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 firstborns are more likely to have additional births—a measure that is often used as an instrument for family size (Conley and Glauber 2006; Angrist, Lavy, and Schlosser 2010). Black, Devereux, and Salvanes (2005) also use this instrument in their analysis of family size, but they note that (1) same-sex siblings may have an independent effect on child outcomes and (2) that the birth order effects are stable when instrumenting for completed family size. 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 that drive the instrument for family size used in the literature. This serves 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 with mixed-sex siblings.

Another issue is that last-born children may have worse outcomes when 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 secondborn is not the last born.

V. Main Results

This section first reports results for delinquency outcomes (table 2), which is then followed by the analysis of different types of criminal activity in Denmark (table 3). Table 4 presents short-run noncognitive 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 A3

and 2002. We construct the imputed longitudinal grade starting in the first observed grade in these samples. The results are robust to restricting the delinquency measures to grades 3–8.

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

(tables A1–A12 are available online). Subsequent tables further examine potential mechanisms and heterogeneity focusing on spacing between siblings (table 6) and maternal education (table 7). Finally, appendix tables document contrasts between native-born and immigrant parents (table A6), contrasts by either family-level (Denmark) or neighborhood-level (Florida) income (table A7), and contrasts by racial and ethnic differences for Florida only (table A8).

A. Delinquency

Table 2 reports our main results for delinquency. Panels A–C show results for Denmark, where secondborn boys are more likely to have criminal justice involvement and serve time in prison both by age 16 and by age 21. In models with family fixed effects, secondborn boys are 1.6 percentage points more likely to have been convicted of a crime when age 15 or 16 compared with firstborns. Recall that all secondborns in the analysis sample are boys, and thus in the tables we include the mean of the outcome for firstborn boys as a useful comparison along with the percent difference for secondborns compared with this firstborn mean; for example, this 1.6 percentage point increase is 35% higher compared with the mean for firstborn boys. By age 21, the estimate suggests a 3.6 percentage point increase, or 22% higher than the mean for firstborn boys. These results are fairly stable comparing ordinary least squares (OLS) models with controls and in models with family fixed effects. The early-age result grows somewhat in magnitude when we include family fixed effects. The larger effect (compared with 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 figure 1, which depicts elevated effects on criminal activity for ages 16–18 that subsequently stabilize for all outcomes.

When we look at more serious crimes—those that yield a prison sentence—the means of the dependent variables for implemented and suspended sentences among firstborn boys are 0.1% and 1.0% by age 16 and 2.7% and 7.2% by age 21, respectively. While the outcomes are exceedingly rare by age 16, we find that secondborn boys are much more likely to have these outcomes by that age compared with their older siblings. By age 21, when the outcomes are observed for more young adults, table 2 shows that secondborn boys are found to be 1.1 and 2.4 percentage points more likely to have spent time or be sentenced to spending time in prison, respectively, which implies 40% and 33% effects. We view these effects as remarkably large given that we are controlling for family environment and that delinquency outcomes are associated with significant externalities.

Panel D of table 2 provides analogous results for juvenile delinquency by age 16 in a single, large anonymous county in Florida. In the OLS model without family fixed effects but with a wider set of controls, secondborn boys are 0.5 percentage points more likely to become involved with the juvenile

Table 2
Main Results

	OLS (1)	OLS with Controls (2)	Fixed Effects (3)	OLS (4)	OLS with Controls (5)	Fixed Effects (6)
	A. Denmark: Convictions					
	By Age 16			By Age 21		
Secondborn	.647***	1.370***	1.616***	2.034***	3.866***	3.618***
	(.167)	(.259)	(.307)	(.284)	(.427)	(.483)
Girl	−3.156***	−3.116***	−2.740***	−12.114***	−12.017***	−11.923***
	(.137)	(.137)	(.218)	(.240)	(.236)	(.356)
Mean of *Y* for firstborn boy	4.571	4.571	4.571	16.330	16.330	16.330
% effect	14.2	30.0	35.4	12.5	23.7	22.2
	B. Denmark: Sentenced to Prison					
	By Age 16			By Age 21		
Secondborn	.444***	.732***	.917***	.944***	2.221***	2.393***
	(.090)	(.152)	(.174)	(.201)	(.310)	(.348)
Girl	−.916***	−.898***	−.655***	−6.360***	−6.312***	−6.242***
	(.061)	(.061)	(.121)	(.156)	(.155)	(.248)
Mean of *Y* for firstborn boy	1.038	1.038	1.038	7.217	7.217	7.217
% effect	42.8	70.5	88.3	13.1	30.8	33.2
	C. Denmark: Incarcerated					
	By Age 16			By Age 21		
Secondborn	.065*	.246***	.311***	.271**	.980***	1.086***
	(.034)	(.059)	(.068)	(.129)	(.199)	(.227)
Girl	−.127***	−.123***	−.080*	−2.586***	−2.566***	−2.619***
	(.022)	(.021)	(.046)	(.094)	(.094)	(.155)
Mean of *Y* for firstborn boy	.138	.138	.138	2.710	2.710	2.710
% effect	47.1	178.3	225.4	10.0	36.2	40.1
Number of children	121,100	121,100	121,100	121,100	121,100	121,100
Number of families	60,550	60,550	60,550	60,550	60,550	60,550

	D. Large Florida County: In Juvenile Justice System					
	By Age 16			NA		
Secondborn	.547**	.514*	1.146**			
	(.267)	(.266)	(.561)			
Girl	−1.511***	−1.522***	−1.229**			
	(.239)	(.237)	(.509)			
Mean of *Y* for firstborn boy	2.582	2.582	2.582			
% effect	21.2	19.9	44.4			
Number of children	24,928	24,928	24,928			
Number of families	12,464	12,464	12,464			
	E. Florida: Behavioral Outcomes in School					
	Suspensions			Absences		
Secondborn	3.664***	4.272***	1.726***	.351***	.230***	.008
	(.151)	(.210)	(.224)	(.030)	(.040)	(.030)
Girl	−3.935***	−3.974***	−4.279***	.051	.035	−.034
	(.126)	(.120)	(.177)	(.034)	(.032)	(.024)
Mean of *Y* for firstborn boy	5.942	5.942	5.942	3.725	3.725	3.725
% effect	61.7	71.9	29.0	9.4	6.2	.2
Number of observations	349,184	349,184	349,184	347,736	347,736	347,736
Number of children	76,036	76,036	76,036	75,914	75,914	75,914
Number of families	38,018	38,018	38,018	37,957	37,957	37,957

NOTE.—Standard errors clustered at mother level. All dependent variables, except for absence rate, are binary indicators multiplied by 100. These are probability of being convicted (panel A), probability of being sentenced to suspended imprisonment (panel B), probability of being incarcerated (panel C), probability of being in juvenile detention center (panel D), and probability of being suspended in school (cols. 1–3 in panel E). Ordinary least squares (OLS) and fixed effects regressions in cols. 1, 3, 4, and 6 include only child birth year indicators. Controls in cols. 2 and 5 in panels A–C include, in addition to birth year indicators, mother's age at first birth, mother's age, father's age, municipality indicators, maternal and paternal education, maternal and paternal employment indicators, family income, immigrant indicator, and number of children in family. Controls in col. 2 of panel D include, in addition to birth year indicators, first observed limited English proficiency indicator, subsidized school meal status indicator, and average school meal status in student microneighborhood. Controls in cols. 2 and 5 of panel E include, in addition to birth year indicators, mother age at first birth, mother age, father age, zip code of birth indicators, mother and father education indicators, and indicator variables for race, ethnicity, immigrant status, and marital status at the time of birth. Panels A–C are based on 1981–90 birth cohorts; panel D is based on September 1979 to August 1989 births, while panel E is based on 1994–2002 birth cohorts. Sample is based on boy-boy and girl-boy sibling pairs from families with two or more siblings.

* Statistically significant at the 10% level.

** Statistically significant at the 5% level.

*** Statistically significant at the 1% level.

Table 3
Types of Crime by Age 21: Denmark Birth Cohorts 1981–90

	Violent Crime (1)	Property Crime (2)	Special Crime (3)
Secondborn	1.606***	2.163***	2.099***
	(.292)	(.416)	(.356)
Girl	−3.925***	−7.406***	−5.877***
	(.204)	(.300)	(.257)
Mean of *Y* for firstborn boy	4.526	10.885	6.551
% effect	35.5	19.9	32.0
Number of children	121,100	121,100	121,100
Number of families	60,550	60,550	60,550

NOTE.—Standard errors clustered at mother level. All estimates come from fixed effects regressions controlling for child birth year indicators. All crime outcomes are measured on the basis of convictions for violent, property, and special offenses. Special crime includes, e.g., drug offenses and illegal weapon possession. Sample is based on boy-boy and girl-boy sibling pairs from families with two or more siblings.
*** Statistically significant at the 1% level.

justice system, which is approximately 20% higher than the mean for firstborn boys. When we focus on within-family comparisons by adding family fixed effects, the estimate increases to 1.1 percentage points, or 44%. Notably, even though as documented in table 1 the state of Florida is very different

Table 4
Short-Run Noncognitive Outcomes: Denmark Birth Cohorts 1998–2000

	Close to Average (1)	Slightly Raised (2)	High (3)	Very High (4)
	A. Total Difficulties Score			
Secondborn	−.041*	.021	.006	.014
	(.023)	(.018)	(.011)	(.013)
Girl	.009	−.033**	.009	.015
	(.019)	(.014)	(.010)	(.011)
Mean of *Y* for firstborn boy	.829	.094	.034	.043
% effect	−4.9	22.3	17.6	32.6
	B. Prosociality Score			
Secondborn	−.024	.020	.002	.003
	(.027)	(.021)	(.017)	(.014)
Girl	.138***	−.062***	−.041***	−.035***
	(.021)	(.017)	(.013)	(.010)
Mean of *Y* for firstborn boy	.695	.155	.090	.059
% effect	−3.5	12.9	2.2	5.1
Number of children	3,370	3,370	3,370	3,370

NOTE.—Heteroskedasticity -robust standard errors. All outcome variables are binary indicators. Ordinary least squares regressions in cols. 1–4 include the following controls: child birth year indicators, mother age at first birth, mother and father age, municipality indicators, maternal and paternal education, maternal and paternal employment indicators, family income, immigrant indicator, and number of children in family. The questionnaire was answered by sixth-grade students from birth cohorts 1998–2000. Panel A is a combination of emotional problems, conduct problems, hyperactivity, and peer effects problem scores. We present the results for these scores separately in table A1.
* Statistically significant at the 10% level.
** Statistically significant at the 5% level.
*** Statistically significant at the 1% level.

Table 5
Mechanisms: Neonatal and Childhood Health, Parental Investment, and School Quality

	A. Denmark: Birth Cohorts 1981–90							
	ln(Birth Weight) (1)	Complications in Pregnancy (2)	Days of Maternity Leave (3)	Maternal Employment 1 Year after Birth (4)	Out-of-Home Day Care at Age 2 (5)	School Starting Age (First Grade) (6)	Disorders of Psychological Development (7)	Emotional and Behavioral Disorders (8)
Secondborn	.037***	−.053***	−8.574***	−.005	.039***	−.235***	−.000	−.002
	(.002)	(.005)	(.692)	(.004)	(.006)	(.006)	(.003)	(.003)
Girl	−.040***	−.002	−.232	−.006*	−.006	−.107***	−.015***	−.021***
	(.001)	(.004)	(.538)	(.003)	(.004)	(.005)	(.002)	(.002)
Mean of *Y* for firstborn boy	8.141	.264	150	.767	.667	6.760	.018	.030
% effect	3.7	−20.1	−5.7	−.7	5.8	−3.5	−.0	−6.7
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

	B. Florida: Birth Cohorts 1994–2002							
	ln(Birth Weight)	Complications in Pregnancy	Prekindergarten Participation	Held Back a Year	Attending A Quality School in Third Grade	School Quality (0–4) in Third Grade	Cognitive Disability	Behavioral Disability
Secondborn	.026***	−.027***	.066***	−.006	−.014**	−.019*	−.008*	−.000
	(.003)	(.007)	(.008)	(.005)	(.006)	(.010)	(.004)	(.004)
Girl	−.040***	.005	−.030***	−.041***	.001	.006	−.036***	−.032***
	(.002)	(.005)	(.006)	(.004)	(.005)	(.008)	(.003)	(.003)
Mean of *Y* for firstborn boy	8.114	.220	.546	.067	.761	3.648	.068	.069
% effect	2.6	−12.3	12.1	−9.0	−1.8	−.5	−11.8	−.0
Number of children	76,036	76,036	76,036	62,753	71,902	71,902	76,036	76,036
Number of families	38,018	38,018	38,018	37,237	35,951	35,951	38,018	38,018

NOTE.—Standard errors clustered at mother level. All estimates come from fixed effects regressions controlling for child birth year indicators. Sample is based on boy-boy and girl-boy sibling pairs from families with two or more siblings.

* Statistically significant at the 10% level.

** Statistically significant at the 5% level.

*** Statistically significant at the 1% level.

Table 6
Heterogeneity Effects by Spacing between First- and Secondborn Child

	Spaced Up to 2.5 Years Apart (1)	Spaced Above 2.5 Years Apart (2)	Spaced Up to 2.5 Years Apart (3)	Spaced Above 2.5 Years Apart (4)
	A. Denmark: Convictions			
	By Age 16		By Age 21	
Secondborn	.143	.332	4.119***	1.982**
	(.704)	(.487)	(1.073)	(.796)
Girl	−2.926***	−2.625***	−13.194***	−11.081***
	(.365)	(.270)	(.577)	(.450)
Mean of Y for firstborn boy	5.213	4.137	18.112	15.127
% effect	2.7	8.0	22.7	13.1
	B. Denmark: Sentenced to Prison			
	By Age 16		By Age 21	
Secondborn	.884**	.203	4.198***	.935*
	(.412)	(.263)	(.813)	(.546)
Girl	−.863***	−.519***	−6.977***	−5.762***
	(.208)	(.146)	(.417)	(.307)
Mean of *Y* for firstborn boy	1.407	.789	8.202	6.552
% effect	62.8	25.7	51.2	14.3
	C. Denmark: Incarcerated			
	By Age 16		By Age 21	
Secondborn	.435**	.115*	1.896***	.108
	(.180)	(.070)	(.552)	(.335)
Girl	−.191**	−.006	−3.080***	−2.315***
	(.091)	(.047)	(.272)	(.185)
Mean of *Y* for firstborn boy	.230	.075	3.203	2.377
% effect	189.1	153.3	59.2	4.5
Number of children	48,552	72,548	48,552	72,548
Number of families	24,276	36,274	24,276	36,274
	D. Large Florida County: In Juvenile Justice System			
	By Age 16		NA	
Secondborn	.449	.911		
	(.886)	(1.516)		
Girl	−1.377**	−.925		
	(.623)	(.886)		
Mean of *Y* for firstborn boy	2.540	2.674		
% effect	17.7	34.1		
Number of children	16,958	7,970		
Number of families	8,479	3,985		

Table 6 (*Continued*)

	Spaced Up to 2.5 Years Apart (1)	Spaced Above 2.5 Years Apart (2)	Spaced Up to 2.5 Years Apart (3)	Spaced Above 2.5 Years Apart (4)
	E. Florida: Behavioral Outcomes in School			
	Suspensions (Grades 1–8)		Absences (Grades 4–8)	
Secondborn	1.748***	2.911***	.144**	.416***
	(.426)	(.433)	(.071)	(.096)
Girl	−4.770***	−3.620***	−.144***	−.088*
	(.249)	(.246)	(.042)	(.050)
Mean of *Y* for firstborn boy	6.764	4.842	3.761	3.485
% effect	25.8	60.1	3.8	11.9
Number of observations	198,872	150,312	113,774	86,382
Number of children	40,064	35,972	35,076	31,360
Number of families	20,032	17,986	17,538	15,680

NOTE.—Standard errors clustered at mother level. All estimates come from fixed effects regressions controlling for child birth year indicators. Sample is based on boy-boy and girl-boy sibling pairs from families with two or more siblings.

* Statistically significant at the 10% level.

** Statistically significant at the 5% level.

*** Statistically significant at the 1% level.

from Denmark in terms of observable sociodemographic characteristics as well as the judicial systems, the estimated effects of being born second 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 for suspensions, as they are 1.7–4.3 percentage points higher (or 29%–72% higher than the mean for firstborn boys). For absences, we find point estimates of 0.01 to 0.35 percentage points more absences from school, or 0.2%–9.4% higher. For suspensions, similar to the criminal activity results, we document moderately larger secondborn effects earlier in life, namely, in elementary school in comparison to middle school (fig. 2*A*). This pattern is not confirmed for absence rates (fig. 2*B*), however, where we observe fewer absences for the youngest grades and more absences among secondborns in grades 4, 5, and 8.[30] This could be explained by the fact that in early schooling years absenteeism is much more related to health and acclimatization to education

[30] The approximately zero effects documented in table 2 are driven by this heterogeneity over time, as the negative early schooling coefficients cancel out with positive coefficients in grades 4, 5, and 8. Thus, in subsequent tables we mostly focus on truancy in grades 4–8.

Table 7
Heterogeneity Effects by Maternal Education at Birth

	<12 Years (1)	≥12 Years (2)	<12 Years (3)	≥12 Years (4)
	A. Denmark: Convictions			
	By Age 16		By Age 21	
Secondborn	1.651***	.642*	4.468***	2.301***
	(.629)	(.339)	(.936)	(.599)
Girl	−3.511***	−1.629***	−16.208***	−8.580***
	(.451)	(.234)	(.698)	(.425)
Mean of *Y* for firstborn boy	6.559	2.741	22.594	11.158
% effect	25.2	23.4	19.8	20.6
Number of children	39,386	68,234	39,386	68,234
Number of families	19,693	34,117	19,693	34,117
	B. Denmark: Sentenced to Prison			
	By Age 16		By Age 21	
Secondborn	1.259***	.245	2.845***	1.271***
	(.365)	(.167)	(.722)	(.375)
Girl	−.664**	−.424***	−8.757***	−3.610***
	(.261)	(.115)	(.521)	(.263)
Mean of *Y* for firstborn boy	1.459	.514	10.855	3.974
% effect	86.3	47.7	26.2	32.0
Number of children	39,386	68,234	39,386	68,234
Number of families	19,693	34,117	19,693	34,117
	C. Denmark: Incarcerated			
	By Age 16		By Age 21	
Secondborn	.454***	.075	.862*	.515**
	(.127)	(.056)	(.478)	(.216)
Girl	.035	−.004	−4.125***	−1.106***
	(.088)	(.036)	(.336)	(.144)
Mean of *Y* for firstborn boy	.099	.051	4.158	1.187
% effect	458.6	147.1	20.7	43.4
Number of children	39,386	68,234	39,386	68,234
Number of families	19,693	34,117	19,693	34,117
	D. Florida: Behavioral Outcomes in School			
	Suspensions (Grades 1–8)		Absences (Grades 4–8)	
Secondborn	2.883***	1.421***	.084	.158***
	(.826)	(.225)	(.161)	(.040)
Girl	−7.478***	−3.836***	−.154	−.117***
	(.696)	(.177)	(.134)	(.032)
Mean of *Y* for firstborn boy	12.439	5.096	5.349	5.558
% effect	23.2	27.9	1.6	2.8
Number of observations	40,980	308,204	23,186	176,970
Number of children	8,760	67,276	7,506	58,930
Number of families	4,380	33,638	3,753	29,465

NOTE.—Standard errors clustered at mother level. All estimates come from fixed effects regressions controlling for child birth year indicators. Sample is based on boy-boy and girl-boy sibling pairs from families with two or more siblings. Total number of observations is slightly different than in the main results due to missing observations for the variables used to define these subsamples.

* Statistically significant at the 10% level.

** Statistically significant at the 5% level.

*** Statistically significant at the 1% level.

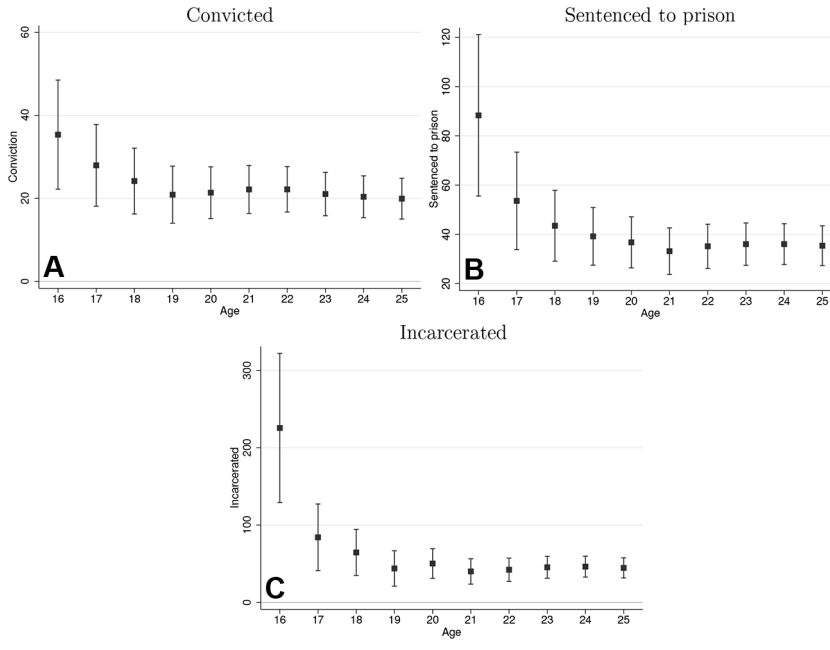

FIG. 1.—Birth order effects on criminal activity in early adulthood: estimates for secondborn boys by age in Denmark. All estimates come from fixed effects regressions controlling for child birth year indicators and are scaled by means of the dependent variable for firstborn boy in a given group. Dependent variables are delinquency measures by a given age. Standard errors clustered at mother level with reported 95% confidence intervals. Sample is based on boy-boy and girl-boy sibling pairs from families with two or more siblings.

processes than intentionally missing classes: a sign of misconduct in later grades that corroborates the delinquency findings.[31]

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 D and E because of data availability. Given that there are meaningful controls at our disposal in both settings, 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. In any event, we favor the within-family comparison including family fixed effects to absorb time-invariant characteristics

[31] The early-grade results are less negative and the later-grade results are more positive for absences when we estimate OLS regressions with or without controls, and thus in cols. 4 and 5 of panel E in table 2 we estimate positive and significant coefficients. This discrepancy supports the need for within- and across-family comparisons rather than just across-family comparison.

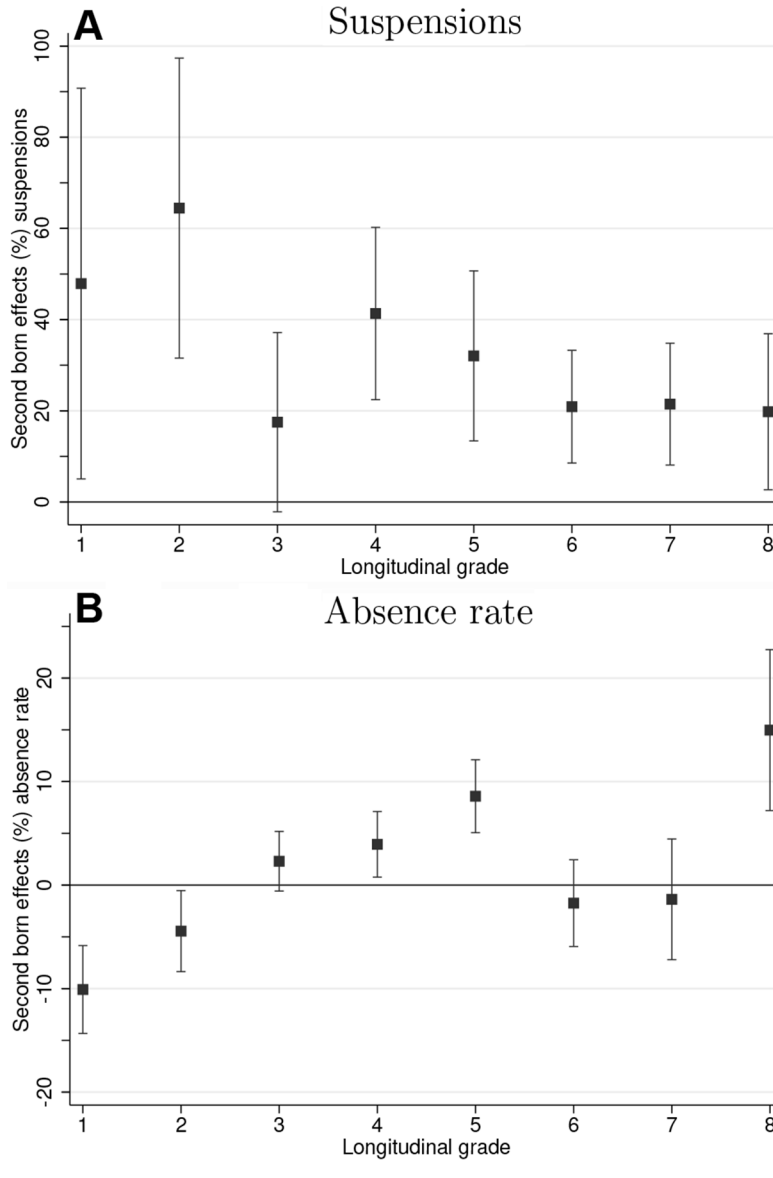

FIG. 2.—Birth order effects on delinquency in childhood: estimates for secondborn boys by grade in Florida. Sample is based on boy-boy and girl-boy sibling pairs from families with two or more siblings. Dependent variables are delinquency measures in a given grade. For further details, see the figure 1 legend.

of families, and we proceed with it throughout the subsequent sections of the paper.[32]

The uniqueness of Danish registry data allows us to investigate different types of crime. Given the larger effects found here for relatively rare delinquency outcomes compared with the smaller effects found for more common labor market outcomes in the literature, it is possible that decreased noncognitive abilities affect particularly extreme parts of the distribution. If this working hypothesis is correct, we should see larger birth order effects for more severe rather than petty crimes. Table 3 reports the results for violent crime (e.g., assault, 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) convictions. First, as expected, the conviction rate is the highest for property crimes, followed by special crimes and lowest for violent crimes. However, the secondborn effects as a proportion of the sample mean are the largest among violent crimes, which is suggestive that birth order has particularly strong influences for more extreme outcomes.

B. Noncognitive Skills

In addition to measures of delinquency, we are able to study the relationships between birth order and measures of noncognitive skills observed as part of the SDQ. These measures are available for children aged approximately 12 years old for a subset of the Danish sample. One limitation of this data set is that we cannot implement the family fixed effects strategy due to observations on only three cohorts in selected schools. Therefore, we present OLS estimates with a rich set of controls, including child birth year indicators, mother's age at first birth, mother's age, father's age, municipality indicators, maternal and paternal education, maternal and paternal employment, family income, immigrant dummy, and number of children in family.

Tables 4 and A1 present the results. Panel A of table 4 reports results for the total difficulties score, and we show its subcomponents—emotional, conducts, hyperactivity, and peer problems—in panels A–D of table A1. In panel B of table 4 we present results for a positive outcome, namely, prosociality score.

Secondborn boys are about 5% less likely to be categorized as close to average (the category that exhibits the lowest level of difficulties) in comparison to their older siblings, and although the estimates are statistically insignificant, we find positive coefficients on all the remaining categories of total

[32] 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 1 comparisons are old enough to make it to grade 8 comparisons. Because of data restriction we are underpowered to run this panel analysis; however, when we restrict the sample to grades 1–6, our results are qualitatively consistent with the repeated cross-section estimates for these grades.

difficulty score. Investigation of the subcomponents of the total score reveals that secondborn 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. Given that we cannot use family fixed effects and only some of the relationships are statistically significant, some caution is warranted in the interpretation. Still, we view these results as consistent with Heckman (2000), who finds noncognitive skills to be important determinants of success: the suggestive increase in hyperactivity problems may also be a precursor to criminal justice involvement later in life (Heller et al. 2017).

C. 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 probe 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 secondborns weigh 3.7% more on average in Denmark and 2.6% more in Florida. Similarly, secondborns have fewer complications during pregnancy compared with firstborns (20% lower in Denmark, 12% lower in Florida). These differences are not explained by the fact that mothers are older for secondborn births.[33] This result suggests that secondborns are not starting out in worse health compared with their older sibling, ruling out one potential mechanism. This is consistent with work by Brenøe and Molitor (2018) and Lundberg and Svaleryd (2017), who find that at-birth and early-life health measures such as birth weight or hospitalizations are higher among firstborns in both Denmark and Sweden.

Next we consider parental time investment in the form of day care/preschool and maternal employment. We find that day care at age 1 is 17 percentage points lower in Denmark for secondborn boys (table A2). However, by

[33] 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. We have also investigated several other birth outcomes, and we find positive effects for birth weight in 1- and 5-minute Apgar scores; negative effects for the 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.

age 2 and 3 secondborn boys are 3.4 and 10.8 percentage points more likely to be enrolled in out-of-home day care (5% and 14% higher than the mean for firstborn boys). This finding corresponds well with maternal employment effects, which we depict in figure 3 for 0–10 years after child's birth. It shows that 2–4 years after birth mothers of secondborn boys are significantly more likely to be employed compared with mothers of firstborns. We additionally document that maternity leave is modestly shorter for secondborn boys compared with the firstborns—8.6 fewer days of maternity leave compared with a mean of 150 days for firstborn boys yields about a 6% effect. It thus appears that the addition of a secondborn child results in mothers spending more of a firstborn's early childhood out of the labor force: maternity leave on the arrival of a secondborn adds time that mothers spend with firstborns in addition to the undivided attention received by firstborns in their first year of life. In Florida, we cannot observe maternal employment or maternity leave uptake, but we do observe prekindergarten participation, which can begin as early as age 2. We define our outcome variable as either parents declaring prekindergarten attendance of their children at the time of kindergarten enrollment or actually observing children being enrolled in public prekindergarten. We find a nearly 7 percentage points higher participation rate among secondborn boys, which is equivalent to a 12% effect.

The net effect of substituting maternal care with institutional care on a range of child outcomes is ambiguous. In fact, earlier return to the labor market may be harmful for boys (Fan, Fang, and Markussen 2015), but prekindergarten participation is generally viewed in the literature as a positive investment in human capital (Havnes and Mogstad 2011). If that is the case, then our findings suggest that this early-life time-investment channel does not explain the difference in delinquency. Furthermore, when we include the endogenous maternal employment measures in the main specifications as a control, we continue to find sizable birth order effects. This suggests that it is not maternal employment per se that results in the delinquency differences, but this choice may be a proxy that is correlated with different levels of parental attention for firstborns not only prior to when the secondborn arrives but into the first years of the secondborn's life.

In terms of school starting age, we see a 3.5% 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 for school starting age and age at testing is mixed, we view our estimates as rather not supporting this particular channel of the lower investment in secondborn children.[34] In fact, it seems that secondborn boys in Florida are initially attending

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

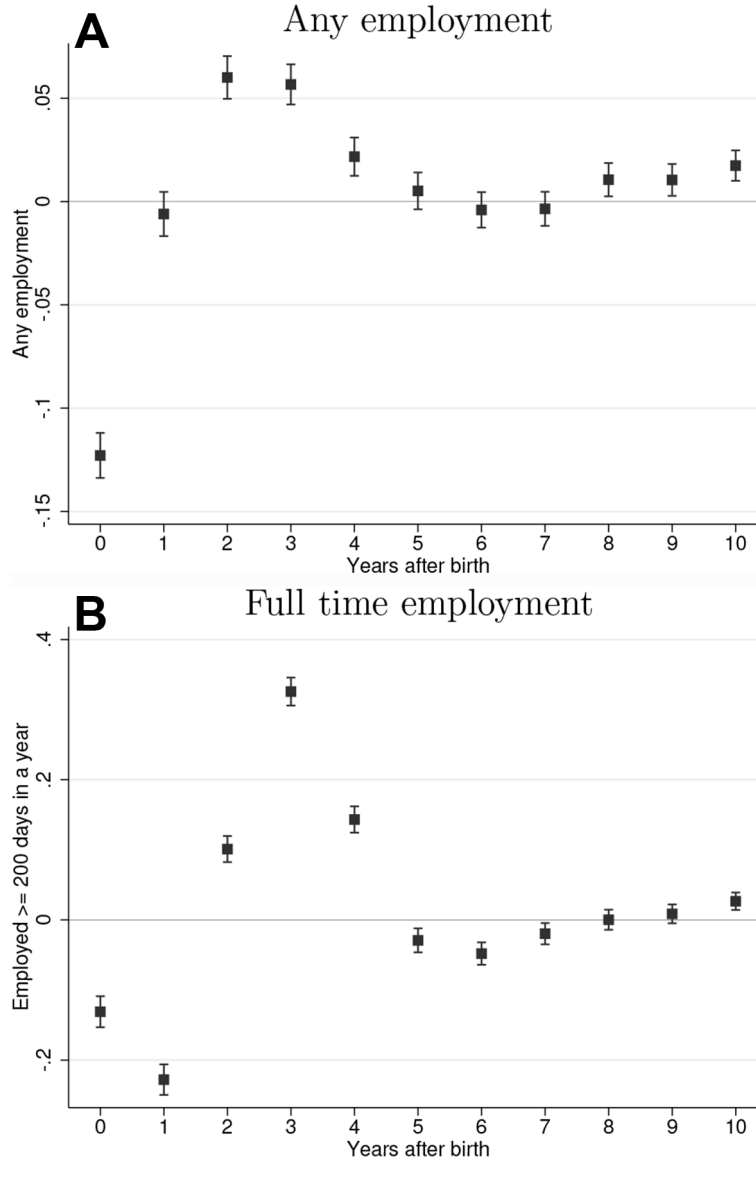

FIG. 3.—Maternal labor market activity after birth: estimates for secondborn boys in Denmark. Sample is based on boy-boy and girl-boy sibling pairs from families with two or more siblings. Dependent variables are maternal employment measures in a given year after child birth (i.e., being employed in first year after birth, second year after birth, etc). For further details, see the figure 1 legend.

higher-quality primary schools in comparison to their older siblings, although the school quality gradient changes as children progress through schooling. In subsequent grades we observe a mix of positive and negative coefficients generally oscillating around zero (fig. 4). Thus, attending lower-quality schools located in less affluent neighborhoods should not explain a large part of our delinquency results.

Both data sets allow us to also investigate childhood health as measured by various disabilities. About 18% of school-age children in Florida are diagnosed with some form of disability, and in our sibling sample we observe 6.8% and 6.9% of firstborn boys having been diagnosed with cognitive and behavioral disability, respectively. The incidence of disability diagnoses in Denmark is far lower, at about 2.4% 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 secondborns being diagnosed with cognitive disability in Florida.[35]

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 as well as the use of day care, and school choice. While we do not find the primary mechanism that results 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 children in favor of indirect investment in the form of formal childcare arrangements. Whether and how these differences could affect observed later-life gaps 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. Another channel that could plausibly lead to the observed later-life differences is child's own differential investment in adolescence, which could be different for first- and secondborns, perhaps partially due to different role models and sibling spillovers. This would be consistent with findings that parental inputs matter more early in life, while own investments yield relatively higher returns in adolescence (Del Boca, Monfardini, and Nicoletti 2017).

[35] In the case of Denmark, we have also investigated addiction-related hospitalizations by either age 16 or age 21, which include poisoning by narcotics or psychodysleptics or toxic effects of alcohol. We do not find any birth order gaps for these hospitalization outcomes. Similarly, we do not find differences between secondborn boys and their older siblings in the probability of dying by either 16 or 21. Finally, we looked at the number of emergency department visits by age 5 and 10. For both of these outcomes, we find that secondborn boys have about 10% more visits than their older siblings; however, we are unable to distinguish whether these are due to poorer underlying health or more accidents related to, e.g., the increased hyperactivity documented in table A1.

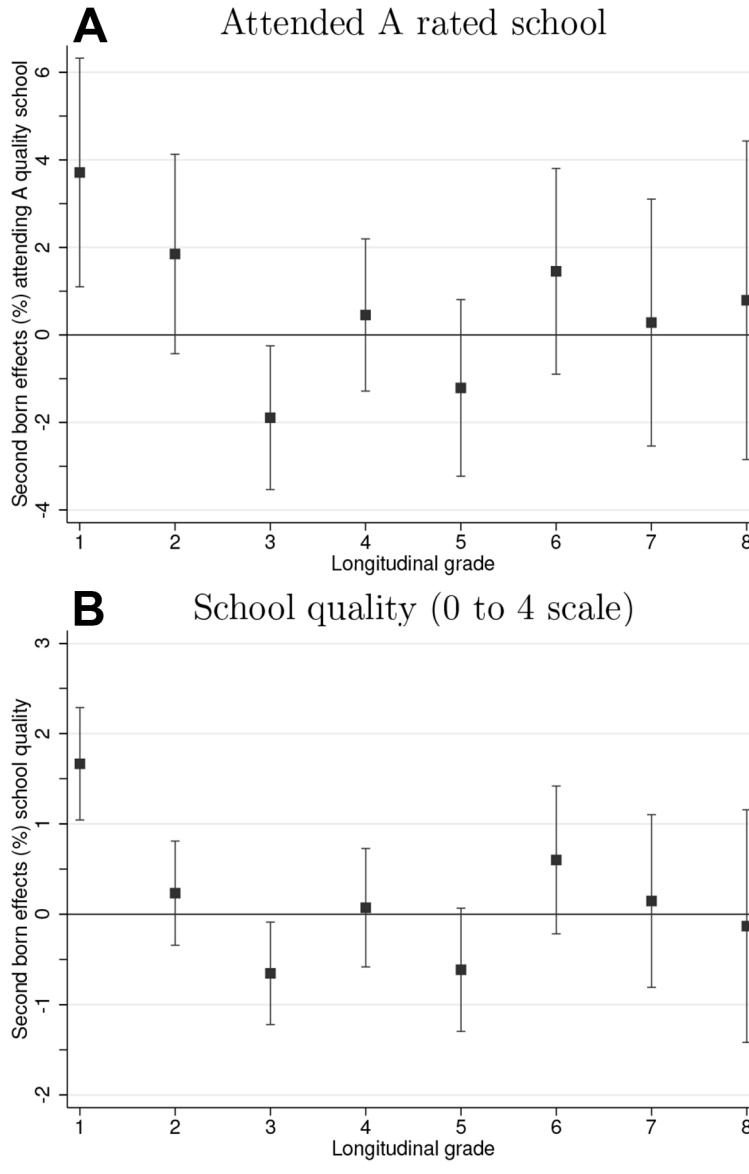

FIG. 4.—Birth order effects on attended school quality: estimates for secondborn boys by grade in Florida. Sample is based on boy-boy and girl-boy sibling pairs from families with two or more siblings. Dependent variables are school quality measures in a given grade. For further details, the figure 1 legend.

D. 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 previously in the literature. We believe that the similarity in the results with the previous literature, to the extent that it occurs, bolsters the credibility of our empirical approach and corroborates the quality of the data used in both settings. We are also interested in test scores to investigate whether the behavioral differences identified in our main results are also evident in these measures that are more traditionally thought of as measures of cognitive skills, and these could themselves have effects on delinquency. In Denmark, we observe them for ninth 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 A3 shows that in Denmark, secondborn 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 secondborn boys. When we look at each grade separately (fig. A1), we find that the positive but insignificant estimate for mathematics is driven by early grades. In fact, for grades 3 and 4 we find positive and statistically significant effects of being the secondborn. This result would be consistent with the higher early investment into cognitive skills of secondborn boys that fades out over time, allowing the noncognitive aspects to dominate. For reading we observe negative estimates in all studied grades that, except for grade 8, are relatively constant over time.

E. 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 the heterogeneity of these effects in much more detail. Given the precision of the results, we tend not to find statistically significant differences across subgroups, but an exploration of the changing point estimates can point toward areas for future research and begin to separate different explanations. 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 investments related to the nature of family arrangements. Second, we investigate whether birth order effects are different in more versus less advantaged families; this is proxied by education, family-level (Denmark) or neighborhood-level (Florida) income, maternal employment (only Denmark), nativity, and race and ethnicity (only Florida).

We begin by presenting in table 6 the differential effects of birth order by spacing between first- and secondborn children in our data to investigate whether the results vary by family structure.[36] To preserve sample sizes, we divide families into those that had the second birth up to two and a half years after the first one and those where the distance in age between siblings is greater than two and a half years. We find that in both locations delinquency is generally 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 duration 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 results are larger for siblings spaced farther apart akin to what we found for suspensions. In Denmark the results for convictions at age 16 are weaker and we do not have precise estimates, yet the point estimate for prison sentences by age 16 is substantially larger for families where the siblings are closely spaced. Our results are more precise at age 21, where we see both higher convictions and incarceration sentencing for the secondborns born up to two and a half years after their older sibling. Unfortunately, these spacing comparisons cannot separate the leading explanations of the sources of birth order effects, as spacing affects not only parental capacity for investment in children but also simultaneously changes the influence siblings have on one another.[37]

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. 2019), then this finding could help explain why more closely spaced sibling pairs have greater incidence of delinquency. It is 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 V.C, a potential mechanism for birth order effects, at least in Denmark, where we observe maternal labor market outcomes, is that the firstborn child experiences extra maternal attention when they are very young and again when the secondborn child is born; if maternal attention is differentially important during

[36] Buckles and Munnich (2012) document that a 1-year increase in spacing increases test scores for older siblings by about 0.17 standard deviations, which is comparable to their birth order effect.

[37] We also explored how results vary by spacing and by sibling composition; however, the results were imprecisely estimated, and the point estimates did not point to a consistent explanation for the findings.

very early childhood, then this difference 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 that the "double dose" of extra maternal attention would be attenuated, thereby putting more weight on the time at home without siblings explanation, which privileges firstborn children the longer the birth spacing. These explanations, of course, are speculative.

In addition to birth spacing, another family-structure measure of interest is the sibling sex composition, as described in the discussion of the empirical model. We chose to include all families that have a secondborn boy in the main specification because restricting the analysis to boy-boy families could introduce a sample selection bias. For example, two children of the same gender can impact family size, which can have its own effects on our outcomes. Nevertheless, if there is gender antagonism between siblings, then it is plausible that the secondborn 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, for instance, peer pressure), we might expect to observe higher estimates among the boy-boy pairs. The results along these dimensions are largely mixed (table A4). In the case of both types of incarceration sentences in Denmark, boys fare somewhat worse in families with an older sister compared with those in families with an older brother. For example, in the case of incarceration by age 21, secondborn boys in girl-boy families have an expected rate of 4.4%, whereas secondborn boys in boy-boy families have an expected rate of 3.3%, both of which are higher than the mean for firstborn boys of 2.7%. On the other hand, the results are similar in the two-family compositions for convictions in Denmark and truancy in Florida, while the pattern is actually reversed for juvenile incarceration in Florida.

One explanation for birth order effects is that parental investment is diluted with the arrival of more children, which motivates us to investigate heterogeneity by SES. In table 7 we divide families into those with mothers having less than 12 years of formal education (the equivalent of a high school dropout in the United States) and those with mothers having 12 or more years of schooling. More educated families tend to have more resources, tend to 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 of our measures. That said, the estimates for Denmark suggest very similar secondborn effects for convictions among both high- and low-educated parents. The estimates are larger among the families where the mother has less education, but this is offset by the higher baseline delinquency rate among children raised in these households. This pattern is somewhat different for crimes that involve either form of prison sentence. Specifically, by age 16 the differences are much larger among households with lower-educated mothers relative to

the sample means, and this pattern is reversed by age 21. In Florida, the estimated effect sizes are similar for both suspensions and truancy.

Another way in which we can measure affluence in the data is through either family-level income in Denmark or neighborhood-level income in Florida. We present these results in table A7, where we divide the sample into terciles based on conditions that a family experiences at the time of first birth.[38] This more continuous measure of SES largely confirms findings for more versus less educated mothers discussed above. In Denmark, by age 16 birth order gaps in delinquency are concentrated among the lowest-income households. On the other hand, by age 21 they are either comparable across income terciles for the two less severe measures or even reversed and largest among the richest households for incarceration. In Florida, we observe quite similar estimates for suspensions, while birth order gaps for truancy are concentrated among children from bottom-tercile households. It would thus appear, at least in the case of Denmark, that secondborns are particularly worse off among low-SES households in teenagehood, while this pattern reverses when we move toward adult crime.

A similar resource availability story can be examined by looking at maternal employment, although this also impacts time spent with children, as discussed above. Our results, reported in table A5, document that delinquency is on average higher in households where the mother is not employed 1 year after birth in the case of both children. The point estimates and effect sizes are also higher for the nonemployed samples. Thus, it appears that the beneficial effects of maternal employment, such as higher income, may dominate the potential negative impacts of being away from home 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 2017), although the differences vary for schooling outcomes, with Åslund et al. (2011) documenting a relative disadvantage in Sweden but Figlio and Ozek (2016) showing superior educational outcomes for the children of immigrants in the United States. However, very little is known about the birth order effects in these families. We document the gradient between secondborn boys and their older siblings for immigrant and native families in table A6. First, it is worth noting that the children of immigrants in Denmark have higher convictions and prison sentencing rates, but the children of immigrants in Florida have lower rates of suspensions and absences in comparison to the children of native-born mothers. In both locations, however, we find larger secondborn effect sizes among the children of immigrants

[38] In Florida, data are based on median income measured at zip code level at the time of first child's birth. In Denmark, we observe total family income and divide the sample based on its level in the year prior to the first birth.

relative to the children of native-born residents with the notable exception of teen incarceration in Denmark, where the pattern is reversed.

Although Denmark is fairly racially and ethnically homogeneous, in Florida the student population we investigate is 20% African American and another 18% Hispanic. It is also the case that African Americans and Hispanics have on average lower SES, 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 A8. Absenteeism is lower among these two minority groups 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 secondborn effect is similar among Hispanics and non-Hispanics for suspensions but larger for the former group for truancy. When comparing African Americans with non–African Americans, however, the effect sizes for both outcomes are larger among non–African Americans relative to the means of the subsamples.

Thus far we have focused our analysis on a more positively selected sample of stable families where the mother and father are the same for both children. However, in Florida 30% of children in families with two or more children have different or unknown fathers for the first two births, while in Denmark this number is lower (9.5%) but still nontrivial. Since family instability is likely correlated with behavioral problems and delinquency, especially among boys who appear to be more sensitive to this input (Cobb-Clark and Tekin 2014; Autor et al. 2019), we did not want to pool together these two types of families. In table A9 we present separately the results for boy-boy and girl-boy families with different fathers across the two births.[39] First, with the exception of truancy, the delinquency rates are much higher in these families in comparison to the baseline sample—from about two times for convictions and suspensions to five times for teenage incarceration. Second, the samples are much smaller, resulting in much larger standard errors. Nevertheless, for convictions and suspensions we find very similar effect sizes relative to the sample mean compared with table 2. In cases where the mean values increase the most across samples—suspended or implemented imprisonment sentences—we do not estimate any significant birth order gaps. The point estimates are also substantially smaller than those documented for more stable families. A hypothesis consistent with this set of results may suggest that resources and parental attention that could prevent the most extreme behavior do not matter so much in families with changing male role models. It is also possible that changing family structure might alter the ways in which male role models treat firstborn versus secondborn children.

[39] The set of families where the identity of the father is unknown for at least one birth is 20.6% in Florida and only 2.3% in Denmark.

F. Robustness Checks

Given the very large magnitude of the differences between first- and secondborn children, we check the robustness of the results in a number of ways. In the main set of results our fixed effects specification includes only cohort effects, but it is possible that our estimates are still biased because we do not account for mother time-varying characteristics, such as marital status, education, or place of residence. These characteristics could change across births and influence the secondborn 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, family/neighborhood income, maternal marital status, and location at time of birth in the fixed effects models, our estimates are similar (panel A in table A10).

In table 5 we have documented that secondborns are moderately healthier at the time of birth in comparison to their older siblings; 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 (panel B of table A10), 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 secondborn estimates for test scores increase 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 secondborn child might induce some families to cease their fertility following the second birth. To address this issue, we drop from the sample all families for whom we observe exactly two children (panel C in table A10). This cuts our sample by about 60% and 85% 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 possible that the families that we drop now as having exactly two children will continue their fertility beyond the year where we can observe them. In these larger families the average delinquency rates for the firstborn boys are higher than in the preferred sample, which may be related to the lower SES of families with higher fertility. Nonetheless, our results are very stable whether we include exact parity two families or not.

G. Effects for Girls

We primarily focus on boys in this paper because criminal justice involvement and other forms of delinquency are much less common among girls. For example, less than eight per 10,000 firstborn girls are incarcerated by

age 21 in Denmark, compared with 271 firstborn boys per 10,000 in our analysis sample. The results are imprecise for the sample of girls only but suggest that secondborn girls have higher delinquency compared with firstborn sisters (all compared with a very small base). In the sample of boy-girl pairs, however, secondborn girls have lower delinquency than do firstborn girls in general in four out of nine outcomes, as documented in table A11. School suspensions are somewhat higher for secondborn girls, and truancy occurs at a similar rate across genders and across sibling sex compositions. Overall, we view these results for girls as mixed but also less policy relevant, given our focus on delinquency outcomes that are much more prevalent among boys.

We also investigate the degree to which any differences in birth order effects by secondborn gender are possibly due to different mechanisms affecting girls versus boys. For instance, it may be the case that secondborn girls are in even better health or that parents invest more in early human capital if the secondborn child is female. As can be seen in table A12, compared with the parallel secondborn boy mechanisms presented in table 5, most of the potential mechanisms that we explored (e.g., neonatal health, prekindergarten participation, and school quality) are remarkably similar for secondborn boys and secondborn girls. This general pattern of findings leads us to believe that the mechanisms we explored do not account for a substantial part of boy-girl differences in birth order effects on delinquency.

VI. Conclusions

Previous research 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. To gauge the degree to which birth order is determining delinquent behavior, we perform, to the extent practicable, parallel analyses in two considerably different societies—Denmark and the United States (Florida). These societies have much different approaches to crime and punishment and are demographically very different, but our sets of findings are fundamentally quite similar.

We find, consistently across both locations, that secondborn boys are substantially more likely to exhibit delinquency problems than are their older sibling. Secondborn boys in Denmark 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.

Our data allow us to explore a wide variety of early-life outcomes in order to study potential mechanisms through which birth order effects are

occurring. We are able to rule out broad classes of explanations. We find no evidence that secondborn children are less healthy, and indeed secondborn 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 secondborn children's education. These children attend no-worse schools and are more likely to attend prekindergarten. We consider differences in parental attention as a potential contributing factor to the gaps in delinquency across the birth order. In our administrative data the measures of direct parental investment include maternal employment and use of day care. We discovered that the arrival of the secondborn child has the potential to extend the early-childhood parental investment in the firstborn child, in addition to the fact that firstborns experience undivided attention until the arrival of the secondborn.

Incidentally, it is not clear what parents would do were they to know the results of the birth order literature. Much of the literature from Western developed societies presents evidence that parents actively attempt to invest more resources in their relatively disadvantaged children, suggesting that parents have a taste for redistribution within the family (Loughran, Kilburn, and Datar 2008; Hsin 2012; Bernardi 2014; Figlio et al. 2014; Hsin and Felfe 2014; Bharadwaj, Eberhard, and Neilson 2018). But several recent papers (Datar, Kilburn, and Loughran 2010; Frijters et al. 2013) argue that parents are likely to invest more resources in their relatively advantaged children, and others (Royer 2009; Kelly 2011) find no evidence one way or the other. As such, we are not sure whether parents, on learning of these birth order effects, would pay additional attention to their firstborn children or to their secondborn children.

Regardless of parental responses, 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 suggest potentially fruitful avenues for monitoring and interventions. Our findings regarding systematically different dosages of early-childhood parental attention as a plausible mechanism also provide a call for future research on this topic and engender further discussion of parental leave as a long-run social benefit.

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