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Birth Order and Upper-Secondary School Tracking in Sweden: A Mechanism for Birth Order Inequality in Educational Attainment

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Abstract

Using Swedish register data, this study investigates the association between birth order and upper-secondary school tracks. A large body of research has shown that ordinal position within the sibling group matters for development trajectories and attainment processes. Researchers have also long been interested in the effects of secondary school tracking, showing that it can reinforce the effect of social origins. Using data for over 2 million pupils transitioning from compulsory to non-compulsory upper-secondary school from 1996 to 2019, and sibling fixed-effects, we find that later birth order is negatively associated with the probability of enrolling in university-preparatory academic tracks, known for having higher expected earnings and prestige. These findings persist net of earlier educational performance, gender, socioeconomic background, or migration background. Later-born children are more likely to complete vocational programs. These findings shed light on the mechanisms driving the higher educational attainment, earnings, and employment stability of first- and earlier-born children, as they tend to complete secondary school tracks that provide greater future opportunities. The influence of birth order on completed years of education at age 30 diminishes by half when adjusting for secondary tracking and loses statistical significance when GPA is introduced as an additional control. While an unequivocal explanation for the origins of divergent tracking choices eludes us, existing literature suggests variation in parenting practices, child investments, and the familial environment contribute to these aspirational differences.

Keywords: Birth Order, School Tracking, Sibling Fixed-Effects, Within-Family Inequality

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Introduction

A growing body of research indicates that ordinal position within the sibling group of origin matters for development trajectories and attainment processes (Härkönen and Santacroce 2024): later-born siblings have lower educational attainment (Barclay 2015a; Black, Devereux, and Salvanes 2005; Härkönen 2014), lower cognitive ability scores (Barclay 2015b; Black, Devereux, and Salvanes 2011), and worse labor market outcomes (Barclay, Hällsten, and Myrskylä 2017; Black, Devereux, and Salvanes 2005). However, while many research articles have investigated the effect of birth order on a variety of different outcomes, none have examined the association between birth order and secondary school tracks. Researchers have long been interested in the effects of secondary school tracking (Gamoran and Mare 1989). School tracking can reduce intergenerational mobility in educational attainment by creating obstacles for individuals from progressing to tertiary-level education or limiting their choice of university degrees, thus reinforcing the effect of social origins and reducing equality of opportunity (Brunello and Checchi 2007). The Swedish educational context is comparatively less limiting than in other nations as tracking occurs at the relatively advanced age of 16 and there are few academic dead ends. Nonetheless, the decisions students make regarding their upper secondary education has implications for later occupation, income, and life opportunities, which may perpetuate existing social disparities. Students enrolled in higher tracks receive more challenging curricula with a broader and better range of educational and occupational prospects, including access to professions that require advanced degrees and qualifications, while students placed in lower tracks have more limited career opportunities. Divergent choices would unveil valuable insights into the role of birth order within the family of origin in shaping individual preferences and opportunities despite siblings sharing the same family environment during upbringing.

The lack of previous research connecting the birth order literature to the secondary school tracking literature is problematic because sibling differences in school tracking may explain why later-borns have worse educational, cognitive ability, and labor market outcomes compared to first- and earlier-born siblings. Nonshared environmental factors have been suggested as the primary cause of dissimilarities between siblings (Plomin and Daniels 1987) and school tracking may illuminate some of the reasons behind the substantial variations observed among siblings. One of the most significant puzzles within the realm of birth order research pertains to the

underlying causes and mechanisms governing this phenomenon. The practice of tracking within the education system may be a key factor for comprehending the disparities observed in educational attainment, IQ scores, and labor market outcomes. Birth order is a long-standing contributor towards social disparities, yet the mechanisms by which it exerts its influence remain inadequately understood. Understanding the association between birth order and school tracking can shed light on some of the underlying mechanisms of sibling disparities, elucidating on the underrepresentation of later-borns in education and the labor market.

This study provides, to the best of our knowledge, the first empirical investigation of the relationship between birth order and secondary school tracks. We address this research question using Swedish administrative data. The transition from compulsory to non-compulsory upper-secondary school tracks is examined for over 2 million students over the period 1996–2019 using sibling fixed-effects models. The richness of the data at our disposal presents a unique and exceptional opportunity. While the association between birth order and university major has already been examined (Barclay, Hällsten, and Myrskylä 2017), secondary school choices precede them and play a pivotal role in the developmental trajectory of children. For instance, selecting the natural science track offers students the greatest flexibility when making university applications. The transition from mandatory to non-compulsory education marks the earliest stage at which students can begin to make significant educational choices in Sweden, rendering our study especially salient and insightful. Additionally, our research benefits from a more representative sample given that secondary school choices are made by a wider range of students, in contrast to university decisions, which tend to be concentrated among individuals from more socially advantaged backgrounds. We are fortunate to possess data encompassing an entire population, giving us the ability to make population-based inferences, and ensuring enough power to examine heterogeneities associated with social class, gender, and migration background.

To preview our findings, we observe that first- and earlier-borns are more likely to enroll in university-oriented school tracks associated with higher expected earnings and greater prestige, while later-borns are more likely to complete vocational tracks associated with lower expected earnings and lower prestige. This helps to explain why later-borns complete less education (Barclay 2015a; Black, Devereux, and Salvanes 2005; Härkönen 2014), earn less (Black,

Devereux, and Salvanes 2005), have lower chances of full-time employment (Black, Devereux, and Salvanes 2005), and score lower on cognitive ability tests in adulthood (Barclay 2015b; Black, Devereux, and Salvanes 2011). For example, first- and earlier-born siblings are more likely to enroll in the natural science program, which is widely considered Sweden's most prestigious and demanding upper-secondary school program, providing students with a pathway to enroll in virtually any undergraduate degree program. Later-borns, on the other hand, are more likely to enroll in vocational tracks such as those that train them to work in construction, social care, the hospitality sector, and as heating, ventilation, and air conditioning (HVAC) technicians. We also examine sibling differences in university major preferences and find that firstborns are more inclined to pursue degrees that are normatively considered more prestigious, such as science, technology, engineering, and mathematics (i.e., STEM), law, and professional medical services, even after controlling for GPA, the enrollment in an academic track in secondary education, and the completion of the natural science program, suggesting aspirational differences by birth-rank. Finally, we observe that the influence of birth order on completed years of education at age 30 diminishes by half when adjusting for secondary school tracking and loses statistical significance when GPA is introduced as an additional control. This suggests that tracking plays a pivotal role as a mechanism for the extensively documented birth order effects in completed education (Barclay 2015a; Black, Devereux, and Salvanes 2005; Booth and Kee 2009; de Haan 2010; Härkönen 2014; Kantarevic and Mechoulan 2006; Kristensen and Bjerkedal 2010).

Background

Empirical Evidence

The body of literature on birth order is extensive and has examined a wide range of outcomes. Scholarly interest in the effects of birth order can be traced back as far as Galton (1874) on the study of eminence. Researchers have long been interested in investigating the effects of birth order on personality traits, career paths, and other important aspects of life. One important area of research has focused on the effects of birth order on educational outcomes. Studies have shown that first- and earlier-borns tend to have higher educational attainment and greater academic success than later-borns (Black, Devereux, and Salvanes 2005; Booth and Kee 2009; De Haan 2010; Iacovou 2008; Kalmijn and Kraaykamp 2005; Kantarevic and Mechoulan

2006; Kristensen and Bjerkedal 2010; Silles 2010). Birth order differences in completed years of education range from one-third of a year between first- and second-borns to more than a year among high birth order children (Barclay 2015a; Black, Devereux, and Salvanes 2005). Moreover, later-born siblings are less likely to transition to non-compulsory education (Härkönen 2014) and tend to have lower grades in math, science, and English (Iacovou 2008). These findings suggest that later-born siblings should be less likely to enroll in university-oriented or more academically demanding school tracks, and instead be more likely to complete vocational programs.

Another area of research that is relevant to educational attainment is the relationship between birth order and cognitive ability. A number of studies have reported a negative association between birth order and cognitive ability test scores (Barclay 2015b; Bjerkedal et al. 2007; Black, Devereux, and Salvanes 2011; Boomsma et al. 2008; Kristensen and Bjerkedal 2007; Rohrer, Egloff, and Schmukle 2015). This suggests that first- and earlier-born siblings may have an advantage in academic achievement, which should lead to higher grades in school and a greater likelihood of enrolling in university-oriented or more academically challenging tracks relative to later-borns. However, causality may operate in the reverse direction, with disparities in cognitive ability emerging because of different educational experiences; for example, enrollment in mathematical, scientific, or university disciplines could contribute to higher cognitive ability test scores observed in adulthood. Either way, if first-borns are more likely to choose school tracks that increase the likelihood of attending university, this would contribute to educational attainment and labor market differentials between early- and later-born siblings.

Mechanisms

Resource Dilution Theory and the Confluence Hypothesis

Various theories have attempted to explain why later-born children tend to fare worse than their older siblings. Two prominent theories are the resource dilution hypothesis (Blake 1981, 1989) and the confluence hypothesis (Zajonc and Markus 1975). The dilution hypothesis posits that earlier-born children have a cumulative advantage in their access to finite parental resources and more generally that there is a dilution of favorable parenting practices as more children enter the family. This theory has received empirical validation. For example, parents spend more quality time with firstborns compared to second-borns of the same age (Price 2008) and take

more parental leave (Sundström and Duvander 2002). Mothers are more likely to breastfeed, seek prenatal care, and decrease their cigarette and alcohol consumption with firstborns than later-borns (Buckles and Kolka 2014; Lehmann et al. 2018). In contrast, the confluence hypothesis (Markus and Zajonc 1977; Zajonc 1976; Zajonc and Markus 1975) suggests that earlier-born children have higher cognitive development compared to their younger siblings due to greater intellectual stimulation within the household, particularly at early ages; this intellectual stimulation is hypothesized to be a function of the average cognitive ability of all family members, and the average declines as additional newborn children join the family. This theory has received less empirical support. In both theories, the firstborn is expected to exhibit higher cognitive ability due to the relative disadvantages faced by their younger siblings in parental treatment and the intellectual family environment during infancy and adolescence. Given that earlier-born children receive greater parental investments, we expect them to pursue more scientific tracks and be more likely to enroll in private education, such as the International Baccalaureate (IB) program, which is a diploma offered mainly by independent schools with public funding (*friskola*).

Differences in Parental Treatment

Insights for our work can be drawn from other explanations of birth order phenomena that have been put forward by the literature. For instance, research has shown that parents tend to be more academically strict with firstborns to set an example and discourage their younger children from performing poorly in school (Hao, Hotz, and Jin 2008; Hotz and Pantano 2015). Additionally, firstborns often harbor greater educational aspirations, influencing their academic achievements later in life (Bu 2016) and have been found to be more status-oriented (Davis 1997). This evidence suggests that parental expectations and aspirations for their children's educational and career success vary by birth order. Studies have also shown that investments in human capital during early childhood carry greater significance compared to interventions later in life (Heckman 2006). This underscores the advantage enjoyed by first-born children, who receive exclusive parental attention and investments during their crucial early years of life. Furthermore, empirical findings suggest that parents may unevenly allocate their investments among their offspring, occasionally offering more cognitive stimulation to higher-ability children (Grätz and Torche 2016), thereby reinforcing the advantages of being a firstborn. This evidence

on differences in aspirations, strategic parenting, exclusive early-childhood investments, reinforcement behavior, as well as the potential cultural vestiges of primogeniture, all suggest that earlier-born children may be more likely to pursue traditionally prestigious tracks, such as preparatory programs for tertiary education, and more specifically the natural science program.

Birth Order and Personality

Personality is another trait that has been investigated as a potential mechanism for understanding birth order differences (Adler 1928). Sulloway's (1996) influential work argues that firstborns tend to be more conservative, traditional, and risk-averse. These traits may lead them to pursue traditionally prestigious school tracks with tertiary education opportunities that are more predictable and secure, such as completing the natural science program which offers students the opportunity to pursue any academic discipline in university. Sulloway argues that later-born children are less conforming, more rebellious, and occupy different niches within the family to avoid sibling competition with older siblings, which should lead them to pursue riskier, more creative, and less traditional tracks. Relating Sulloway's research to our work, this would suggest that later-borns may be more likely to enroll in creative university programs, such as art and media.

While, some studies have failed to find any significant birth order effects on personality (Ernst and Angst 1983; Rohrer, Egloff, and Schmukle 2015; Schooler 1973); other studies claimed that firstborns tend to be more conformist, conscientious, traditional, achievement-oriented, and later-borns more rebellious, creative, outgoing, and agreeable (Healey and Ellis 2007; Paulhus, Trapnell, and Chen 1999; Sulloway 1996). The association between birth order and personality is particularly important given the connection between personality and college major and occupational choices. Research has shown that individuals tend to choose professions (Holland 1996) and college majors (Allen and Robbins 2008) that match their personality. According to research conducted by Kline and Lapham (1992) and Van Der Molen, Schmidt, and Kruisman (2007), individuals pursuing natural sciences and applied sciences exhibit higher levels of conscientiousness and lower levels of openness to experience compared to those pursuing arts, humanities, and social sciences. Additionally, studies by Corulla and Coghill (1991), De Fruyt and Mervielde (1996), and Harris (1993) have shown that social science majors tend to score higher on extraversion compared to students studying humanities or natural

sciences. Lievens et al. (2002) also found that medical students tend to have higher levels of extraversion. Considering this research, first-borns may have a higher propensity than later-borns to pursue the natural science program, while later-borns may have a greater inclination to pursue tracks in art, business and administration, social science, humanities, and social care.

Overall, despite numerous studies on birth order and personality, there has been a lack of agreement on the relationship between birth order and personality traits. According to Rodgers et al. (2000), Rodgers (2001), Paulhus, Trapnell, and Chen (1999), and Damian and Roberts (2015), the reason for the inconsistent results may be due to the use of different methodologies and inappropriate between-family designs. According to the authors, the effects of birth order on personality, as well as other outcomes, may be moderated by other factors, such as gender, cultural context, and social class. In this study we use sibling fixed-effects to compare children from the same family and conduct heterogeneity analyses by sex, migration background, and parental education to take these factors into account when investigating the effects of birth order on school tracking choices. While the relationship between birth order and school tracking has never been examined, considering existing research showing birth-rank differentials in various outcomes we expect birth order to be associated with tracking decisions too. Understanding this relationship may provide insights into some of the mechanisms of why firstborns are more likely to pursue more prestigious and lucrative college majors (Barclay, Hällsten, and Myrskylä 2017), occupational choices with higher earnings (Black, Devereux, and Salvanes 2005), and why they study for longer (Barclay 2015a; Black, Devereux, and Salvanes 2005; Booth and Kee 2009; De Haan 2010; Härkönen 2014; Kantarevic and Mechoulan 2006; Kristensen and Bjerkedal 2010).

Data & Methods

Data

In this study, we utilize a rich administrative register data source covering the entire population of Sweden to examine the relationship between birth order and educational track choice. Specifically, our dataset captures the progression from compulsory education to non-compulsory upper-secondary school tracks, known as Gymnasium national programs, for over 2 million pupils from 1996 to 2019. This progression typically occurs around age 16, a pivotal point in the educational trajectory of Swedish students. Sibling groups are defined as children

that share the same biological mother and father, and birth order is constructed using data on month and year of birth. Since large sibling groups are relatively uncommon in Sweden, we recoded sibships greater than 6 as 6. We also dropped singletons from the model as we apply sibling fixed effect models, and sibling groups with only one child do not have any within-group variance. We further drop children of multiple pregnancies (i.e., twins, triplets, etc.) from the sample as the interpretation of birth order in these families is ambiguous. The sample size of our study consists of 2,121,566 individuals born between 1980 and 2006.

Our analysis of upper-secondary school track choice and birth order draws upon a comprehensive dataset that contains information on student's choice of national program, covering both vocational and academic pathways (see Supplementary Table 1). Of the 18 national programs available in Sweden today, 12 are vocational tracks that train students for specific professions. For example, the Health and Social Care program may train you to become a nurse, a physiotherapist, a social worker, and other related professions in the healthcare and social care sector. The remaining 6 programs are preparatory or university-oriented tracks and are designed to prepare students for future academic studies. The 6 current university-focused tracks encompass a range of disciplines, including social science, natural science, business and management, technology, arts, and humanities, offering a variety of options for students seeking a pathway into tertiary education. Notably, the natural sciences program is generally acknowledged as the most prestigious and challenging track, providing a comprehensive education offering students to matriculate in nearly any undergraduate degree. In addition to these national programs, our dataset also includes students who completed the International Baccalaureate (IB), a globally recognized degree offered by independent schools in Sweden, and the Media track which was a school track until 2012 but is no longer offered today.

To obtain information on the socioeconomic characteristics of parents, we use anonymized identifiers to link children to their parents using the multigenerational register. We do this to investigate the potential moderating effect of parental socioeconomic status (SES) and migration background on the educational choices of their children. SES is proxied using data on the highest parental educational attainment, where parents with compulsory-only education are coded as low SES, those with upper-secondary education as middle SES, and those with tertiary education as high SES. In addition to SES, we also retrieve data on the migration history of

parents and link it to their children. Migration background is coded as having two migrant parents, one migrant parent, and no migrant parent (i.e., two Swedish-born parents). This enables us to examine potential heterogeneity and to disentangle the effect of birth order from those of parental characteristics that might influence the educational trajectories of children. To control for and to test for potential heterogeneity due to sex and birth order interactions, we also retrieve data on sex at birth. We also explore student's preferences in university majors, by capturing the subject field for the program that they ranked first in their university application among 20 distinct disciplines, categorizing STEM (science, technology, engineering, and mathematics), law, and professional medical services as traditionally prestigious preferences (see Supplementary Table 2). This data stands out for its uniqueness as it captures student's preferences regarding what they would like to study in university. We also investigate completed years of education by age 30 by converting educational attainment into their corresponding number of years. For example, compulsory school completion is coded as 9 years, upper-secondary school as 12 years, undergraduate education as 15 years, and postgraduate education as 18 years. Maternal age at child birth and birth year are also retrieved and included as dummies in the model's controls.

Methods

The appropriate estimation model for correctly estimating birth order effects has been a subject of methodological debates (see Rodgers 2001; Rodgers et al. 2000). There is a consensus that models involving within-family comparisons, such as sibling fixed-effects, are the appropriate choice for correctly estimating birth order effects. As such, in our study, we employ a linear fixed effects model to investigate the relationship between birth order and educational tracks which are coded as binary outcome variables (0 or 1). While we explored the possibility of using the multinomial fixed effects logit estimator, we encountered challenges as the likelihood function failed to converge. As a result, we have chosen to prioritize the Linear Probability Model (LPM) as our preferred estimator. We also prefer a linear probability model over the nonlinear logit model as it allows for easier interpretation of coefficients and enables direct comparisons of coefficients across educational tracks, which is a key objective of our research. Angrist and Pischke (2009) have demonstrated that linear probability models are consistent estimators for binary outcomes and that the marginal effects of logit models are comparable to unstandardized coefficients of linear probability models.

We estimate various models to explore the relationship between birth order and educational choices. Firstly, we examine the likelihood of pursuing an academic track based on birth order. Then, we investigate the association between birth order and all upper-secondary school programs, both with and without controlling for grade point average (GPA). Subsequently, we conduct a heterogeneity analysis without a GPA control, stratifying the dataset by parental socioeconomic status and migration background, as well as assessing the effect of gender by estimating an interaction model of sex (female or male) and birth order. To augment our research, we examine the propensity of earlier-born individuals to rank university majors traditionally regarded as prestigious as their first choice in their university application. These preferences can be considered as implicit aspirations, distinguishing them from surveys that directly inquire about ambitions and aspirations. Finally, to investigate whether school tracking is a mechanism for birth order inequality we examine birth order effects on completed education at age 30 net of tracking choices. All regressions include dummy variable controls for the child's birth year, the mother's age at the child's birth, and sex at birth, and incorporate cluster-robust standard errors with sibships specified as the clustering unit.

Context

The Swedish school system is tax-financed (tuition-free) and compulsory from the year children turn 6. Compulsory schooling (grundskolan) consists of four stages: förskoleklass (a preschool year, or year 0), lågstadiet (years 1-3), mellanstadiet (years 4-6) and högstadiet (years 7-9). At the end of compulsory education, students can enrol in upper-secondary school (Gymnasium, years 10-12), which includes 18 national programs, 12 of which are vocational and 6 are preparatory for tertiary education, provided they have met the requirements to do so. Studying in upper secondary school is free and voluntary in Sweden and almost all Swedes choose to continue their studies in upper-secondary school[1]. To be eligible for vocational or preparatory programs leading to higher education, students must have passed a specific number of subjects. If these requirements are met, they are considered eligible to apply for upper secondary school. Students who are not eligible to apply for upper secondary school can instead attend an introductory program, which is designed to provide students with the opportunity to enter a national program or to secure employment. Given the high number of available upper-

[1] Source: https://sweden.se/life/society/the-swedish-school-system

secondary programs, the decision of which one to apply for is typically made with the guidance of a study counsellor.

Results

This section discusses the results of the regression analysis exploring the association between birth order and upper-secondary school track choice. Table 1 presents the regression coefficients unscaled by the baseline probability controlling for individual year of birth, maternal age at childbirth, and sex for the full sample. Figure 1 visualizes the same results. The green dashed line adds a control for GPA at the end of compulsory schooling to capture educational choices that are independent of academic performance or ability. Heterogeneity analyses by social class, migration background, and sex are presented in Figures 2-4, respectively. We provide the reader with spreadsheets of regression coefficients for all heterogeneity analyses as Supplementary Results. All models use within-family sibling fixed effects.

To provide a sense of scale of our results, we estimate the difference in the probability of completing each track between first- and later-borns and divide it by the baseline probability. The baseline probability is defined as the enrollment rate for each track in the entire population (i.e., the sum of all baseline probabilities is 1). Thus, our results can be interpreted as birth order differences in the probability of completing each track relative to the baseline population probability. For example, in our sample, the baseline probability of completing the natural science program is 14.45 percent. Second-borns are 4.8 percentage points less likely than firstborns to complete this track, and fifth-borns are 7.3 percentage points less likely. We express these differences in relative terms in the graphs as a 33 percent difference between first- and second-borns and a 50 percent difference between first- and fifth-borns. We undertake this calculation to determine whether a 4.8 and 7.3 percentage point difference carries substantive weight or not.

Birth order is negatively associated with the probability of enrolling in university tracks. Later-born children are more likely to complete vocational tracks and firstborns are more likely to complete university tracks. We found that the likelihood of completing a university track (Art, Business and Administration, Humanities, International Baccalaureate, Natural Science, Social Science, Technology) decreases among second-borns by 13 percent (5 pp) and by 26 percent (10

pp) among sixth-borns, relative to the baseline probability (39 pp). More specifically, the results show that earlier-born children are more likely to complete university-oriented upper-secondary school tracks in natural science, humanities, technology, and the international baccalaureate. In contrast, later-born children are more likely to complete vocational programs in building and construction, business and administration, child and recreation, HVAC (heating, ventilation, and air conditioning), handicraft, hotel and tourism, media, and restaurant management and food. Among the remaining programs, there is smaller variation in university-oriented track choices art, business and administration, and social science, and vocational programs in electricity and energy, health and social care, industrial technology, natural resource use, and vehicle and transport. These findings are independent of GPA (Figure 1, green dashed line), and are largely unaffected by social class, migrant background, and sex (Figures 2-4). Program choices follow a monotonically increasing or decreasing pattern in relation to birth order, which indicates that the relationship between birth order and tracking is more nuanced than a simple dichotomy between first- and later-born children.

Table 1: Regression Coefficients Unscaled by the Baseline Probability for the Full Sample

Without GPA Control

	(VOC) Building & Construction	(VOC) Child & Recreation	(VOC) Electricity & Energy	(UNI) Business & Admin.	(UNI) Arts	(VOC) Vehicle & Transport	(VOC) Business & Admin.	(VOC) Hotel & Tourism	(UNI) Humanities	(VOC) Handicraft	(UNI) International Baccalaureate	(VOC) Industrial Technology	(VOC) Media	(UNI) Natural Science	(VOC) Natural Resource Use	(VOC) Restaurant & Food	(UNI) Social Science	(UNI) Technology	(VOC) HVAC	(VOC) Health & Social Care	(UNI) Any Academic Track
Birth Order: 2	0.00252***	0.00595***	-2.54e-05	0.00437***	0.00417***	0.00221***	0.00972***	0.0125***	-0.000278*	0.0102***	-0.00345***	-0.00851***	0.00407***	-0.0483***	-0.00137***	0.00391***	0.000488	-0.00685***	0.00958***	0.00367***	-0.0498***
	(0.000304)	(0.000447)	(0.000540)	(0.000471)	(0.000568)	(0.000475)	(0.000453)	(0.000427)	(0.000125)	(0.000483)	(0.000208)	(0.000934)	(0.000393)	(0.000777)	(0.000402)	(0.000240)	(0.000563)	(0.000582)	(0.000454)	(0.000428)	(0.00100)
Birth Order: 3	0.00381***	0.00847***	0.00164	0.00367***	0.00654***	0.00384***	0.0155***	0.0163***	-0.000543*	0.0138***	-0.00545***	-0.0142***	0.00748***	-0.0683***	-0.00165*	0.00563***	0.00147	-0.00953***	0.0133***	0.00515***	-0.0722***
	(0.000596)	(0.000895)	(0.00106)	(0.000898)	(0.00111)	(0.000952)	(0.000910)	(0.000850)	(0.000234)	(0.000962)	(0.000412)	(0.00185)	(0.000770)	(0.00151)	(0.000786)	(0.000479)	(0.00109)	(0.00111)	(0.000899)	(0.000882)	(0.00197)
Birth Order: 4	0.00557***	0.0105***	0.00113	-0.00181	0.00649***	0.000983	0.0172***	0.0176***	-0.00115**	0.0150***	-0.00616***	-0.00990***	0.0111***	-0.0738***	-0.000970	0.00694***	0.000758	-0.0136***	0.0167***	0.00378**	-0.0893***
	(0.000948)	(0.00144)	(0.00165)	(0.00136)	(0.00173)	(0.00155)	(0.00148)	(0.00134)	(0.000351)	(0.00153)	(0.000654)	(0.00293)	(0.00121)	(0.00235)	(0.00122)	(0.000758)	(0.00170)	(0.00168)	(0.00144)	(0.00146)	(0.00309)
Birth Order: 5	0.00672***	0.0122***	0.00253	-0.00774***	0.00796**	0.00141	0.0164***	0.0241***	-0.00124*	0.0134***	-0.00691***	-0.0149***	0.0146***	-0.0731***	-0.00246	0.00719***	0.00460	-0.0172***	0.0200***	0.000152	-0.0936***
	(0.00149)	(0.00224)	(0.00248)	(0.00200)	(0.00251)	(0.00242)	(0.00232)	(0.00202)	(0.000522)	(0.00234)	(0.000951)	(0.00442)	(0.00172)	(0.00348)	(0.00176)	(0.00116)	(0.00262)	(0.00241)	(0.00215)	(0.00237)	(0.00461)
Birth Order: 6	0.00923***	0.0186***	-0.000168	-0.0150***	0.00569	-0.00673*	0.0174***	0.0301***	-0.00200**	0.0132***	-0.00702***	-0.0185**	0.0220***	-0.0652***	-0.00373	0.00755***	0.00699	-0.0242***	0.0252***	-0.00542	-0.101***
	(0.00216)	(0.00309)	(0.00332)	(0.00277)	(0.00333)	(0.00334)	(0.00330)	(0.00268)	(0.000707)	(0.00324)	(0.00126)	(0.00620)	(0.00225)	(0.00480)	(0.00226)	(0.00157)	(0.00378)	(0.00319)	(0.00297)	(0.00347)	(0.00643)
Female	-0.0240***	0.0346***	-0.0964***	0.00378***	0.0506***	-0.0686***	0.0196***	0.0171***	0.00322***	0.0295***	0.00480***	0.0738***	0.0101***	-0.00312***	0.0188***	0.00546***	0.0388***	-0.0884***	-0.0667***	0.0444***	0.00974***
	(0.000231)	(0.000350)	(0.000422)	(0.000354)	(0.000444)	(0.000380)	(0.000349)	(0.000331)	(9.39e-05)	(0.000381)	(0.000156)	(0.000718)	(0.000310)	(0.000594)	(0.000316)	(0.000182)	(0.000422)	(0.000458)	(0.000363)	(0.000338)	(0.000771)
# Individuals	2,121,566	2,121,566	2,121,566	2,121,566	2,121,566	2,121,566	2,121,566	2,121,566	2,121,566	2,121,566	2,121,566	2,121,566	2,121,566	2,121,566	2,121,566	2,121,566	2,121,566	2,121,566	2,121,566	2,121,566	2,121,566
# of Sibships	1,064,057	1,064,057	1,064,057	1,064,057	1,064,057	1,064,057	1,064,057	1,064,057	1,064,057	1,064,057	1,064,057	1,064,057	1,064,057	1,064,057	1,064,057	1,064,057	1,064,057	1,064,057	1,064,057	1,064,057	1,064,057
R-squared	0.030	0.011	0.050	0.037	0.015	0.034	0.004	0.005	0.004	0.009	0.002	0.066	0.006	0.020	0.004	0.006	0.079	0.042	0.041	0.018	0.082
Baseline Prob.	0.0159	0.0342	0.0511	0.0475	0.0621	0.0405	0.0338	0.0313	0.0025	0.0387	0.0079	0.2153	0.0270	0.1445	0.0280	0.0092	0.0653	0.0647	0.0357	0.0293	0.3946

With GPA Control

	(VOC) Building & Construction	(VOC) Child & Recreation	(VOC) Electricity & Energy	(UNI) Business & Admin.	(UNI) Arts	(VOC) Vehicle & Transport	(VOC) Business & Admin.	(VOC) Hotel & Tourism	(UNI) Humanities	(VOC) Handicraft	(UNI) International Baccalaureate	(VOC) Industrial Technology	(VOC) Media	(UNI) Natural Science	(VOC) Natural Resource Use	(VOC) Restaurant & Food	(UNI) Social Science	(UNI) Technology	(VOC) HVAC	(VOC) Health & Social Care	(UNI) Any Academic Track
Birth Order: 2	0.00134***	0.00137**	-0.00341***	0.00770***	0.00389***	-0.00277***	0.00683***	0.0103***	-4.75e-05	0.00876***	-0.00244***	-0.00553***	0.00377***	-0.0312***	-0.00335***	0.00337***	0.00103	-0.00430***	0.00771***	0.000709	-0.0254***
	(0.000330)	(0.000488)	(0.000600)	(0.000513)	(0.000636)	(0.000524)	(0.000498)	(0.000473)	(0.000136)	(0.000539)	(0.000223)	(0.00103)	(0.000445)	(0.000821)	(0.000447)	(0.000264)	(0.000612)	(0.000641)	(0.000505)	(0.000464)	(0.00106)
Birth Order: 3	0.00195**	0.000810	-0.00348**	0.00836***	0.00669***	-0.00411***	0.0114***	0.0128***	-0.000154	0.0119***	-0.00372***	-0.00795***	0.00766***	-0.0430***	-0.00486***	0.00504***	0.00165	-0.00620***	0.0106***	0.000428	-0.0364***
	(0.000659)	(0.00100)	(0.00121)	(0.00100)	(0.00129)	(0.00108)	(0.00103)	(0.000974)	(0.000264)	(0.00111)	(0.000455)	(0.00209)	(0.000906)	(0.00164)	(0.000902)	(0.000541)	(0.00121)	(0.00126)	(0.00103)	(0.000976)	(0.00215)
Birth Order: 4	0.00404***	0.00118	-0.00415*	0.00391*	0.00704***	-0.00799***	0.0120***	0.0145***	-0.000804*	0.0126***	-0.00415***	0.000592	0.0125***	-0.0481***	-0.00477***	0.00676***	-5.47e-05	-0.0109***	0.0137***	-0.00266	-0.0530***
	(0.00107)	(0.00163)	(0.00192)	(0.00155)	(0.00204)	(0.00178)	(0.00168)	(0.00157)	(0.000404)	(0.00179)	(0.000728)	(0.00332)	(0.00145)	(0.00258)	(0.00143)	(0.000871)	(0.00192)	(0.00193)	(0.00168)	(0.00161)	(0.00341)
Birth Order: 5	0.00524**	0.00140	-0.00387	-0.00296	0.0102**	-0.00920**	0.0116***	0.0200***	-0.00110	0.0102***	-0.00488***	0.00778	0.0162***	-0.0508***	-0.00657**	0.00760***	0.00297	-0.0156***	0.0178***	-0.00822**	-0.0621***
	(0.00176)	(0.00264)	(0.00300)	(0.00236)	(0.00311)	(0.00289)	(0.00274)	(0.00243)	(0.000626)	(0.00288)	(0.00110)	(0.00516)	(0.00214)	(0.00391)	(0.00215)	(0.00142)	(0.00310)	(0.00287)	(0.00263)	(0.00270)	(0.00524)
Birth Order: 6	0.00543	0.00192	-0.0102*	-0.0118**	0.00909	-0.0145**	0.00809	0.0303***	-0.00306***	0.00941	-0.00370*	0.0107	0.0249***	-0.0441***	-0.00607	0.00738**	0.00184	-0.0229***	0.0202***	-0.00609	-0.0747***
	(0.00311)	(0.00438)	(0.00490)	(0.00391)	(0.00521)	(0.00493)	(0.00489)	(0.00411)	(0.000891)	(0.00523)	(0.00185)	(0.00872)	(0.00358)	(0.00637)	(0.00343)	(0.00240)	(0.00553)	(0.00466)	(0.00452)	(0.00490)	(0.00879)
Female	-0.0200***	0.0451***	-0.0901***	-0.00196***	0.0545***	-0.0572***	0.0285***	0.0251***	0.00281***	0.0352***	0.00256***	0.0685***	0.0134***	-0.0532***	0.0237***	0.00778***	0.0363***	-0.0978***	-0.0614***	0.0483***	-0.0568***
	(0.000234)	(0.000397)	(0.000443)	(0.000379)	(0.000491)	(0.000384)	(0.000386)	(0.000372)	(9.92e-05)	(0.000419)	(0.000161)	(0.000779)	(0.000344)	(0.000627)	(0.000346)	(0.000202)	(0.000451)	(0.000505)	(0.000379)	(0.000374)	(0.000808)
# Individuals	1,976,558	1,976,558	1,976,558	1,976,558	1,976,558	1,976,558	1,976,558	1,976,558	1,976,558	1,976,558	1,976,558	1,976,558	1,976,558	1,976,558	1,976,558	1,976,558	1,976,558	1,976,558	1,976,558	1,976,558	1,976,558
# of Sibships	1,015,011	1,015,011	1,015,011	1,015,011	1,015,011	1,015,011	1,015,011	1,015,011	1,015,011	1,015,011	1,015,011	1,015,011	1,015,011	1,015,011	1,015,011	1,015,011	1,015,011	1,015,011	1,015,011	1,015,011	1,015,011
R-squared	0.033	0.022	0.055	0.042	0.016	0.044	0.011	0.010	0.004	0.012	0.005	0.068	0.007	0.095	0.006	0.007	0.082	0.047	0.045	0.021	0.157
Baseline Prob.	0.0157	0.0340	0.0518	0.0478	0.0631	0.0405	0.0336	0.0317	0.0025	0.0390	0.0073	0.2128	0.0276	0.1449	0.0282	0.0092	0.0650	0.0653	0.0361	0.0283	0.3959

Note: All models include controls for year of birth and maternal age dummies. The models use linear probability sibling fixed-effects regressions to examine enrollment in the specified upper-secondary school track (0/1). Cluster-robust standard errors in parentheses.

*** p<0.001, ** p<0.01, * p<0.

Figure 1: Full Sample

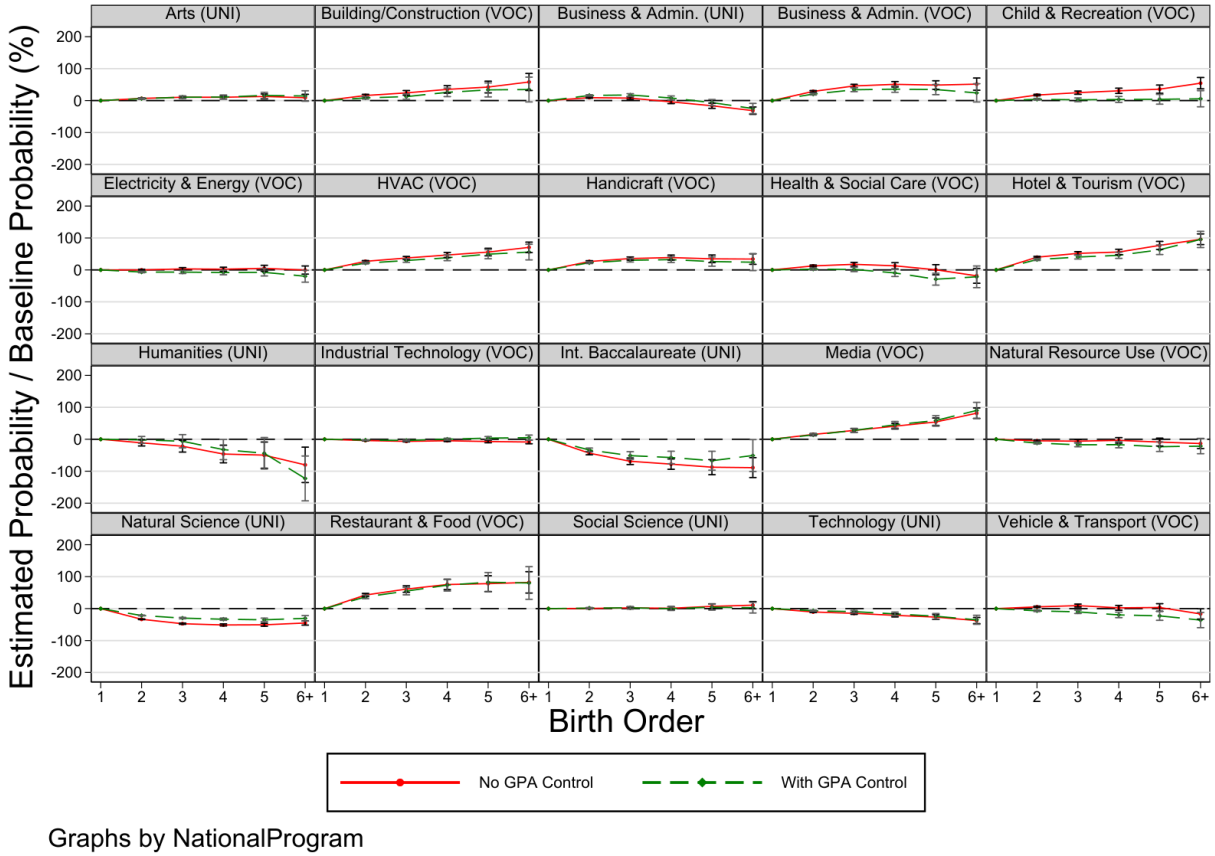
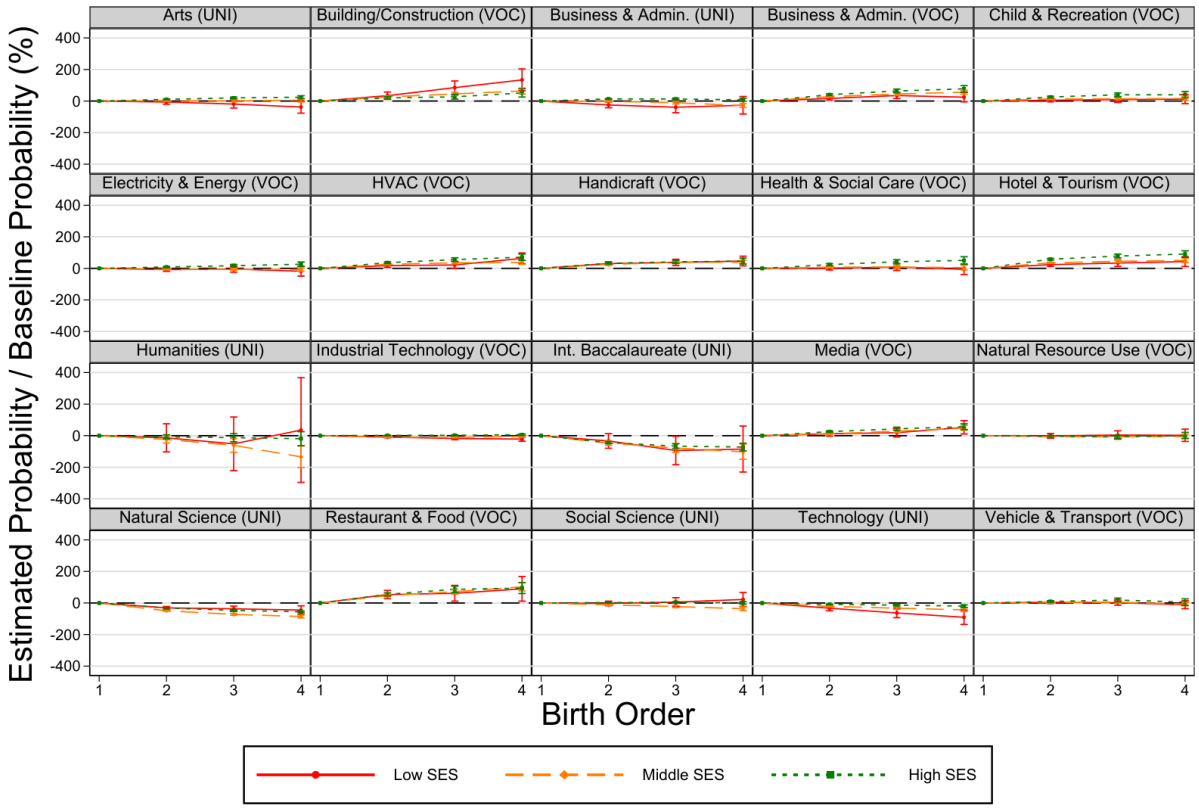


Figure 2 presents the results of a stratified analysis by social class, which was conducted to investigate the potential moderating effect of socioeconomic status (SES). Social class is proxied by the highest parental educational attainment, where parents with compulsory-only education were categorized as low SES, those with upper-secondary education as middle SES, and those with tertiary education as high SES. To ensure sample size adequacy and to improve the visibility of our results we examine families with up to four children. The results suggest minimal birth order differences by social class, except for a modestly steeper positive birth order effect for the enrollment into the building and construction program among low SES families. The humanities track displayed some heterogeneity between high, middle, and low SES families, with fourth-borns from disadvantaged parental backgrounds being more inclined to select this track. However, this effect was not statistically significant as suggested by its confidence interval, and it should be stated that sample size of fourth-born children in low SES families studying humanities is limited. The results suggest that the negative effect of birth order on the selection of educational tracks is not limited to specific socio-economic backgrounds, indicating a universal effect of birth order.

Figure 2: Heterogeneity by Socioeconomic Background



In Figure 3, we present the regression results stratified by the migration history of the parents. Migration background is categorized into three groups based on whether both parents are migrants (labeled as both migrants), whether one parent is a migrant (referred to as mixed), or whether neither parent is a migrant (termed both natives). In line with the other figures that show heterogeneity, families with more than four children were omitted from the analysis to ensure an adequate sample size and to enhance the clarity of our results. The results indicate that, apart from building and construction, and HVAC and property maintenance, there are minimal birth order differences by migration background. Later-born children of immigrant parents are more likely to select these tracks. As evidenced by these stratified results, the effect of birth order on educational track choices is not affected by whether the parents are Swedish-born or not.

Figure 3: Heterogeneity by Migration Background

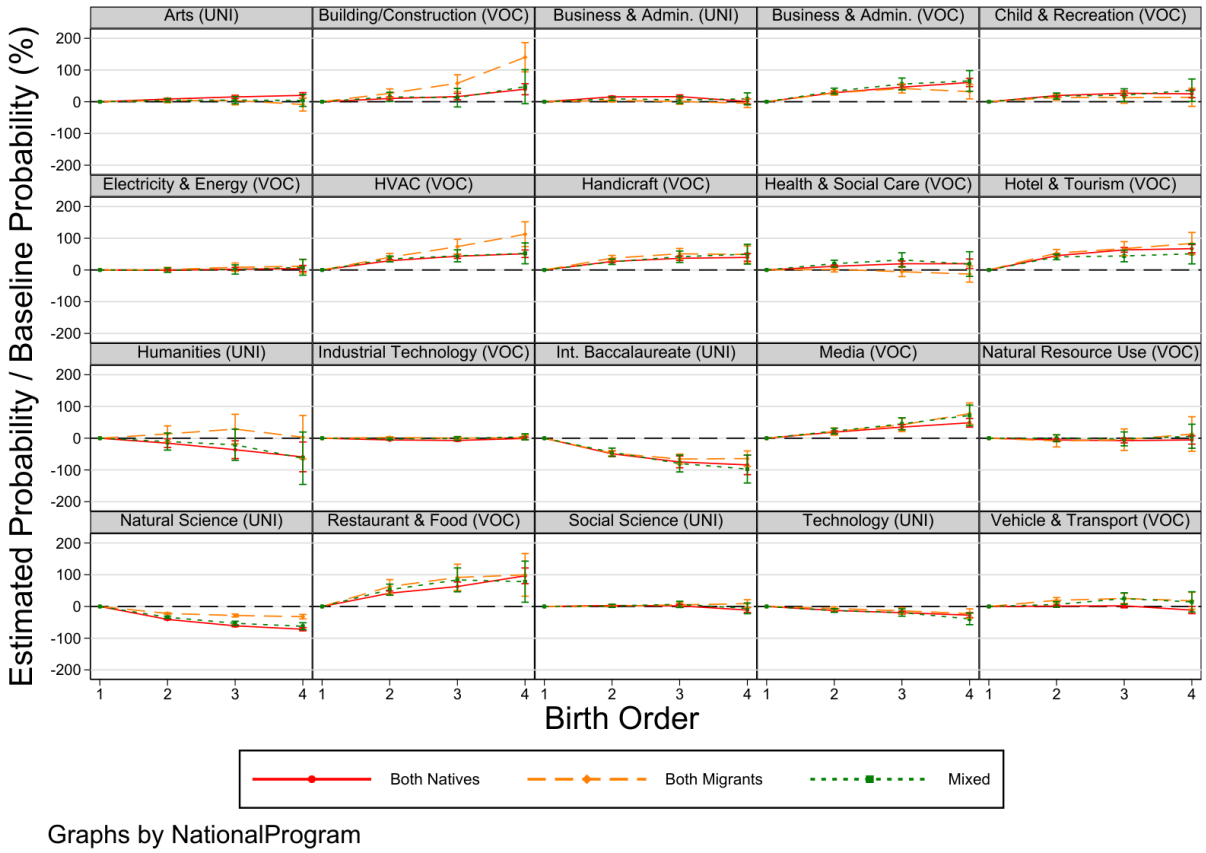
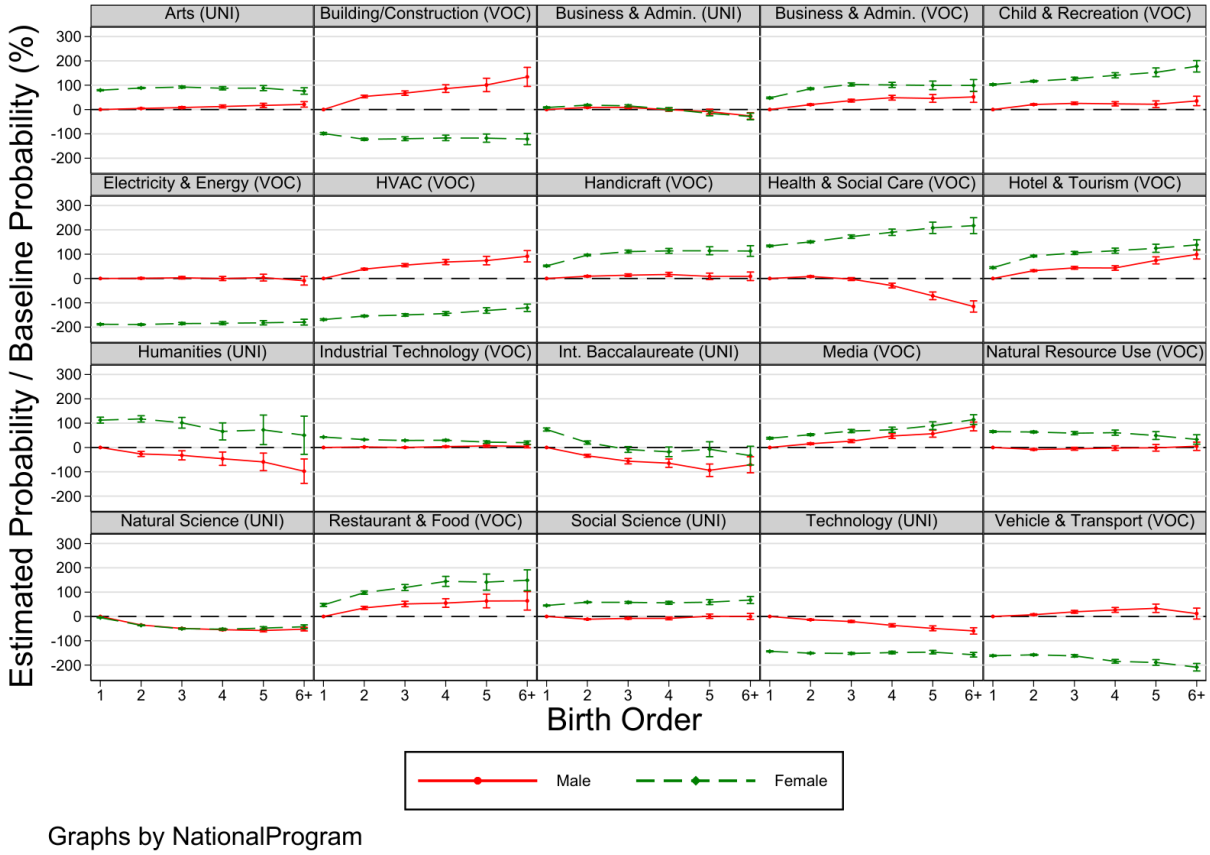


Figure 4 examines the potential interaction between sex and birth order in determining program choice. While there are substantial differences in program choice between males and females, birth order gradients are largely the same. Our findings reveal that gender plays an important role in shaping educational choices, and this aligns with a body of literature which highlights how gender equalitarian countries, such as Sweden, have high levels of gender-segregated labor markets (Charles and Grusky 2004). For instance, females are more likely to choose programs such as art, child and recreation, handicraft, health and social care, hotel and tourism, humanities, media, restaurant management and food, and social science, which typically lead to careers in communication, nursing, social care, and hospitality that are widely perceived as more feminine. In contrast, males are more inclined to choose programs such as building and construction, electricity and energy, HVAC, technology, and vehicle and transport, which often leads to jobs as plumbers, construction workers, electricians, building maintenance personnel, and drivers, which are typically regarded as more masculine occupations. Notably, the only tracks that do not reveal sex differences are the prestigious natural science program and the business and administration university track. However, after

controlling for GPA female enrollment in the natural science program is lower compared to males of the same birth order. This difference is roughly 5 percentage points, signifying a 30 percent reduction relative to the baseline probability. When examining the remaining tracks, disparities in tracking based on sex persist even after controlling for GPA, although to a modestly lesser degree. This implies that a fraction of the initial divergence can be attributed to academic performance, yet this effect, while statistically significant, may not be substantive. We refrain from visualizing the results controlling for GPA in this section, as they closely resemble those showed in Figure 4. However, these results are available in Supplementary Figure 1. Overall, across tracks most birth order trends are similar, except building and construction and health and social care which show opposite trends between males and females. Later-born females have a higher probability of choosing health and social care, while later-born males have a lower probability. In building and construction later-born males have higher likelihoods, while later-born females do not. Overall, the largest sex differences in school tracks, often in the range of 100 to 200 percent relative to the baseline probability, are found in building and construction (approximately a 2-4 percentage point difference between males and females of the same birth order), child and recreation (4 pp), electricity and energy (9 pp), HVAC (7 pp), health and social care (4-10 pp), humanities (0.3 pp), and vehicle and transport (7-9 pp).

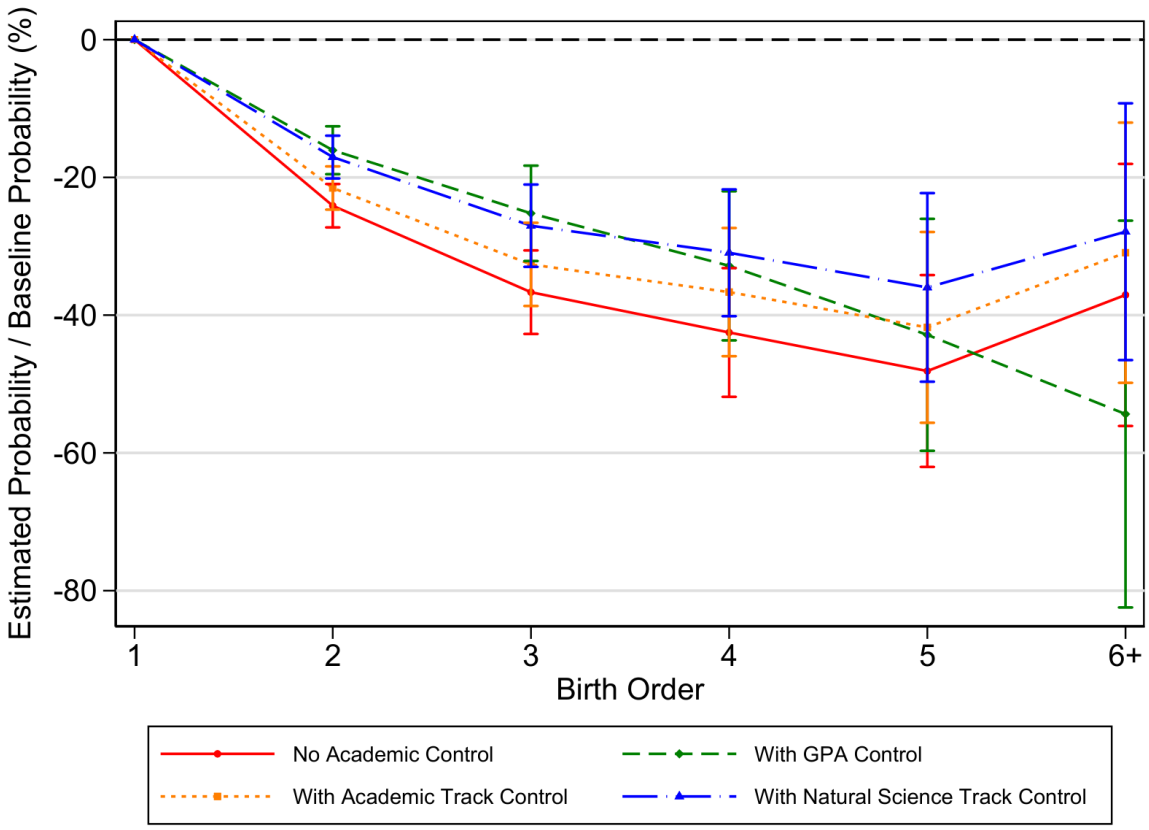
Figure 4: Heterogeneity by Gender



Given the availability of data we augment our research by investigating whether earlier-borns also have greater traditional aspirations in university major preferences (Figure 5). Our results indicate that first- and earlier-borns are also more inclined to pursue university degrees that are traditionally considered prestigious by society, such as STEM (science, technology, engineering, and mathematics), law, and professional medical services. This finding holds true even after controlling for GPA (green dashed line), the enrollment in any academic track (orange dotted line), and the completion of the natural science track (blue dashed line). Specifically, in the model without academic controls (red solid line), the negative birth order effect on traditionally prestigious university major preferences is 24 (3.3 pp) to 48 (6.7 pp) percent lower among second- and fifth-borns, respectively, relative to the baseline probability. In comparison, the effect of gender appears modest (1 pp). While women exhibit a lower likelihood of expressing a preference for a STEM subject, law, or professional medicine as their college major, the negative effect of birth order is three times (3.3 pp) more pronounced among second-borns and six times (6.7 pp) greater among fifth-borns. However, after controlling for GPA, the effect of gender is considerably larger (3.9 pp), approximately equivalent to the gap between first- and third-borns (3.5 pp). With the

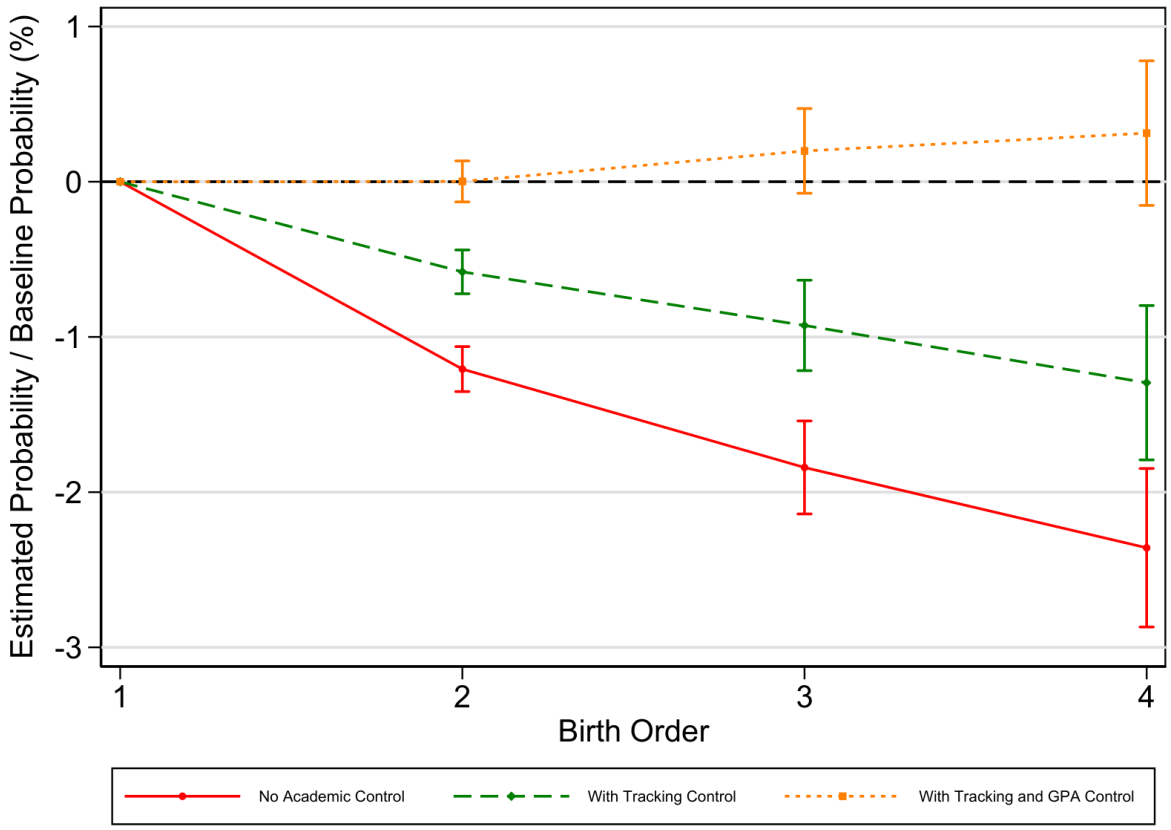
introduction of academic track as a control, the influence of gender reduces substantially (0.5 pp). This suggest that women demonstrate a lower inclination toward declaring preferences for STEM, law, or medicine as their university major. However, their higher GPA scores mask this association, generating an impression of nearly equivalent preferences to men. These findings suggest that first- and earlier-borns have greater educational aspirations for traditionally prestigious secondary school tracks as well as university majors even after controlling on previous educational choices or academic performance.

Figure 5: Preferences for Traditionally Prestigious University Majors



Finally, in Figure 6 we show the potential mediating role of school tracking decisions on the number of completed years of education by age 30 (for individuals born between 1980 and 1988). This outcome has been extensively investigated in birth order research in recent decades (Barclay 2015a; Black, Devereux, and Salvanes 2005; Härkönen 2014). Notably, we observe that the influence of birth order on completed years of education substantially diminishes, by half, when adjusting for secondary school tracking and it loses statistical significance when GPA is introduced as an additional control. This finding underscores the pivotal role of tracking as a mechanism contributing to the extensively documented birth order effects on completed education.

Figure 6: Completed Years of Education



Robustness Checks

In addition to the heterogeneity analyses, we also examine birth order effects among children that transitioned to upper-secondary school after the last educational reform of 2011 to ensure that our results are not driven by trends or changes to the subject options available to students. Sweden enacted an important educational reform in 1991 which was fully implemented by 1996, the year our data set starts. This reform led to an increasing differentiation within national programs during the late 1990s (Halldén 2008). In 2011 a new educational reform was enacted, which included changes to the grading system to conform to the standard European system. The popularity of certain disciplines may have changed over time, or ceased to exist like the Media track, which could potentially lead to spurious correlations with higher birth order. We limit our analysis to families with up to three children to ensure an adequate sample size and find that the birth order patterns remained consistent among children progressing to non-compulsory education between 2012 and 2019 a period with no changes to Sweden's national curriculum (see Supplementary Figure 2). Therefore, the association between birth order and school tracks is not attributable to changes in the Swedish educational system.

Discussion

Past research has consistently reported that later-born siblings have lower levels of educational attainment and perform worse in the labor market (see Härkönen and Santacroce 2024). However, previous studies have not investigated the association between birth order and school tracking choices. This gap in the literature is problematic, since differences in tracking can shed light on some of the underlying mechanisms that lead later-borns to have worse outcomes relative to their earlier-born siblings. This study has demonstrated that first- and earlier-borns are more likely to complete university-oriented school tracks, including the natural science program, which is highly esteemed in the Swedish educational system and provides students with a comprehensive education that paves the way into virtually any undergraduate degree program. In contrast, later-borns are more likely to pursue vocational tracks, which can hinder their prospects for tertiary-level education, limits their career options, and results in lower expected lifetime earnings. Research has shown that school tracking is crucial since it has significant consequences for the educational and occupational opportunities of individuals, such as reducing intergenerational mobility in educational attainment and reinforcing the effect of social origins (Brunello and Checchi 2007). While the Swedish educational system provides ways for vocational track students to transition to university, opting for less favorable tracks can nonetheless create obstacles to educational attainment and professional opportunities, thus perpetuating a pattern of social and educational disadvantages and limit social mobility due to path dependency and cumulative disadvantage. This research has shown that these disadvantages substantially and disproportionately impact later-born children.

Earlier-born children, who tend to have higher cognitive ability test scores and stay in education longer, are more likely to enroll in Sweden's most prestigious tracks, the natural science program, as well as in university-preparatory tracks, which offer more predictable and greater expected earnings and employment opportunities. This may contribute to exacerbating sibling inequalities later in life. On the other hand, later-born children are more likely to choose programs that are traditionally seen by society as having lower prestige and lower earnings. For example, later-borns are more likely to train as caregivers, construction workers, plumbers, or work in hospitality. While some theories (Sulloway 1996) suggest that later-born children are more creative and less traditional, we found only a modest positive association between birth rank and the art program. However, it is important to acknowledge that creativity can find outlets across almost all fields of endeavor. Additionally, we also find

that earlier-borns have greater educational aspirations for traditionally prestigious university majors even after controlling for previous educational choices and achievement. These findings shed light on why earlier-born children tend to have higher educational attainment, earnings, and employment stability, as they are more likely to complete university-oriented tracks with more favorable and predictable life trajectories. Indeed, when we explore the role of school tracking decisions on completed education at age 30, we observe that the influence of birth order diminishes by half when adjusting for secondary school tracking and loses statistical significance when GPA is introduced as an additional control. This notable discovery draws attention to the role of school tracking as a mechanism for birth order inequality. However, differences in school tracking do not provide a definitive answer to the underlying causes for tracking differences in the first place. The literature suggests that variations in parenting practices, child investments, and the family environment may explain the differences in cognitive test scores, personality, and ambition, which, in turn, may lead to different educational choices.

The findings of this research have significant implications for educational equity and social stratification. Similarly to family background characteristics, birth order is a circumstance that children do not choose, but seems to exert a significant influence on academic and career prospects. The existence of birth order inequality in education raises questions about the extent to which meritocracy is upheld if factors beyond academic ability play a role in determining student's opportunities. Even after controlling for GPA, birth-rank inequalities persist. According to theory (Blake 1981; Zajonc 1976), the presence of birth order disparities within a familial context are likely caused by differences in parental investment and the family environment. This phenomenon is observed even within socially advantaged family contexts. Such disparities suggest an unconscious and/or structurally determined nature, wherein parental inputs, such as parent-child quality time, diminishes with sibship size. This implies that birth order effects are not solely contingent upon conscious parental choices but may also be inherently shaped by systemic and structural factors influencing the allocation of family resources within the household. It is plausible that variations in parental treatment may also influence children's aspirations, as evidenced by their choices of upper-secondary school tracks and preferences for university majors. Birth order disadvantages can be, in some cases, greater than those attributable to gender differences; specifically, while males and females are equally likely to choose the natural science program, later-borns are up to 50 percent less likely to complete it compared to their

earlier-born siblings. Stratification researchers ought to consider the substantial inequalities produced by birth order.

Even within the framework of within-family comparisons, birth order exerts a substantial influence on children's educational outcomes, leading them towards a less advantaged life trajectory. Researchers and sociologists often overlook birth order as noteworthy driver of disadvantage despite numerous studies consistently reporting on large birth order disadvantages. These findings warrant increased attention, particularly given that birth order effects stem from social rather than genetic or biological factors (Barclay 2015a; Isungset et al. 2022; Kristensen and Bjerkedal 2007). Among these factors, variations in parenting practices and investments emerge as the most well-supported theory (Blake 1981, 1989). Consequently, the potential for remediation exists, as it is feasible to provide equitable opportunities for children regardless of their birth order. However, in the absence of due consideration, the persistence of birth order social inequality remains a concern. Considering that birth order effects are rooted in dynamics within the family, and that individuals have no control over their birth order, it is important to induce a shift in parenting by raising awareness about birth order inequality to ensure equal opportunities for all students.

While parenting practices may vary from one context to another it is worth noting that birth order disparities have been revealed across diverse countries and contextual settings worldwide, suggesting that these findings are likely not confined solely to Sweden. Therefore, there is reason to believe in the generalizability of the findings from this empirical inquiry to other countries despite cultural, economic, and educational system differences, further underscoring the significance of the pronounced disparities in tracking unveiled through our research. Indeed, if birth order effects are discernible in Sweden, a context where family resources should exert relatively less influence on educational disparities, there is a compelling rationale to consider that these effects could be even more pronounced in countries where family resources wield a more substantial role in shaping educational trajectories, such as the United States and the United Kingdom. In such settings, where disparities in access to educational opportunities are often compounded by socio-economic disparities, it is plausible that birth order effects not only endure but may potentially manifest with greater intensity. This perspective suggests that educational disadvantages, including those linked to birth order, may not only persist but could potentially be more pronounced in these nations where family resources are strained and leading to disproportionate investments

in firstborn children, thus underscoring the urgency of addressing such disparities through scholarship.

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