THE BIRTH ORDER PARADOX: SIBLING DIFFERENCES IN EDUCATIONAL ATTAINMENT

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ABSTRACT. This study uses population register data to examine the relationship between birth order and educational attainment in Sweden, and demonstrates that while the causal effect of birth order on educational attainment is negative, later born children actually perform better. The explanation for this finding is due to educational expansion in Sweden in the 20th century, which outweighs the negative causal effect of birth order. This is particularly true for women due to the fact that the rate of increasing educational enrollment has been greater for women than for men. These results also show that later borns in large families particularly benefit from educational expansion due to the longer average birth interval between the first and last child in large families. The difference between the negative causal effect and actual experience of birth order is likely to be contributing to the confusion regarding birth order effects in the literature.

INTRODUCTION

The influence of birth order on a range of later life outcomes, including educational achievement, intelligence, and personality, has been the subject of scholarly interest for over a century (Galton, 1874; Gini, 1915; Blau and Duncan, 1967; Ernst and Angst, 1983; Sulloway, 1996; Black et al., 2005). Part of the reason for this consistent interest in birth order as an explanatory variable is the way that it appeals to personal experience (Rodgers, 2001*a*), as well as the typical ease with which it can be measured (Rodgers, 2000). Partly because of the long history of research on this topic, the study of birth order has been approached from every conceivable research angle, from psychiatrist case studies, to qualitative interviews, to quantitative analysis of large data (Toman, 1961; Conley, 2004; Black et al., 2005). However, the majority of birth order research has received scathing criticism due to a lack of methodological care and rigour (Schooler, 1972; Ernst and Angst, 1983; Townsend, 2000; Rodgers, 2001*b*). This lack of care has meant that all variety of patterns in the data have been reported, from earlier born children performing best (Black et al., 2005), to later born children performing best (Blake, 1989), to middle born children performing worst (Blau and Duncan, 1967; Conley, 2004). This has led to great confusion as to what influence birth order actually has in Western, developed societies. The purpose of this article is to clarify the nature of the relationship between birth order and educational attainment by demonstrating that the pattern observed for this relationship is

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dependent upon how the research question is approached. Recent rigorous research on the relationship between birth order and educational attainment shows that birth order has a negative causal effect, meaning that later born siblings perform worse (Black et al., 2005; Kristensen and Bjerkedal, 2010; Barclay, 2013; Härkönen, 2014). However, paradoxically, it is advantageous to be a later born, as later born siblings have greater educational attainment due to educational expansion over the course of the 20th century.

Birth Order and Educational Attainment. A number of theories have been proposed to explain why later born children should perform less well than their older siblings. Two theories that have attracted particular scientific attention are the resource dilution hypothesis (Blake, 1981), and the confluence hypothesis (Zajonc, 1976). While both theories state that later born children should perform less well than their older siblings, the hypothesised mechanisms differ. The resource dilution hypothesis argues that relative to later born children in the same family, earlier born children have a cumulative advantage in terms of access to finite parental resources. Assuming that parents follow a heuristic where they will distribute resources equally amongst their children at any given size of the sibling group (Hertwig et al., 2002), the first born will have access to 100% of the parents resources until the second child is born, at which point they would both have access to 50% of the parents resources, and so on for third and later borns. However, this still means that earlier born children have an advantage, particularly in terms of access to resources early in life. The confluence hypothesis argues that earlier born children outperform their younger siblings because the average degree of intellectual stimulation within the household decreases as more infants enter the household, and that this intellectual stimulation is key for cognitive development. Although the confluence hypothesis was developed to explain cognitive development and not educational attainment, this mechanism could be expected to influence educational attainment through the relationship between intelligence and educational achievement. Both of these theories presume that greater access to resources and intellectual stimulation are more important in early childhood than in later childhood or adolescence.

Recent research on the relationship between birth order and educational attainment has attempted to identify the causal relationship between these variables by using a within-family comparison study design. This means comparing siblings to one another within the same family. Because these siblings share the same biological parents and the same family environment and background, after adjusting for variables that are not constant amongst the siblings, namely maternal age at the time of birth, and cohort, it has been argued that the causal relationship is identified. Previous studies examining the relationship between birth order and educational attainment using this approach have consistently shown that later born children are at a disadvantage relative to first borns, in Norway (Black et al., 2005), the Netherlands (Kalmijn and Kraaykamp, 2005), the United States (Kantarevic and Mechoulan, 2006), Germany (Härkönen, 2014), and Sweden (Barclay, 2013). However, within each family there is a mechanical relationship between year of birth, the age of the mother at the time of birth, and birth order. This means that higher birth order children within the same sibling group will always be born to an older mother, and into a later birth year.

Environmental Conditions and Sibling Correlations. Recent research examining the relationship between maternal age at the time of birth and intelligence shows that even though the causal effect of delayed maternal age has a negative impact on children, the fact that they are

born into a later cohort counterbalances, or even outweighs, this negative impact (Myrskylä et al., 2013). By the same principle, higher birth order children are born into a later birth year, and therefore positive cohort trends may mean that later borns may do just as well, or even better, than their older siblings. Such a pattern has also been observed in historical datasets. Alter and Oris (2008) found that later born brothers were taller than their older siblings due to improvements in environmental conditions, and the longer the birth interval was, the greater the younger brother benefitted. In modern Sweden there has been a clear secular trend in educational attainment, with each successive cohort achieving a greater average in terms of years of education, as well as a higher proportion entering tertiary education (Shavit and Blossfeld, 1993; Breen et al., 2009; OECD, 2013). This educational expansion is a parallel 'environmental improvement', which could be expected to benefit those who are born later on during the process. This study shows that this pattern also pertains for the relationship between birth order and educational attainment in modern Sweden. Furthermore, increased educational attainment is likely to have a substantive impact on the lives of later borns, due to the beneficial effects of education on social mobility (Breen, 2010), earnings (OECD, 2013), and health (Lager and Torssander, 2012).

The Swedish Education System and Educational Expansion. Education in Sweden is state funded at all levels, and tertiary education is free for Swedish and European Union citizens, though in 2011 fees for tertiary education were introduced for non-European Union citizens (Halldén, 2008; Högskoleverket, 2012). To give an idea of the relative burden that university tuition fees place on students in different countries, average tuition fees as a percentage of GDP per capita in 2006/07 were 2.7% in Norway, 0.0% in Sweden, 3.1% in the Netherlands, 1.3% in Germany, and 25.5% in the United States (Willemse and De Beer, 2012). Students in tertiary education are eligible for financial support from the Swedish state for living costs in the form of study grants and student loans with low interest rates (Högskoleverket, 2012), minimising the need for reliance on family resources for maintenance. This has meant that family resources in Sweden are not crucial for the transition to tertiary education in the same way that they are in other contexts, such as the United States. This does not mean that there is no socioeconomic stratification in educational attainment in Sweden, but that the choice to continue in the education system is not affected by the direct costs of tuition. However, it remains possible that indirect costs, such as foregone earnings, would influence the decision-making process of high and low socioeconomic status individuals to a different extent.

The Swedish education system today is divided into three sections: *grundskolan*, which is 9 years of compulsory schooling, *gymnasium*, which is three additional years of upper secondary education, and finally, tertiary education (Halldén, 2008). Tertiary education in Sweden today consists of two parts. The first is a traditional university education, with degrees at the Bachelors (*kandidatexamen*), Magister (*magisterexamen*), Masters, Licentiate, and Doctoral levels. The second part is a vocational tertiary education (*Högre yrkesutbildning / Högskolor*) (Halldén, 2008). Although I discuss the data in greater detail in the next section, the cohorts that I analyse in this study were born 1960 to 1982. This means that they will have been 16 and in secondary school in Sweden between approximately 1976 and 1998. This was a period of substantial change in the Swedish educational system, as is summarised in Halldén (2008). In 1965 and 1971 *gymnasium* was reorganised into three tracks; the first prepared students for university, the second was a two-year continuation program, and the third was two years of vocational

training (Erikson and Jonsson, 1996*b*). While the first track was the most direct route to a typical university education, it was not impossible to apply to university from either of the latter two tracks (Halldén, 2008). Before 1971, these three educational tracks were split into separate schools, and applying to university directly from either of the less traditionally academic tracks was much more difficult (Halldén, 2008).

A major motivation for reforming upper secondary education in Sweden was to increase social fluidity, meaning to reduce the strength of the relationship between the class of origin and destination (Erikson and Jonsson, 1996*b*), and this has indeed led to a large increase in the proportion who make the transition to upper secondary education (Erikson and Jonsson, 1996*b*; Rudolphi, 2013). Indeed, this was part of a broad package of educational expansion in Sweden in the post-war period, which also included an expansion of adult education, and changes to the tertiary education system (Erikson and Jonsson, 1996*b*). The tertiary education system in Sweden was reorganised in 1977, with the incorporation of post-secondary non-tertiary education for nurses and teachers, and the establishment of new universities in Stockholm and Gothenburg, as well as regional university colleges (Halldén, 2008). Although there have been some fluctuations in tertiary education enrolment, between the 1960s and 2000s attendance has increased substantially (Breen et al., 2009), just as it has in many other countries in Western Europe and the United States (Breen and Jonsson, 2007; Breen et al., 2009). Today, approximately 33% of the Swedish population has undergone post-secondary education, which is higher than the OECD average (Högskoleverket, 2012). This educational expansion has clearly benefited individuals born into later born cohorts, which has implications for patterns of educational attainment by birth order.

While educational expansion in the 20th century will have, on average, benefited later born children over earlier borns from the same family, the degree to which individuals were able to take advantage of this environmental improvement will have varied by gender and socioeconomic status. For example, the increase in educational enrolment with successive cohorts has been greater for women than men in Sweden, and women now have higher levels of educational enrolment than do men (OECD, 2013). Furthermore, individuals from low socioeconomic status families benefited from educational expansion to a greater extent than those from high socioeconomic status families, as the latter already had relatively high rates of entry to upper secondary and tertiary education (Rudolphi, 2013). This higher level of educational achievement for higher socioeconomic status individuals could be explain by better academic performance, as well as a greater likelihood of choosing to continue in the educational system (Boudon, 1974; Erikson et al., 2005; Jackson, 2013). However, developments over the course of the 20th century have meant that the gap between high and low socioeconomic status origin individuals on both of these dimensions has decreased (Breen et al., 2009; Rudolphi, 2013). This study will examine the interaction between gender, and socioeconomic status, and educational expansion, and how that has had implications for patterns of educational attainment by birth order. Given that the benefit of being born later primary extends from environmental improvements in the intervening period, it is also critical to consider the role of birth intervals. In this study I will show that the increase in educational enrolment can have a large impact even in small families with only two children when the birth interval is long enough. Second born individuals who are born many years after the first child benefit a great deal from educational expansion, though this is particularly clear for women.

DATA AND METHODS

Data. This study is based upon data from the full Swedish administrative population registers. I examine men and women from cohorts born from 1960 to 1982. The reason for using these particular cohorts is that the highest quality data on education is available from 1990 to 2012. Using these cohorts therefore allows me to look at the educational attainment of these individuals in the year that they turn 30 with a high degree of accuracy. The total number of individuals born in Sweden in these cohorts was 2,435,773. However, the final population used for the analyses is 1,578,667, of whom 766,266 are women, and 812,441 are men. The reason for this is that it is necessary to apply several exclusion criteria, which are summarised in table 1. I define a sibling group as a group of children who share the same biological mother and father. I restrict the population used for the analysis to those sibling groups where all the children are born in Sweden so that information about birth order and the size of the sibling group is known with a high degree of accuracy. I also exclude sibling groups that include a multiple birth such as twins, as the meaning of birth order is much less clear in these families. As will be outlined in more detail below, the statistical approach used in this study is sibling fixed effects, meaning a within-family comparison. As this type of analysis compares siblings to one another within the same sibling group, it is necessary that there are at least two individuals in the data for each sibling group. This means that individuals who were only-children are not included in the analyses. This study also focuses on sibling groups of two to six children, as sibling groups with greater than six children are relatively rare in Sweden.

TABLE 1. Sample Exclusion Process.

Exclusion Criteria	N	N Excluded
Total Born in Sweden 1960-1982	2,435,773	
ID for both parents	2,405,610	30,163
All siblings born in Sweden	2,364,749	40,861
No multiple births	2,304,319	60,430
No only children	1,928,247	376,072
Sibling group size<7	1,913,165	15,082
Cohort cut	1,663,128	250,549
No missing values on any variables	1,578,667	84,461
Final	1,578,667	

Source: Swedish administrative register data, compiled by the author.

Given that the cohorts that I examine in this study were born 1960 to 1982, it is important to consider whether the increased prevalence of blended families introduces error into the measurement of the birth order variable. Amongst those borns in the 1960s, 23% of individuals have at least one half-sibling, and for those born in the 1970s and 1980s the corresponding figure is 25% and 30%, respectively (Thomson, 2014). Furthermore, these figures do not include the experience of step-siblings. Previous studies have indicated that it is social order within the sibling group rather than biological birth order that explains birth order patterns (Kristensen and Bjerkedal, 2007; Barclay, 2013). Using register data to accurately capture the experience of social birth order is difficult, and this is particularly true in blended families. One way of

approaching this issue is to examine the research question in this study only amongst sibling groups where neither of the the parents have any children with a third person. In these cases, the experience of social birth order is likely to conform more closely to the measure of biological birth order. Although the main results presented in this study will be based upon the population without taking into account half-siblings, I present results in the appendices based upon sibling groups without half-siblings as a robustness check.

Outcome Variables. This study uses two outcome variables. The first is years of education achieved by age 30. This measure is based upon the number of years that correspond to the specific level of education achieved by age 30, and may not in all cases reflect that actual number of years that an individual spent in the educational system. The second outcome measure used for this study is a binary variable for whether individuals made the transition to tertiary education by age 30. The variable for highest educational level and the corresponding years of education required to reach that level come from the Swedish education registers and Statistics Sweden (Halldén, 2008; SCB, 2000). The second outcome variable is whether the individuals under analysis had entered tertiary education by age 30. Tertiary education in Sweden consists of two post-secondary education tracks, which are a traditional university education, and a vocational tertiary education. The university education system in Sweden is consistent with the Bologna accords, and has degrees at the Bachelors (3-years undergraduate), Magister (1-year taught postgraduate), Masters (2-year taught postgraduate), Licentiate (2-years of postgraduate research), and Doctoral (4-years of postgraduate research) levels (Halldén, 2008). The vocational tertiary education system (*Högre yrkesutbildning*) consists of practical, technical, or occupation-specific tertiary training programs (Halldén, 2008).

Socioeconomic Status. To examine how birth order is related to socioeconomic status, I use the 1970, 1980, and 1990 Swedish censuses to obtain information on parental socioeconomic status measured between the ages of 1 and 9. The EGP class schema is used as a guide for categorising individuals into two groups, either high, or low, socioeconomic status (Erikson et al., 1979). The reason for classifying socioeconomic status as being either high or low is because the way that socioeconomic status was measured in the census changed between 1970 and 1980 in Sweden. These changes mean that it is somewhat difficult to categorise groups in the middle of the socioeconomic distribution consistently using the two different types of categorisation from 1970 and 1980. The socioeconomic status of parents is classified as high if they fall into the upper service class, including professionals. The socioeconomic status of parents is classified as being low if they had occupations in the categories of skilled or unskilled workers. In some cases the measure for parental socioeconomic status was drawn from different censuses for children within the same sibling group, which could happen in families with more children, or in small families with larger birth intervals. If the measure for the socioeconomic status of the parents was classified as low for some siblings, but high for others (e.g. if the parents experienced great social mobility over a ten-year period), then these sibling groups were not included in the analyses focusing on socioeconomic status.

Statistical Analyses. The estimation strategy used for analysing educational attainment is fixed effects linear regression. By this I mean that the analysis compares the years of education attained by age 30 by siblings who share the same biological mother and father to one another. The estimation of the standard errors allows for correlation of errors within each sibling group.

The estimation strategy for analysing the likelihood of entering tertiary education by age 30 is fixed effects logistic regression, again comparing siblings within the same family to one another. These fixed effects estimation approaches produce a within-family comparison, and inherently adjust for both observed and non-observed intrafamily characteristics that remain constant, thereby minimizing residual confounding. In contrast to a between-family comparison approach, this allows for the isolation of the effect of birth order on educational attainment independent of shared family environment characteristics that are also important for educational outcomes.

RESULTS

Descriptives. As can be seen in table 2, the mean years of education achieved by age 30 by women for the individuals born 1960 to 1982 was 12.9 years, and for men 12.5 years. For women the mean years of education achieved by age 30 across families decreases with rising birth order and increasing set size, and also increases by birth year. Table 2 shows that that mean years of education for women is greatest, at 13.4, for women whose mothers were aged 30-34 at the time of their birth, and it is lower for women born to mothers who were older and younger than that at the time of birth. It is particularly low for those born to teenage mothers. For men the patterns in the summary statistics for years of education by age 30 are generally very similar to those seen for women.

Table 3 shows the summary statistics regarding entrance into tertiary education for Swedish women and men born 1960 to 1982. For women the mean proportion who enter tertiary education was 0.49. The mean proportion rises by birth order, from 0.48 for first borns, to 0.61 for sixth borns. The mean proportion also increases by maternal age, but decreases by set size. The mean proportion entering tertiary education varies by birth year decreased from 0.51 in 1960 to 0.43 in 1968, before rising again until 0.56 in 1980, and falling again for those born in 1981 and 1982. For men the mean proportion who enter tertiary education was also 0.49. Across families, first borns have the highest mean entering tertiary education, while second borns have the lowest mean, and the mean increases from second borns to fourth borns, before levelling out. The mean proportion entering tertiary education decreases by set size, but varies relatively little by the age of the mother at the time of birth. For men the mean proportion entering tertiary education does not vary a great deal by birth year.

Fixed Effects Models.

Years of Education: Women. The results for educational attainment measured by years of education at age 30 can be seen for women and men in Table 4, and in Figure 1 for women, and Figure 2 for men. Table 4 show the results from the analyses pooling children in sibling groups with between two and six children, and Figures 1 and 2 show the results for both the pooled analyses as well as the sibship-size specific analyses for women and men respectively. Both Table 4 and Figures 1 and 2 show the results from within-family comparison models that i.) include only birth order as an explanatory variable, ii.) adjust for maternal age at the time of birth, and iii.) adjust for both maternal age at the time of birth and birth year. Focusing on Figure 1, it can be seen that when adjusting for both maternal age at the time of birth and birth year, there is a negative relationship between birth order and educational attainment for women. This result is found in the pooled analysis of sibling groups with between two and six children, as

well as the sibship-size specific analyses, with the exception of sibling groups with six children. Aside from the results examining sibling groups with six children, the results are statistically significant and substantive. In the pooled analysis, second borns have almost a third of a year less education than first borns, while the difference is greater than half a year less education for fourth borns to sixth borns.

While the causal effect of birth order on educational attainment is negative for women, the results that do not adjust for maternal age at the time of birth and birth year show that later born women actually have *greater* educational attainment than earlier born children. This is true in both the pooled analysis of sibling groups with between 2 and 6 children, as well as the sibship-size specific analyses. In the pooled analysis the second born has almost a tenth of a year more education than first borns, while sixth borns have 1.23 years additional educational attainment. These results show that while the causal effect of birth order is negative, in the period under study, cohorts born between 1960 and 1982, later born women have actually spent more time in the educational system by age 30 than earlier born women. Furthermore, the disparity between the causal estimates and the actual educational attainment of later borns relative to first borns is greatest for the last borns in the largest sibling groups. This is because in small sibling groups the birth interval between the first and last child is on average substantially shorter than the birth interval between the first and the last child in a six-child sibling group.

Table 4 and Figure 1 also show the results from models where I adjust for maternal age at the time of birth, but not birth year. These results are different from both the bivariate relationship between birth order and years of education, as well as the causal effect of birth order on years of education. These results show that when only adjusting for maternal age at the time of birth using a within-family comparison, in sibling groups with two to four children, later borns still have lower educational attainment at age 30 than first borns. In sibling groups with five or six children, and in the pooled analysis, there is no longer a clear statistically significant pattern in terms of educational attainment by birth order. This suggests that children born to older mothers have greater educational attainment, and adjusting for this factor mediates the relationship between birth order and educational attainment. Part of the explanation for this may be due to increasing material resources within the household to older parents, but will also be partially due to the fact that maternal age at the time of birth is positively correlated with birth year.

Years of Education: Men. The results for men can be seen in Table 4 and Figure 2. The results for the causal effect of birth order, adjusting for maternal age at the time of birth and birth year, on years of education are similar to those seen for women, both in the pooled analysis, as well as the sibship-size specific analyses. For men, however, the negative effect persists in sibling groups of all sizes, including those with six children. The results from the pooled analysis show that second borns have almost a third of year less education than first borns, while the difference between sixth borns and first borns is almost two thirds of a year. However, when examining the bivariate relationship between birth order and educational attainment, the advantage of later borns over first borns is less pronounced for men than it is for women. Amongst men, the second born does not achieve greater educational attainment than the first born in any size sibling group. The advantage gained for third and later borns is also less than that seen in the analyses of women; in the pooled analysis the sixth born women spent more than a year in the educational system relative to the first born, whereas for men the sixth born spends just

under two-thirds of a year more than the first born. This is nonetheless an advantage, but a substantially smaller one. The explanation for this is due to the fact that increasing educational enrolment for women has outpaced increasing educational enrolment for men (see Table 2).

Transition to Tertiary Education: Women. Table 5 show the results for the transition to tertiary education by age 30 for women, and figure 3 shows the results for the transition to tertiary education by age 30 for the pooled analyses and sibship-size specific analyses. As with the results for years of educational attainment, these results are based upon within-family comparison models that i.) include only birth order as an explanatory variable, ii.) adjust for maternal age at the time of birth, and iii.) adjust for both maternal age at the time of birth and birth year. The pooled analyses and sibship-size specific analyses show that the causal effect of birth order on making the transition to tertiary education by age 30 is negative, with later borns clearly performing worse than the first born, though this pattern is not statistically significant in sibling groups with six children. The bivariate relationship between birth order and making the transition to tertiary education by age 30 is different to that seen for years of education. Whereas second born girls had greater educational attainment that first born children in terms of years of education, in none of the transition to tertiary education analyses are second borns more likely to make this educational transition. However, third borns and other later born children have a substantially greater likelihood of making the transition, and this is true in sibling groups of all sizes except those with six children. The pooled analyses underline just how much more likely later born girls were to make the transition to tertiary education than were first borns.

Transition to Tertiary Education: Men. The results for men for the transition to tertiary education by age 30 from the pooled analyses of sibling groups with between 2 and t6 children can be seen in table 5, and figure 4 shows the results for the transition to tertiary education by age 30 for the pooled analyses and sibship-size specific analyses. As was true for women, the relationship between birth order and making the transition to tertiary education by age 30 is negative, with later borns performing worse than first borns. This is true in the pooled analysis, as well as the sibship size specific analyses. However, the bivariate relationship between birth order and making the transition to tertiary education is very different for men in comparison to women. In sibling groups with between two and five children, and the pooled analysis, the second and third borns are less likely to make the transition to tertiary education even when not adjusting for improving environmental conditions. Looking at the sibship size specific analyses, it is only the last born in sibling groups with five children that has a greater likelihood of making the transition to tertiary education than the first born son. These results are consistent with the pattern seen in the summary statistics in table 3 which showed that proportion entering tertiary education did not increase by birth year for men like it did for women.

TABLE 2. Descriptives: Mean Years of Education by Age 30 and Frequency for Analytical Sample, Women and Men in Sweden born 1960 to 1982.

		Women			Men		
Variable	Category	Mean	SD	N	Mean	SD	N
Years of Education		12.9	2.3	766,226	12.5	2.3	812,441
Birth Order	1	12.9	2.3	308,929	12.5	2.3	328,149
	2	12.9	2.3	324,725	12.5	2.2	344,676
	3	12.7	2.3	100,582	12.3	2.2	106,215
	4	12.3	2.3	23,892	11.8	2.2	25,056
	5	11.8	2.1	6,419	11.5	2.0	6,610
	6	11.7	2.0	1,679	11.3	1.9	1,735
Set Size	2	13.0	2.3	416,020	12.6	2.2	438,981
	3	12.9	2.3	246,349	12.5	2.3	263,707
	4	12.5	2.3	74,437	12.1	2.2	79,249
	5	12.1	2.2	21,277	11.7	2.1	22,343
	6	11.8	2.1	8,143	11.4	2.1	8,161
Mother's Age at	<20	11.7	1.9	42,431	11.4	1.8	44,308
Time of Birth	20-24	12.4	2.2	236,722	12.0	2.1	250,655
	25-29	13.1	2.3	288,274	12.7	2.3	306,663
	30-34	13.4	2.3	147,516	12.9	2.3	156,128
	35-39	13.2	2.3	43,854	12.8	2.3	47,033
	40-44	12.9	2.3	7,129	12.5	2.3	7,317
	>44	12.9	2.3	300	12.1	2.3	337
Birth Year	1960	11.9	2.1	22,613	11.8	2.2	23,797
	1961	12.0	2.1	24,185	11.8	2.2	25,688
	1962	12.0	2.0	27,331	11.8	2.2	28,802
	1963	12.0	2.1	31,548	11.9	2.2	33,738
	1964	12.1	2.0	37,431	11.9	2.1	39,051
	1965	12.1	2.0	39,694	11.9	2.1	42,032
	1966	12.2	2.0	40,909	12.0	2.1	43,481
	1967	12.2	2.0	41,376	12.0	2.1	44,374
	1968	12.3	2.1	39,468	12.1	2.1	41,703
	1969	12.4	2.1	37,971	12.1	2.1	40,635
	1970	12.7	2.2	38,755	12.3	2.2	40,892
	1971	12.9	2.2	39,957	12.4	2.2	42,502
	1972	13.1	2.3	39,575	12.6	2.3	42,009
	1973	13.3	2.3	38,706	12.7	2.3	41,087
	1974	13.4	2.3	38,738	12.9	2.3	41,145
	1975	13.6	2.2	36,068	13.1	2.2	38,043
	1976	13.8	2.2	33,550	13.2	2.2	35,718
	1977	13.8	2.2	31,911	13.1	2.2	34,448
	1978	13.8	2.3	30,448	13.0	2.4	31,896
	1979	13.8	2.3	29,000	13.0	2.4	30,777
	1980	13.9	2.2	25,533	13.1	2.2	26,962
	1981	13.8	2.2	21,396	13.1	2.2	22,271
	1982	13.8	2.2	20,063	13.0	2.2	21,390

Source: Swedish administrative register data, compiled by the author.

TABLE 3. Descriptives: Proportion Entering Tertiary Education by Age 30 and Frequency for Analytical Sample, Women and Men in Sweden born 1960 to 1982.

		Women			Men		
Variable	Category	Mean	SD	N	Mean	SD	N
Enter Tertiary Education		0.49	0.50	137,735	0.49	0.50	141,289
Birth Order	1	0.48	0.50	52,618	0.53	0.50	54,917
	2	0.48	0.50	54,893	0.46	0.50	56,944
	3	0.53	0.50	22,976	0.48	0.50	22,954
	4	0.55	0.50	5,612	0.50	0.50	5,096
	5	0.54	0.50	1,311	0.51	0.50	1,115
	6	0.61	0.49	325	0.50	0.50	263
Set Size	2	0.50	0.50	57,096	0.50	0.50	59,850
	3	0.49	0.50	54,969	0.49	0.50	56,867
	4	0.48	0.50	18,446	0.48	0.50	18,175
	5	0.47	0.50	5,248	0.46	0.50	4,763
	6	0.45	0.50	1,976	0.45	0.50	1,634
Mother's Age at	<20	0.43	0.50	6,561	0.50	0.50	5,591
Time of Birth	20-24	0.46	0.50	41,567	0.49	0.50	40,113
	25-29	0.49	0.50	52,091	0.49	0.50	55,722
	30-34	0.53	0.50	27,603	0.49	0.50	29,402
	35-39	0.57	0.50	8,513	0.52	0.50	9,061
	40-44	0.58	0.49	1,344	0.52	0.50	1,349
	>44	0.59	0.50	56	0.49	0.50	51
Birth Year	1960	0.51	0.50	3,731	0.53	0.50	3,683
	1961	0.49	0.50	4,081	0.50	0.50	4,077
	1962	0.48	0.50	4,718	0.49	0.50	4,672
	1963	0.48	0.50	5,459	0.49	0.50	5,600
	1964	0.45	0.50	6,658	0.47	0.50	6,533
	1965	0.44	0.50	7,027	0.48	0.50	6,961
	1966	0.44	0.50	7,250	0.48	0.50	7,364
	1967	0.44	0.50	7,500	0.48	0.50	7,483
	1968	0.43	0.50	7,285	0.46	0.50	7,249
	1969	0.44	0.50	7,099	0.46	0.50	7,171
	1970	0.46	0.50	7,234	0.49	0.50	7,278
	1971	0.49	0.50	7,538	0.49	0.50	7,735
	1972	0.51	0.50	7,464	0.51	0.50	7,520
	1973	0.52	0.50	7,324	0.51	0.50	7,463
	1974	0.53	0.50	7,160	0.50	0.50	7,564
	1975	0.54	0.50	6,602	0.51	0.50	6,836
	1976	0.55	0.50	5,876	0.52	0.50	6,431
	1977	0.55	0.50	5,663	0.48	0.50	6,126
	1978	0.53	0.50	5,265	0.49	0.50	5,509
	1979	0.55	0.50	5,004	0.49	0.50	5,413
	1980	0.56	0.50	4,361	0.51	0.50	4,794
	1981	0.52	0.50	3,818	0.49	0.50	4,008
	1982	0.51	0.50	3,618	0.48	0.50	3,819

Source: Swedish administrative register data, compiled by the author.

TABLE 4. Within-Family Comparison Results: Analyses of the Relationship between Birth Order and Educational Attainment at Age 30 from Fixed Effect Linear Regressions.

		Women						Men					
		β	95% CI	β	95% CI	β	95% CI	β	95% CI	β	95% CI	β	95% CI
Birth Order	1	0.00		0.00		0.00		0.00		0.00		0.00	
	2	0.09	0.08 , 0.10	-0.12	-0.13 , -0.10	-0.30	-0.32 , -0.28	-0.02	-0.03 , -0.01	-0.17	-0.18 , -0.15	-0.28	-0.30 , -0.26
	3	0.37	0.35 , 0.39	-0.08	-0.11 , -0.05	-0.46	-0.50 , -0.42	0.15	0.13 , 0.16	-0.17	-0.20 , -0.14	-0.42	-0.45 , -0.38
	4	0.62	0.59 , 0.66	-0.05	-0.09 , 0.00	-0.57	-0.63 , -0.51	0.32	0.29 , 0.36	-0.15	-0.20 , -0.10	-0.50	-0.55 , -0.44
	5	0.83	0.77 , 0.90	-0.05	-0.13 , 0.03	-0.70	-0.79 , -0.60	0.49	0.43 , 0.56	-0.13	-0.21 , -0.05	-0.55	-0.64 , -0.47
	6	1.23	1.10 , 1.35	0.14	0.00 , 0.28	-0.63	-0.78 , -0.48	0.63	0.51 , 0.76	-0.14	-0.27 , 0.00	-0.64	-0.79 , -0.50
Maternal Age	<20			-0.59	-0.63 , -0.54	-0.02	-0.08 , 0.03			-0.42	-0.46 , -0.38	-0.05	-0.10 , 0.00
	20-24			-0.33	-0.35 , -0.31	-0.01	-0.03 , 0.02			-0.22	-0.24 , -0.20	-0.01	-0.04 , 0.01
	25-29			0.00		0.00				0.00		0.00	
	30-34			0.32	0.30 , 0.35	-0.04	-0.07 , -0.01			0.23	0.21 , 0.26	-0.01	-0.03 , 0.02
	35-39			0.66	0.62 , 0.71	-0.08	-0.13 , -0.02			0.47	0.43 , 0.51	-0.02	-0.07 , 0.04
	40-44			0.98	0.89 , 1.06	-0.12	-0.22 , -0.01			0.69	0.60 , 0.77	-0.03	-0.13 , 0.07
	>44			1.36	1.01 , 1.71	-0.05	-0.41 , 0.30			0.83	0.48 , 1.17	-0.17	-0.52 , 0.19
Cohort	1960					-0.88	-0.96 , -0.80					-0.56	-0.64 , -0.48
	1961					-0.82	-0.90 , -0.74					-0.55	-0.62 , -0.48
	1962					-0.76	-0.83 , -0.70					-0.53	-0.60 , -0.47
	1963					-0.69	-0.75 , -0.63					-0.48	-0.54 , -0.42
	1964					-0.64	-0.70 , -0.59					-0.44	-0.50 , -0.39
	1965					-0.59	-0.64 , -0.54					-0.40	-0.45 , -0.35
	1966					-0.51	-0.55 , -0.46					-0.33	-0.37 , -0.28
	1967					-0.44	-0.49 , -0.40					-0.31	-0.35 , -0.27
	1968					-0.39	-0.44 , -0.35					-0.29	-0.33 , -0.25
	1969					-0.31	-0.35 , -0.26					-0.22	-0.26 , -0.18
	1970					0.00						0.00	
	1971					0.19	0.15 , 0.23					0.08	0.04 , 0.12
	1972					0.40	0.35 , 0.44					0.22	0.18 , 0.26
	1973					0.56	0.52 , 0.61					0.37	0.33 , 0.41
	1974					0.79	0.74 , 0.83					0.52	0.47 , 0.56
	1975					1.00	0.94 , 1.05					0.72	0.67 , 0.77
	1976					1.12	1.06 , 1.17					0.83	0.77 , 0.88
	1977					1.22	1.16 , 1.28					0.80	0.74 , 0.86
	1978					1.18	1.11 , 1.25					0.73	0.67 , 0.79
	1979					1.28	1.21 , 1.36					0.78	0.71 , 0.85
	1980					1.39	1.31 , 1.47					0.94	0.86 , 1.01
	1981					1.40	1.32 , 1.49					0.90	0.82 , 0.98
	1982					1.44	1.35 , 1.54					0.94	0.85 , 1.03
N		766,226		766,226		766,226		812,441		812,441		812,441	

Source: Swedish administrative register data, compiled by the author.

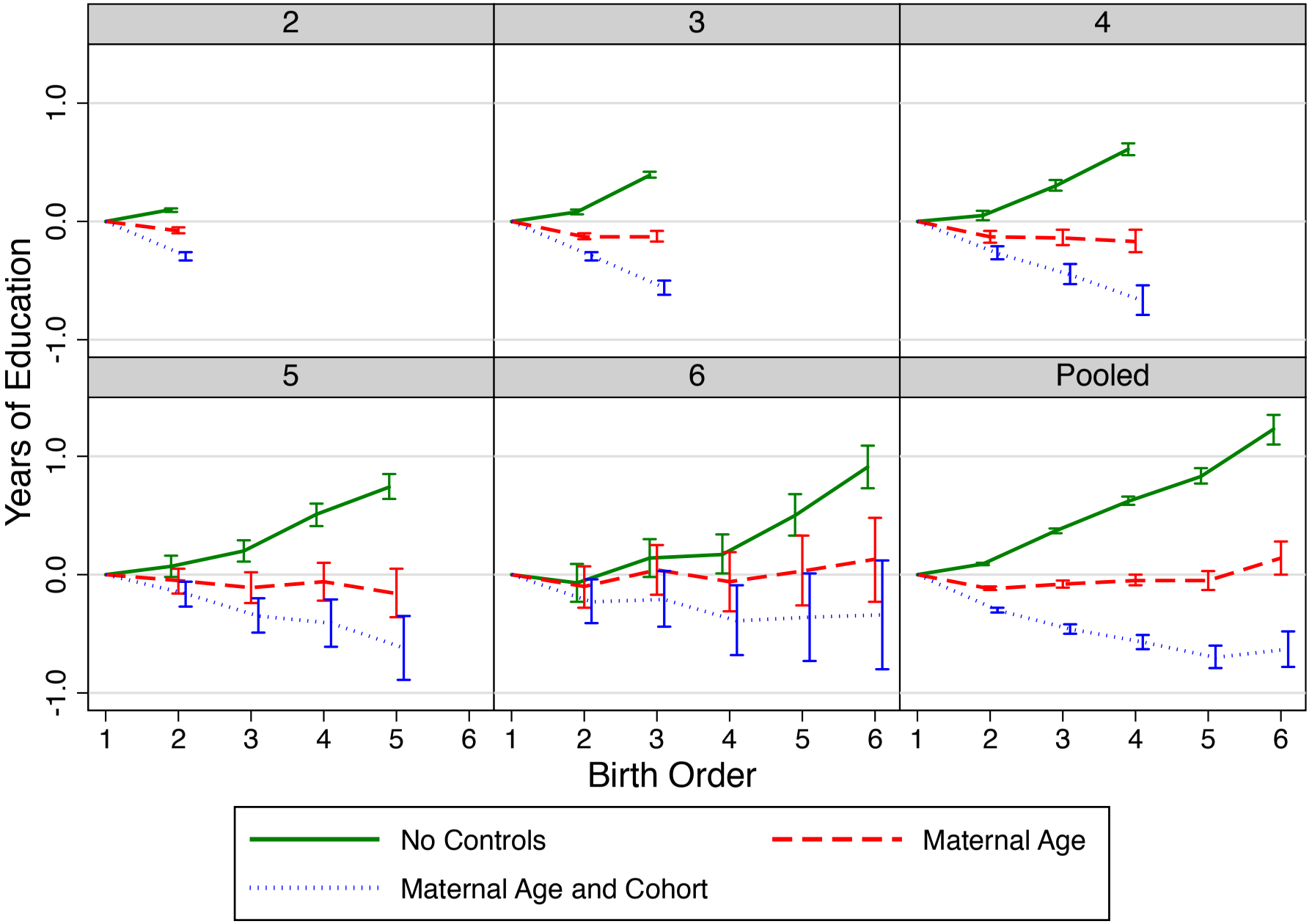


FIGURE 1. Women: Years of Education

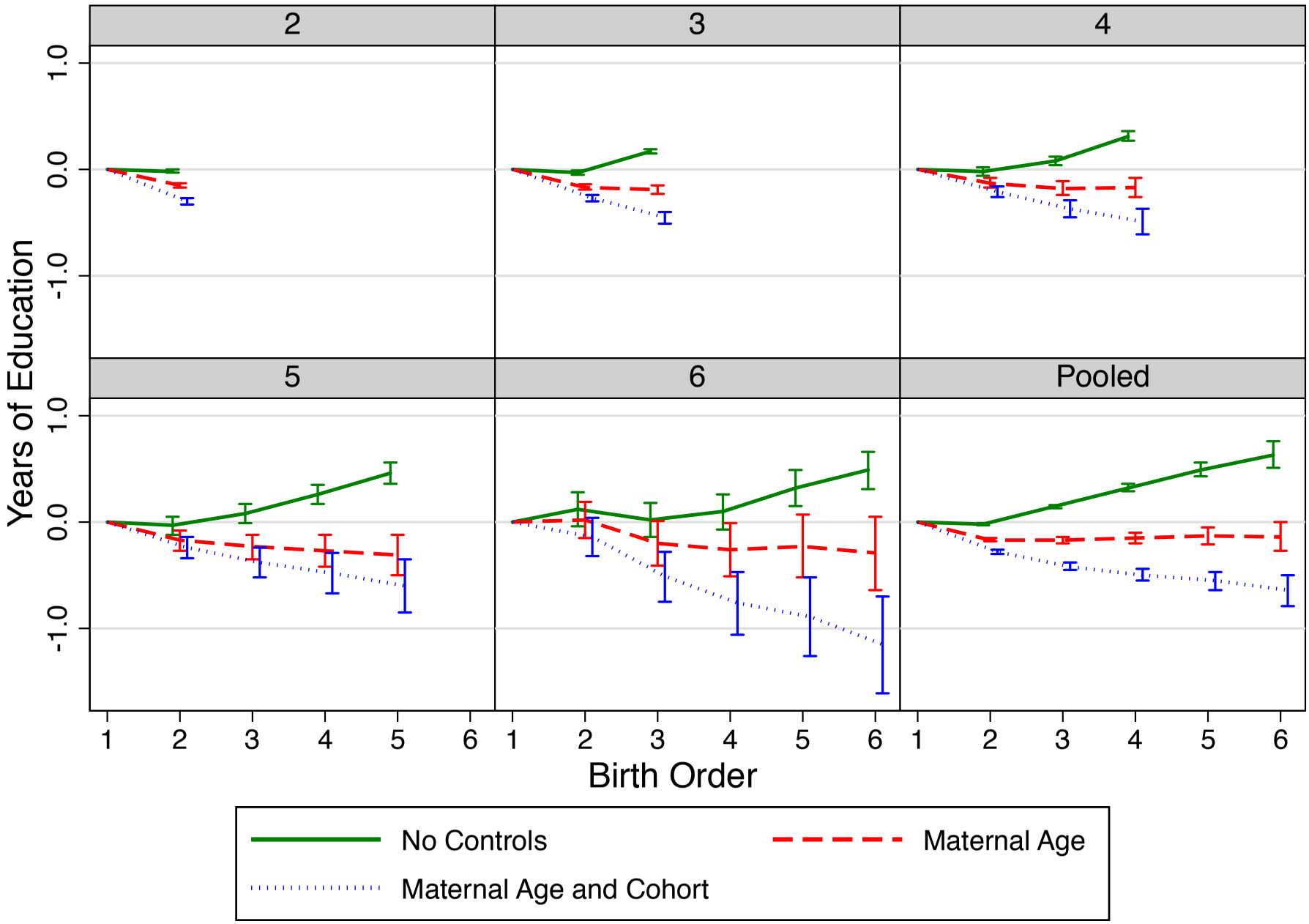


FIGURE 2. Men: Years of Education

TABLE 5. Within-Family Comparison Results: Analyses of the Relationship between Birth Order and the Transition to Tertiary Education by Age 30 from Fixed Effect Linear Regressions.

		Women						Men					
		OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Birth Order	1	1.00		1.00		1.00		1.00		1.00		1.00	
	2	1.02	1.00 - 1.04	0.82	0.80 - 0.85	0.69	0.66 - 0.71	0.84	0.83 - 0.86	0.74	0.73 - 0.76	0.66	0.64 - 0.68
	3	1.30	1.26 - 1.33	0.81	0.78 - 0.85	0.55	0.52 - 0.59	0.91	0.89 - 0.94	0.69	0.66 - 0.72	0.54	0.51 - 0.58
	4	1.66	1.57 - 1.76	0.84	0.77 - 0.91	0.49	0.44 - 0.54	1.08	1.02 - 1.15	0.72	0.66 - 0.78	0.50	0.46 - 0.56
	5	2.17	1.92 - 2.45	0.89	0.78 - 1.03	0.46	0.39 - 0.54	1.31	1.15 - 1.49	0.77	0.66 - 0.89	0.50	0.42 - 0.59
	6	3.36	2.64 - 4.28	1.14	0.88 - 1.48	0.52	0.40 - 0.69	1.43	1.10 - 1.85	0.74	0.56 - 0.97	0.44	0.33 - 0.59
Maternal Age	<20			0.53	0.49 - 0.57	0.91	0.84 - 0.99			0.70	0.65 - 0.76	0.94	0.86 - 1.02
	20-24			0.72	0.70 - 0.75	0.97	0.93 - 1.01			0.83	0.80 - 0.86	0.97	0.93 - 1.01
	25-29			1.00		1.00				1.00		1.00	
	30-34			1.37	1.32 - 1.42	0.98	0.93 - 1.02			1.22	1.18 - 1.27	1.02	0.97 - 1.06
	35-39			1.88	1.76 - 2.01	0.94	0.86 - 1.03			1.51	1.42 - 1.61	1.03	0.94 - 1.12
	40-44			2.47	2.15 - 2.83	0.89	0.75 - 1.05			1.74	1.52 - 1.99	0.97	0.82 - 1.14
	>44			3.08	1.74 - 5.45	0.87	0.48 - 1.57			1.67	0.93 - 2.98	0.74	0.40 - 1.34
Cohort	1960					0.46	0.41 - 0.53					0.58	0.50 - 0.66
	1961					0.46	0.41 - 0.52					0.56	0.50 - 0.64
	1962					0.49	0.44 - 0.55					0.60	0.54 - 0.67
	1963					0.53	0.48 - 0.59					0.64	0.58 - 0.71
	1964					0.54	0.49 - 0.59					0.65	0.60 - 0.72
	1965					0.57	0.52 - 0.62					0.72	0.66 - 0.78
	1966					0.62	0.58 - 0.67					0.76	0.71 - 0.82
	1967					0.69	0.64 - 0.74					0.80	0.74 - 0.86
	1968					0.72	0.68 - 0.77					0.81	0.75 - 0.86
	1969					0.83	0.77 - 0.88					0.86	0.80 - 0.92
	1970					1.00						1.00	
	1971					1.23	1.15 - 1.32					1.07	1.00 - 1.14
	1972					1.51	1.41 - 1.62					1.23	1.15 - 1.31
	1973					1.70	1.58 - 1.83					1.35	1.26 - 1.44
	1974					2.03	1.88 - 2.20					1.36	1.26 - 1.46
	1975					2.33	2.14 - 2.53					1.51	1.39 - 1.64
	1976					2.69	2.45 - 2.95					1.70	1.55 - 1.86
	1977					2.93	2.65 - 3.24					1.54	1.40 - 1.70
	1978					3.08	2.76 - 3.43					1.70	1.53 - 1.90
	1979					3.47	3.09 - 3.91					1.87	1.67 - 2.09
	1980					4.01	3.53 - 4.55					2.16	1.91 - 2.45
	1981					4.00	3.48 - 4.60					2.17	1.89 - 2.48
	1982					4.30	3.71 - 4.99					2.32	2.00 - 2.68
N		137,735		137,735		137,735		141,289		141,289		141,289	

Source: Swedish administrative register data, compiled by the author.

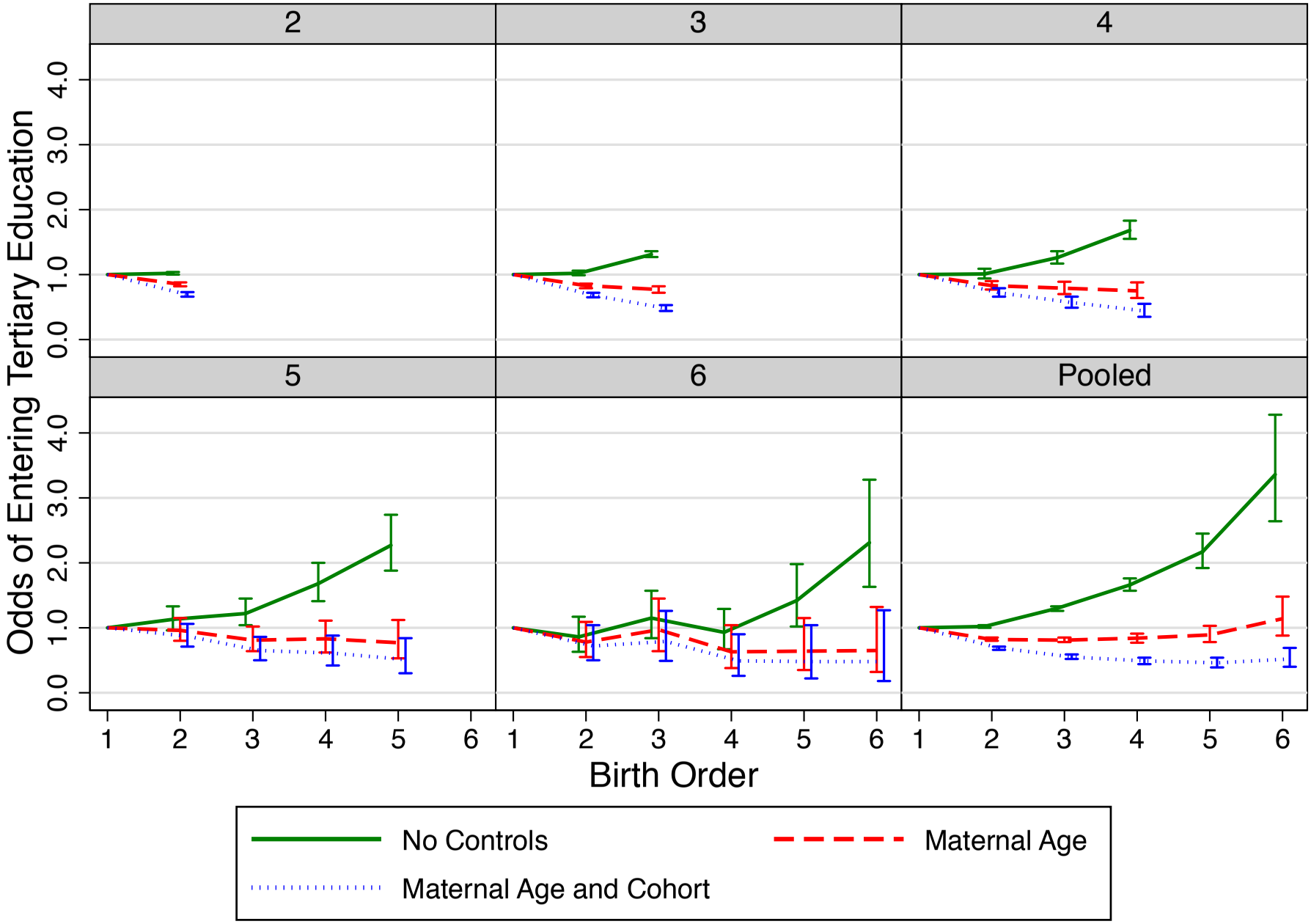


FIGURE 3. Women: Transition to Tertiary Education

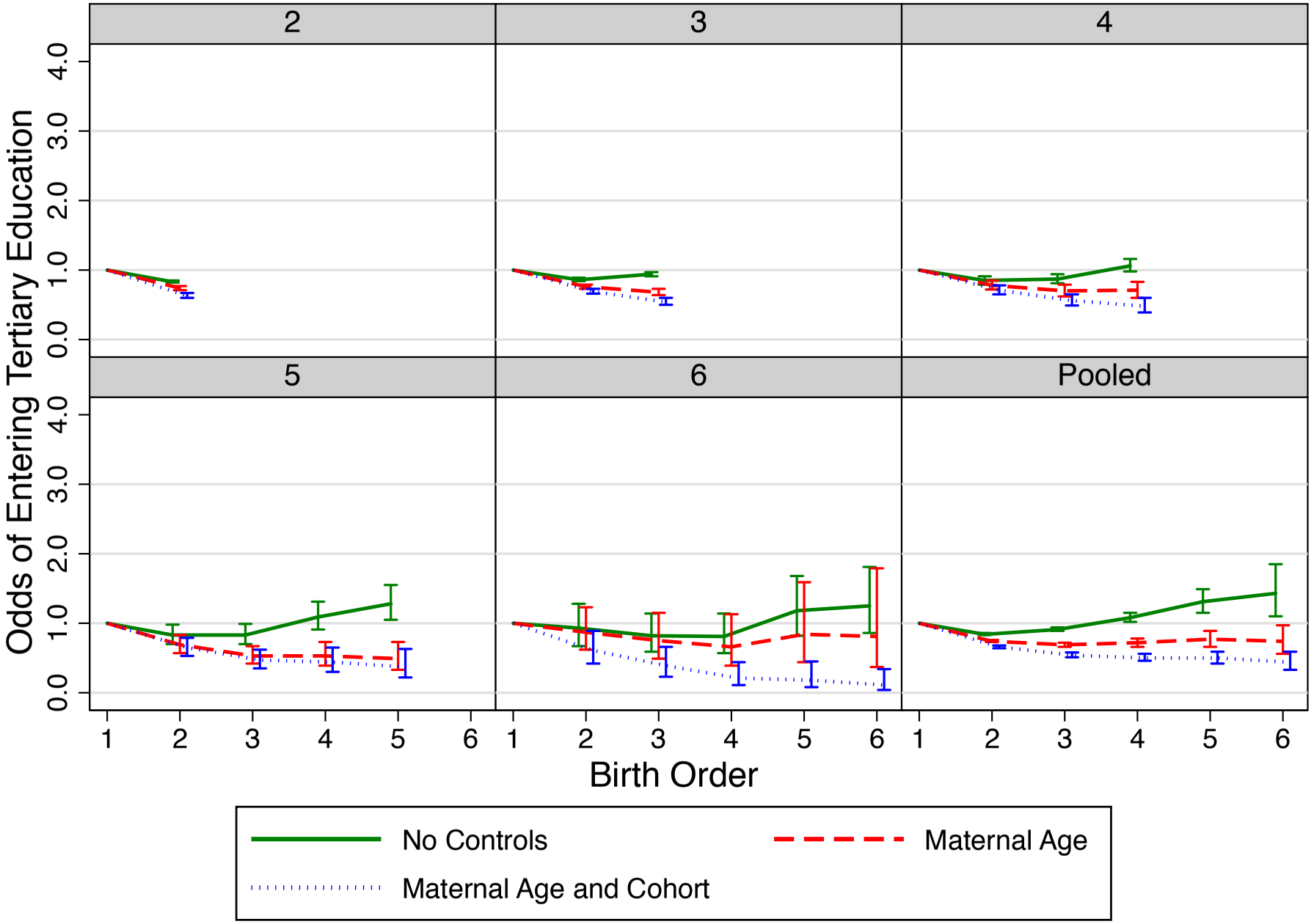
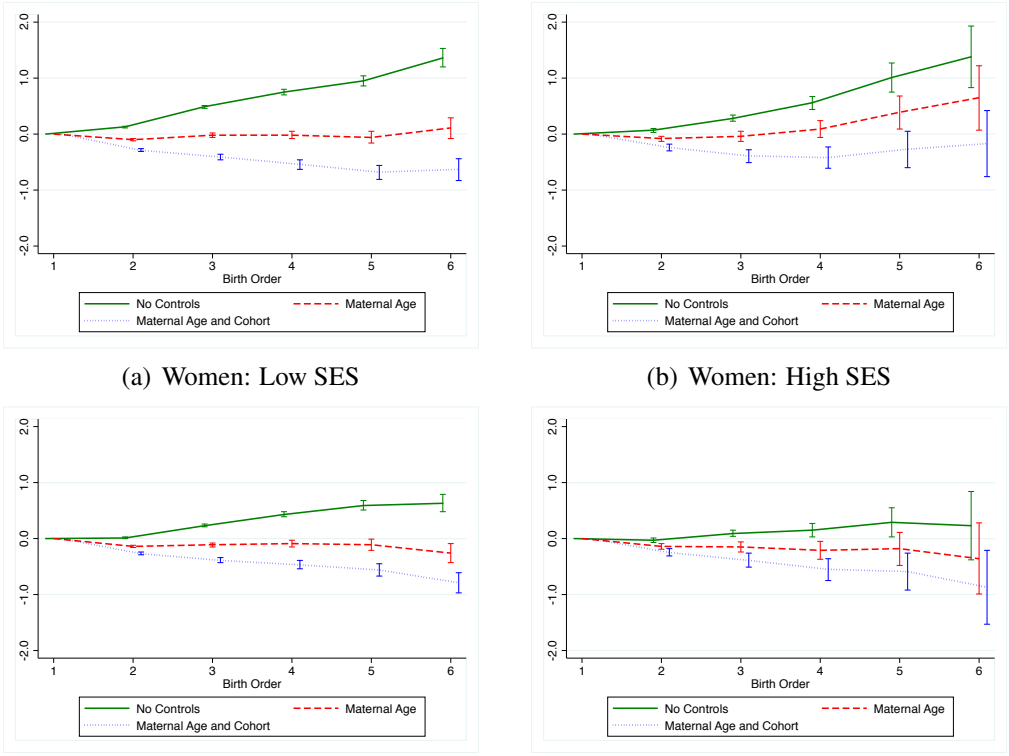


FIGURE 4. Men: Transition to Tertiary Education

Socioeconomic Status Results. As discussed in the introduction, it is likely that the degree to which birth order influences educational attainment is mediated by the socioeconomic status of the family. Since those with greater family resources are more likely to have been continuing with their education than those from a low socioeconomic status background, it is the children with low socioeconomic status parents who are the most likely to have benefitted from educational expansion. Figure 12 shows the results from models where I adjust for birth year and maternal age at the time of birth, only adjust for maternal age at the time of birth, and third, adjust for neither variable. Each of these three models have been estimated for men and women from high and low socioeconomic status backgrounds. Beginning with the results for women, shown in figures 5(a) and 5(b), we can see that the bivariate relationship between birth order and educational attainment shows a strong benefit for later born children for women from both low and high SES families. Third born children have spent approximately half a year longer in the education system by age 30, while sixth born children have spent over a year longer in the educational system by age 30. The effect of birth order after adjusting for birth year and maternal age is negative for women from low SES families, but it is actually the middle born women from high SES families that fare the worst.



(a) Women: Low SES

(b) Women: High SES

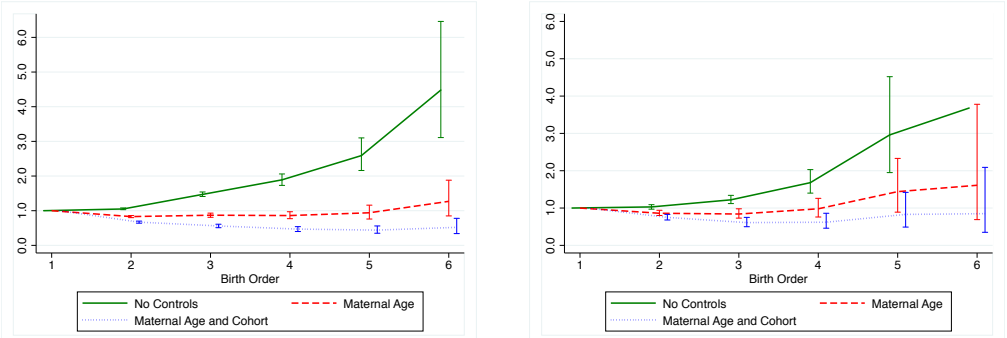
(c) Men: Low SES

(d) Men: High SES

FIGURE 5. Swedish Men and Women, born 1960-1982: Years of Education by Age 30 by Socioeconomic Background.

The results for men can be seen in figures 5(c) and 5(d). The bivariate relationship between birth order and years of education by age 30 seen in figure 5(c) shows that later born men from

low SES families do better than earlier born male siblings, but that the relative difference is smaller than that seen for women from low SES families. Indeed, the gradient is much more shallow, with third borns spending approximately a third of a year longer in the educational system by age 30 than first borns, while sixth borns spend approximately two thirds of a year longer than first borns in the educational system by age 30. As could be seen for women from low SES families, the effect of birth order after adjusting for maternal age at the time of birth and birth year is negative, and approximately mirrors that of the bivariate relationship; third borns have about a third of a year less education, and sixth borns have 0.8 years less education than first borns in the fully adjusted model. Turning to men from high SES families, the bivariate relationship between birth order and years of education by age 30 seen in figure 5(d) shows that later born brothers from high SES families benefited less from educational expansion than men from low SES families, and much less than women from high SES families.



(a) Women: Low SES

(b) Women: High SES

(c) Men: Low SES

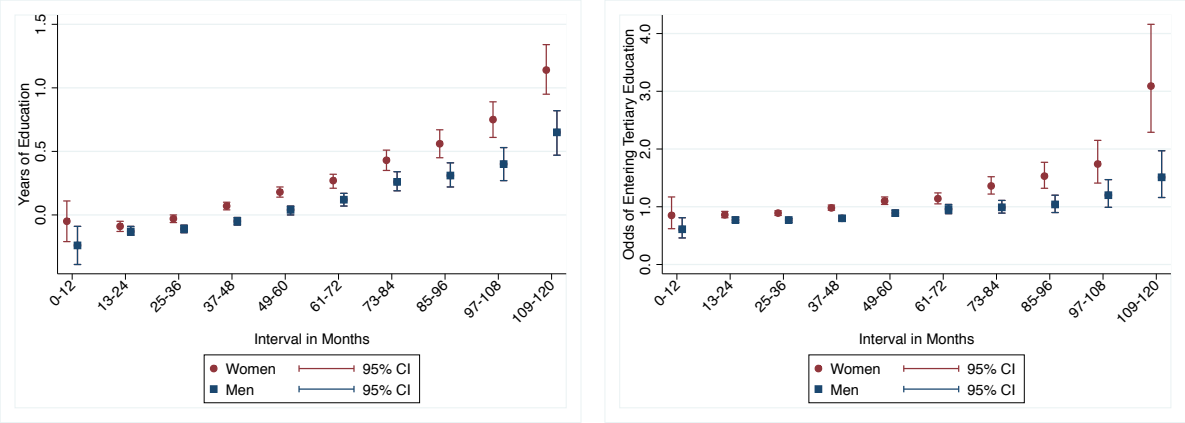
(d) Men: High SES

FIGURE 6. Swedish Men and Women, born 1960-1982: Odds of Entering Tertiary Education by Age 30 by Socioeconomic Background.

Figure 13 shows the results from models examining the transition to tertiary education by age 30. What is most immediately apparent is that later born women from both high and low SES families benefited from educational expansion for this particular educational transition to a much greater extent than did men from either high or low SES families. In figure 6(a) we can see that the odds of entering tertiary education are much greater for later born women relative to first borns from low SES families, even though the effect of birth order after adjusting for

birth year and maternal age continues to be negative. As with the results for years of education shown in figure 5(b), the results for women from high SES families for the transition to tertiary education (figure 6(b)) show a strong bivariate relationship between birth order and making the transition, and only a small negative effect in the fully adjusted model, with middle children faring the worst. The results for men from low and high SES families both show a negative effect of birth order in the fully adjusted model, while the bivariate relationship shows that later born men from high SES families did not outperform first borns in making the transition to tertiary education. However, fourth and fifth born men from low SES families were more likely to make the transition.

Birth Interval Results. While the results presented so far show that later born individuals tend to outperform their older siblings, the underlying assumption has been that the reason for this is because later born children are born several years after the first born child. The degree of educational expansion in the intervening period is what provides the opportunity for later born siblings to extend their educational careers to an extent far less possible for first born individuals. To isolate the degree to which it is the period of time between the first and subsequent births that matters, I have conducted additional analyses where I restrict the models by the birth interval in sibling groups with only two children. The results shown in figure 7(a) are bivariate associations between birth order and years of education by age 30, and the results shown in figure 7(b) are the odds of entering tertiary education by age 30. Both figures show separate results for women and men. Each data point shown on the graph is the difference between the second and first born child for the particular birth interval period indicated by the x-axis. For example, in figure 7(a), second born women in two-child sibling groups with a birth interval of 73-84 months have spent just under half a year longer in the educational system than first borns by age 30.



(a) Years of Education

(b) Odds of Entering Tertiary Education

FIGURE 7. Interval Analyses

The results for years of education by age 30 shown in figure 7(a) clearly show that the birth interval, in combination with educational expansion, is the critical factor underlying the improvements in educational attainment shown by later born siblings throughout the results presented in this study. For women in two-child sibling groups, there is no statistically significant

difference in educational attainment by age 30 when the birth interval was between 0 and 12 months, while the second born does significantly worse than the first born when the interval was 13-24 months. However, in two-child sibling groups where the interval was 37 to 48 months or greater, the second child had spent more time in the educational system by age 30 than the first born. The advantage is approximately 0.25 of a year when the interval was 61-72 months, just over half a year when the interval was 73-84 months, and over a year when the interval was 109-120 months. For men the second child has lower educational attainment at age 30 than the first born when the interval was less than 48 months, but when the interval was greater than 61 months the second born begins to outperform the first born. The advantage gained by second born men, however, is less than that gained by second born women. Even when the interval is 9 or 10 years a second born man would have spent only approximately half a year longer in the educational system by age 30 than his older sibling.

The results in figure 7(b) are organised in the same way as in figure 7(a), but in this case each data point shows the odds of the second born child making the transition to tertiary education relative to the first child for the birth interval indicated by the x-axis. In this case second born women are at a disadvantage relative to first borns when the birth interval is shorter than 48 months, but have a higher likelihood of making the transition to tertiary education when the birth interval is greater than 49 months. In general the likelihood of the second born making the transition to tertiary education relative to the first increases as the birth interval increases from 61 to 120 months. For men in a two-child sibling group, the second born has a lower likelihood than the older sibling of making the transition to tertiary education if the interval is less than 61 months, and only ever shows a statistically signifiant increase in the odds of making the transition to tertiary education if the birth interval was 10 years. This pattern reinforces the results presented earlier showing that later born women benefited from educational expansion to a greater extent than later born men. As stated in the Data section, I also repeated the analyses for families without any half-siblings, to reduce the problem of measurement error for the birth order variable. These are shown in the appendices. These robustness checks show that the results based upon analyses of sibling groups without any half-siblings are remarkably similar to the main results presented in this section.

As mentioned in the Data section, additional analyses have been conducted to check whether the results presented here are robust when the study population consists of individuals whose parents did not have children with a third partner, meaning that there were no half-siblings. These results, shown in full in the appendices, do not differ from the main results presented here in any substantial way.

DISCUSSION

This study has shown that while the causal effect of birth order on educational attainment is negative, educational expansion in the 20th century has meant that in many cases later born children actually do better than their older siblings. Because the secular trend in rising educational attainment has been greater for women than for men, later born girls do better than their earlier born sisters, while later born boys do not always do better than their older brothers. Because of the role of birth intervals, positive outcomes for later born children are actually more common in sibling groups with a larger number of children. It is important to bear in mind that while higher birth order children generally outperform their older siblings in the cohorts that I have studied

in this analysis, the causal effect of birth order on educational attainment remains negative. This means that if the long-term trend of rising educational attainment by cohort flattens out, or declines, later birth order children will do worse than their older siblings. It is also important to note that the results presented in this study represent a within-family phenomenon. While later born children from the same sibling group, and particularly those from large sibling groups or with a long birth interval, outperform earlier born siblings, it is not clear that this would be consistent when comparing individuals of different birth orders across different families. This is because the mechanical relationship between birth year and birth order is a relationship that exists within any specific sibling group, but does not apply across different families.

The greater level of educational attainment that is in practice achieved by later born siblings has substantive implications. There are a large number of studies that show that higher levels of education have a positive effect on all manner of later life outcomes (Cutler and Lleras-Muney, 2008). Research shows that educational expansion in Sweden in the 20th century has increased social mobility (Breen, 2010), and the results from this study suggests that later borns are more likely to benefit from that increase in social mobility. Furthermore, studies indicate that university graduates still benefit from an earnings premium in Sweden (OECD, 2013), though this has been declining (Palme and Wright, 1998; Korpi and Tåhlin, 2009). It is therefore reasonable to assume that, on average, spending more time in the educational system is beneficial and that, in addition to the many benefits of more education that are difficult to measure, the advantage gained by later borns translates into real advantages in the labour market. Although a university degree has become the new entry standard for many types of jobs, and research in the United States shows that a smaller proportion of students actually demonstrate improvements in their critical thinking ability after completing a bachelors degree at university than was true in the past (Arum and Roksa, 2011), it appears that spending more time in the educational system continues to provide a return on this investment (OECD, 2013). Future research should investigate whether the pattern of results shown in this study are consistent when examining earnings in adulthood by birth order.

In addition to research indicating the benefits of increased educational attainment for social mobility, studies also show that increased educational attainment has a positive causal effect on longevity (Lleras-Muney, 2005; Lager and Torssander, 2012). A study using changes to mandatory education in United States has estimated that one additional year of education increased life expectancy at age 35 by 1.7 years for the 1925 birth cohort (Lleras-Muney, 2005). Research examining the effect of Swedish educational reforms for cohorts born between 1943 and 1955, showed that increasing mandatory education by one year decreased the relative risk of all-cause mortality by 4% after age 30 (Lager and Torssander, 2012). As the results above show, last borns in large families spent on average more than one year in the education system relative to first borns. While previous research has shown that there is a positive relationship between birth order and mortality (Barclay and Kolk, 2013), it may be that the bivariate relationship between birth order and mortality reflects the pattern shown in this study. Although the exogenous influence of increasing the number of years of mandatory education is different from the mechanisms that connect birth order to educational attainment, is it possible that the benefit to health that late borns would experience would be comparable to the estimates from the the studies by Lleras-Muney (2005) and Lager and Torssander (2012).

When considering the benefits that spending additional time in the educational system confer to later born, it is notable that the results for the relationship between birth order and years of educational attainment, and making the transition to tertiary education by age 30, are different, and particularly for men. This can be explained by the fact that while educational enrolment has been increasing overall, the pace at which attendance of tertiary educational institutions has been increasing has not been as pronounced as the increased likelihood of completing upper secondary school in Sweden (*Gymnasium*) (Rudolphi, 2013). This was partly due to university quotas (*numerus clausus*) (Erikson and Jonsson, 1996*b*). When considering the advantage that later born individuals may have over their older siblings, it is also useful to bear in mind that the positive effects of increasing educational attainment may be heterogeneous in regards to the level of education that is attained (Breen and Jonsson, 2007). Furthermore, when considering the interaction between social class and gender it is important to note that while educational attainment may have increased, there remains horizontal inequality in terms of the academic rigour of the programs that individuals choose to apply to (Hällsten, 2010; Rudolphi, 2013). For example, Hällsten (2010), examining the interaction between class and gender, found that women were more likely to choose female-typed programs, which are associated with poorer earnings trajectories, though there were not statistically significant class differences by gender. Despite these caveats, educational expansion across Western Europe, and over the course of the 20th century to the present day (Erikson and Jonsson, 1996*b*; Breen et al., 2009; OECD, 2013), mean that the findings presented in this paper may be generalizable both outside of Sweden, and outside of the cohorts that have been analysed in this study.

Given that I am not able to adjust for birth weight, it is likely that the bivariate relationship between birth order and educational attainment partially reflects the advantage that later born children have in this respect. It is well-documented that first born children have a lower birth weight than their later born siblings, and birth weight is on average lowest for the first born. Research has shown that birth weight is positively associated with a range of later life outcomes, including educational attainment, IQ, and earnings (Conley and Bennett, 2000; Hack et al., 2002; Black et al., 2007). Although this study has focused upon the role of educational expansion in allowing later born children to outperform their older siblings, it is likely that birth weight has also contributed to the fact that later born children outperform their older siblings in spite of the negative causal effect of birth order. This may also be true for parental resources. While the within-family comparison design adjusts for observed and unobserved factors that remain constant within the sibling group, the pool of parental resources is likely to increase over time as parents gain more experience in the labour market. This is partially adjusted for in the models shown where I adjust for maternal age at the time of birth, but do not adjust for birth year.

Although changes within the family or between siblings, such as birth weight, and parental earnings over time, are likely to have benefited later born individuals over their older siblings, other social conditions outside of the family are also likely to have benefited later borns. In the past century successive Swedish governments have actively attempted to improve income equality, and have made substantial progress. The second half of the 20th century was also characterised by the expansion of the welfare state and strong economic growth (Erikson and Jonsson, 1996*a*). The introduction of publicly funded pre-school in Sweden in the 1970s (Halldén, 2008), for example, will on average have benefited later born children over earlier borns. There

have also been general improvements to public health conditions and to medical practice, which has measurably improved health over time (SCB, 2010). Thus, while changes to the educational system itself have been the key elements enabling later born siblings to have a better education, general improvements in social conditions over time are likely to have facilitated the degree to which parents have been able to support their children and provide them with opportunities to learn (Erikson and Jonsson, 1996*b*). As this study has shown, what this means in practice is that later born children tend to outperform their older siblings. While the causal effect of birth order on educational attainment is negative, in everyday life, we do not adjust for maternal age at the time of birth and birth year when considering the outcomes of our siblings. Instead, we observe that some siblings do better than others. As outlined in the introduction, it is very possible that educational expansion in the 20th century is a factor contributing to the confusion about the effect that birth order has on the long term prospects of individuals.

REFERENCES

Alter, G. and Oris, M. (2008), 'Effects of inheritance and environment on the heights of brothers in nineteenth-century belgium', *Human Nature* **19**(1), 44–55.

Arum, R. and Roksa, J. (2011), *Academically adrift: Limited learning on college campuses*, University of Chicago Press, Chicago.

Barclay, K. J. (2013), 'Sibling set order and educational attainment: Evidence from fully adopted sibling groups', *Stockholm Research Reports in Demography* **16**, 1–25.

Barclay, K. J. and Kolk, M. (2013), 'Birth order and mortality: A population-based cohort study', *Stockholm Research Reports in Demography* **14**, 1–30.

Black, S. E., Devereux, P. J. and Salvanes, K. G. (2005), 'The more the merrier? the effect of family size and birth order on children's education', *Quarterly Journal of Economics* **120**(2), 669–700.

Black, S. E., Devereux, P. J. and Salvanes, K. G. (2007), 'From the cradle to the labor market? the effect of birth weight on adult outcomes', *The Quarterly Journal of Economics* **122**(1), 409–439.

Blake, J. (1981), 'Family size and the quality of children', *Demography* **18**, 421–442.

Blake, J. (1989), 'Number of siblings and educational attainment', *Science* **245**(4913), 32–36.

Blau, P. M. and Duncan, O. D. (1967), *The American Occupational Structure.*, John Wiley & Sons, New York.

Boudon, R. (1974), *Education, Opportunity, and Social Inequality*, Wiley, New York.

Breen, R. (2010), 'Educational expansion and social mobility in the 20th century', *Social Forces* **89**(2), 365–388.

Breen, R. and Jonsson, J. O. (2007), 'Explaining change in social fluidity: Educational equalization and educational expansion in twentieth-century sweden', *American Journal of Sociology* **112**(6), 1775–1810.

Breen, R., Luijkx, R., Müller, W. and Pollak, R. (2009), 'Nonpersistent inequality in educational attainment: Evidence from eight european countries', *American Journal of Sociology* **114**(5), 1475–1521.

Conley, D. (2004), *The Pecking Order: Which Siblings Succeed and Why*, Pantheon, New York.

Conley, D. and Bennett, N. G. (2000), 'Is biology destiny? birth weight and life chances', *American Sociological Review* **65**(3), 458–467.

Cutler, D. M. and Lleras-Muney, A. (2008), Education and health: Evaluating theories and evidence, *in* R. F. Schoeni, J. S. House, G. Kaplan and H. Pollack, eds, 'Making Americans Healthier: Social and Economics Policy as Health Policy', Russell Sage Foundation, New York.

Erikson, R., Goldthorpe, J. H., Jackson, M., Yaish, M. and Cox, D. R. (2005), 'On class differentials in educational attainment', *Proceedings of the National Academy of Sciences of the United States of America* **102**(27), 9730–9733.

Erikson, R., Goldthorpe, J. H. and Portocarero, L. (1979), 'Intergenerational class mobility in three western european societies: England, france and sweden', *British journal of Sociology* **30**(4), 415–441.

Erikson, R. and Jonsson, J. O. (1996*a*), *Can Education be Equalized? The Swedish Case in Comparative Perspective*, Westview Press.

Erikson, R. and Jonsson, J. O. (1996*b*), The swedish context: Educational reform and long-term change in educational inequality, *in* R. Erikson and J. O. Jonsson, eds, 'Can education be equalized? The Swedish Case in Comparative Perspective', Westview Press, Boulder, CO.

Ernst, C. and Angst, J. (1983), *Birth Order: Its Influence on Personality*, Springer-Verlag, Berlin.

Galton, F. (1874), *English Men of Science: Their Nature and Nurture*, MacMillan & Company, London.

Gini, C. (1915), 'Superiority of the eldest investigation among professors in italian universities shows that the first-born are most frequent among them, while children born late in the generation are the rarest', *Journal of Heredity* **6**(1), 37–39.

Hack, M., Flannery, D. J., Schluchter, M., Cartar, L., Borawski, E. and Klein, N. (2002), 'Outcomes in young adulthood for very-low-birth-weight infants', *New England Journal of Medicine* **346**(3), 149–157.

Halldén, K. (2008), The swedish educational system and classifying education using the isced-97, *in* S. Schneider, ed., 'The International Standard Classification of Education (ISCED-97). An evaluation of content and criterion validity in 15 European countries', MZES, Mannheim, pp. 253–267.

Hällsten, M. (2010), 'The structure of educational decision making and consequences for inequality: A swedish test case', *American Journal of Sociology* **116**(3), 806–54.

Härkönen, J. (2014), 'Birth order effects on educational attainment and educational transitions in west germany', *European Sociological Review* **30**(2), 166–179.

Hertwig, R., Davis, J. N. and Sulloway, F. J. (2002), 'Parental investment: How an equity motive can produce inequality', *Psychological Bulletin* **128**(5), 728–745.

Högskoleverket (2012), *Swedish Universities and University Colleges: Short Version of Annual Report 2012*, Högskoleverket, Stockholm.

Jackson, M. (2013), *Determined to Succeed? Performance Versus Choice in Educational Attainment*, Stanford University Press, Stanford.

Kalmijn, M. and Kraaykamp, G. (2005), 'Late or later? a sibling analysis of the effect of maternal age on children's schooling', *Social Science Research* **34**, 634–650.

Kantarevic, J. and Mechoulan, S. (2006), 'Birth order, educational attainment, and earnings an investigation using the psid', *Journal of Human Resources* **41**(4), 755–777.

Korpi, T. and Tåhlin, M. (2009), 'Educational mismatch, wages, and wage growth: Overeducation in sweden, 1974–2000', *Labour Economics* **16**(2), 183–193.

Kristensen, P. and Bjerkedal, T. (2007), 'Explaining the relation between birth order and intelligence', *Science* **316**(5832), 1717.

Kristensen, P. and Bjerkedal, T. (2010), 'Educational attainment of 25 year old norwegians according to birth order and gender', *Intelligence* **38**(1), 123–136.

Lager, A. C. J. and Torssander, J. (2012), 'Causal effect of education on mortality in a quasi-experiment on 1.2 million swedes', *Proceedings of the National Academy of Sciences* **109**(22), 8461–8466.

Lleras-Muney, A. (2005), 'The relationship between education and adult mortality in the united states', *The Review of Economic Studies* **72**(1), 189–221.

Myrskylä, M., Silventoinen, K., Tynelius, P. and Rasmussen, F. (2013), 'Is later better or worse? association of advanced parental age with offspring cognitive ability among half a million young swedish men', *American Journal of Epidemiology* **177**(7), 649–655.

OECD (2013), *Education at a Glance 2013: OECD Indicators*, OECD Publishing, http://dx.doi.org/10.1787/eag-2013-en.

Palme, M. O. and Wright, R. E. (1998), 'Changes in the rate of return to education in sweden: 1968-1991', *Applied Economics* **30**(12), 1653–1663.

Rodgers, J. L. (2000), 'The birth order trap', *Politics and the Life Sciences* **19**(2), 167–170.

Rodgers, J. L. (2001*a*), The confluence model: An academic tragedy of the commons., *in* E. L. Grigorenko and R. J. Sternberg, eds, 'Family environment and intellectual functioning: A life-span perspective', Lawrence Erlbaum, Mahwah, NJ, pp. 71–95.

Rodgers, J. L. (2001*b*), 'What causes birth order-intelligence patterns? the admixture hypothesis, revived', *American Psychologist* **56**, 505–510.

Rudolphi, F. (2013), Ever declining inequalities? transitions to upper secondary and tertiary education in sweden, 1972-1990 birth cohorts, *in* M. Jackson, ed., 'Determined to Succeed? Performance Versus Choice in Educational Attainment', Stanford University Press, Stanford, chapter 7.

SCB (2000), *Svensk utbildningsnomenklatur, SUN2000*, Statistics Sweden, Stockholm.

SCB (2010), *Cohort mortality in Sweden. Mortality statistics since 1861*, Statistics Sweden.

Schooler, C. (1972), 'Birth order effects: Not here, not now!', *Psychological Bulletin* **78**(3), 161–175.

Shavit, Y. and Blossfeld, H.-P. (1993), *Persistent Inequality: Changing Educational Attainment in Thirteen Countries*, Westview, Boulder, CO.

Sulloway, F. J. (1996), *Born to rebel: birth order, family dynamics, and creative lives*, Little, Brown and Company, London.

Thomson, E. (2014), 'Family complexity in europe', *The ANNALS of the American Academy of Political and Social Science* **654**(1), 245–258.

Toman, W. (1961), *Family Constellation: Its Effects on Personality and Social Behavior*, Springer, New York.

Townsend, F. (2000), 'Birth order and rebelliousness: Reconstructing the research in" born to rebel"', *Politics and the Life Sciences* **19**(2), 135–156.

Willemse, N. and De Beer, P. (2012), 'Three worlds of educational welfare states? a comparative study of higher education systems across welfare states', *Journal of European Social*

Policy **22**(2), 105–117.
Zajonc, R. B. (1976), 'Family configuration and intelligence', *Science* **192**, 227–236.

APPENDICES

TABLE 6. Within-Family Comparison Results in Sibling Groups without Half Siblings: Analyses of the Relationship between Birth Order and Educational Attainment at Age 30 from Fixed Effect Linear Regressions.

		Women						Men					
		β	95% CI	β	95% CI	β	95% CI	β	95% CI	β	95% CI	β	95% CI
Birth Order	1	0.00		0.00		0.00		0.00		0.00		0.00	
	2	0.09	0.08 , 0.11	-0.12	-0.14 , -0.11	-0.31	-0.33 , -0.29	-0.02	-0.04 , -0.01	-0.18	-0.19 , -0.16	-0.30	-0.32 , -0.28
	3	0.39	0.37 , 0.41	-0.08	-0.11 , -0.05	-0.48	-0.53 , -0.44	0.15	0.13 , 0.17	-0.19	-0.22 , -0.16	-0.45	-0.49 , -0.41
	4	0.64	0.60 , 0.68	-0.06	-0.11 , -0.01	-0.62	-0.68 , -0.55	0.34	0.30 , 0.37	-0.17	-0.22 , -0.12	-0.54	-0.60 , -0.47
	5	0.88	0.81 , 0.96	-0.04	-0.13 , 0.05	-0.72	-0.82 , -0.62	0.54	0.47 , 0.61	-0.12	-0.21 , -0.03	-0.57	-0.67 , -0.47
	6	1.33	1.19 , 1.47	0.20	0.05 , 0.35	-0.59	-0.76 , -0.43	0.69	0.55 , 0.83	-0.13	-0.28 , 0.02	-0.67	-0.83 , -0.51
Maternal Age	<20			-0.62	-0.67 , -0.57	-0.03	-0.09 , 0.02			-0.45	-0.50 , -0.41	-0.06	-0.12 , -0.01
	20-24			-0.33	-0.36 , -0.31	-0.01	-0.04 , 0.02			-0.23	-0.26 , -0.21	-0.02	-0.04 , 0.01
	25-29			0.00		0.00				0.00		0.00	
	30-34			0.33	0.30 , 0.35	-0.04	-0.07 , -0.01			0.24	0.21 , 0.26	-0.01	-0.04 , 0.02
	35-39			0.68	0.63 , 0.72	-0.08	-0.14 , -0.02			0.48	0.44 , 0.52	-0.02	-0.08 , 0.03
	40-44			0.96	0.86 , 1.06	-0.17	-0.28 , -0.05			0.71	0.62 , 0.81	-0.04	-0.14 , 0.07
	>44			1.37	0.98 , 1.76	-0.12	-0.52 , 0.28			0.91	0.52 , 1.31	-0.13	-0.53 , 0.27
Cohort	1960					-0.90	-0.99 , -0.81					-0.57	-0.65 , -0.48
	1961					-0.84	-0.92 , -0.76					-0.58	-0.66 , -0.50
	1962					-0.77	-0.85 , -0.70					-0.55	-0.62 , -0.48
	1963					-0.71	-0.78 , -0.64					-0.50	-0.57 , -0.44
	1964					-0.65	-0.72 , -0.59					-0.47	-0.53 , -0.41
	1965					-0.60	-0.66 , -0.54					-0.42	-0.47 , -0.36
	1966					-0.51	-0.56 , -0.46					-0.34	-0.39 , -0.29
	1967					-0.45	-0.50 , -0.40					-0.32	-0.36 , -0.27
	1968					-0.39	-0.44 , -0.34					-0.30	-0.34 , -0.25
	1969					-0.31	-0.36 , -0.26					-0.23	-0.27 , -0.18
	1970					0.00						0.00	
	1971					0.19	0.15 , 0.24					0.08	0.04 , 0.12
	1972					0.39	0.35 , 0.44					0.23	0.19 , 0.28
	1973					0.56	0.51 , 0.61					0.38	0.33 , 0.42
	1974					0.81	0.75 , 0.86					0.53	0.48 , 0.58
	1975					1.01	0.95 , 1.06					0.72	0.66 , 0.77
	1976					1.13	1.07 , 1.20					0.84	0.78 , 0.90
	1977					1.23	1.16 , 1.30					0.82	0.75 , 0.88
	1978					1.22	1.14 , 1.29					0.75	0.68 , 0.82
	1979					1.32	1.23 , 1.40					0.81	0.73 , 0.89
	1980					1.43	1.34 , 1.52					0.98	0.89 , 1.06
	1981					1.44	1.35 , 1.54					0.92	0.83 , 1.01
	1982					1.51	1.41 , 1.61					0.97	0.88 , 1.07
N		345,107		345,107		345,107		386,941		386,941		386,941	

Source: Swedish administrative register data, compiled by the author.

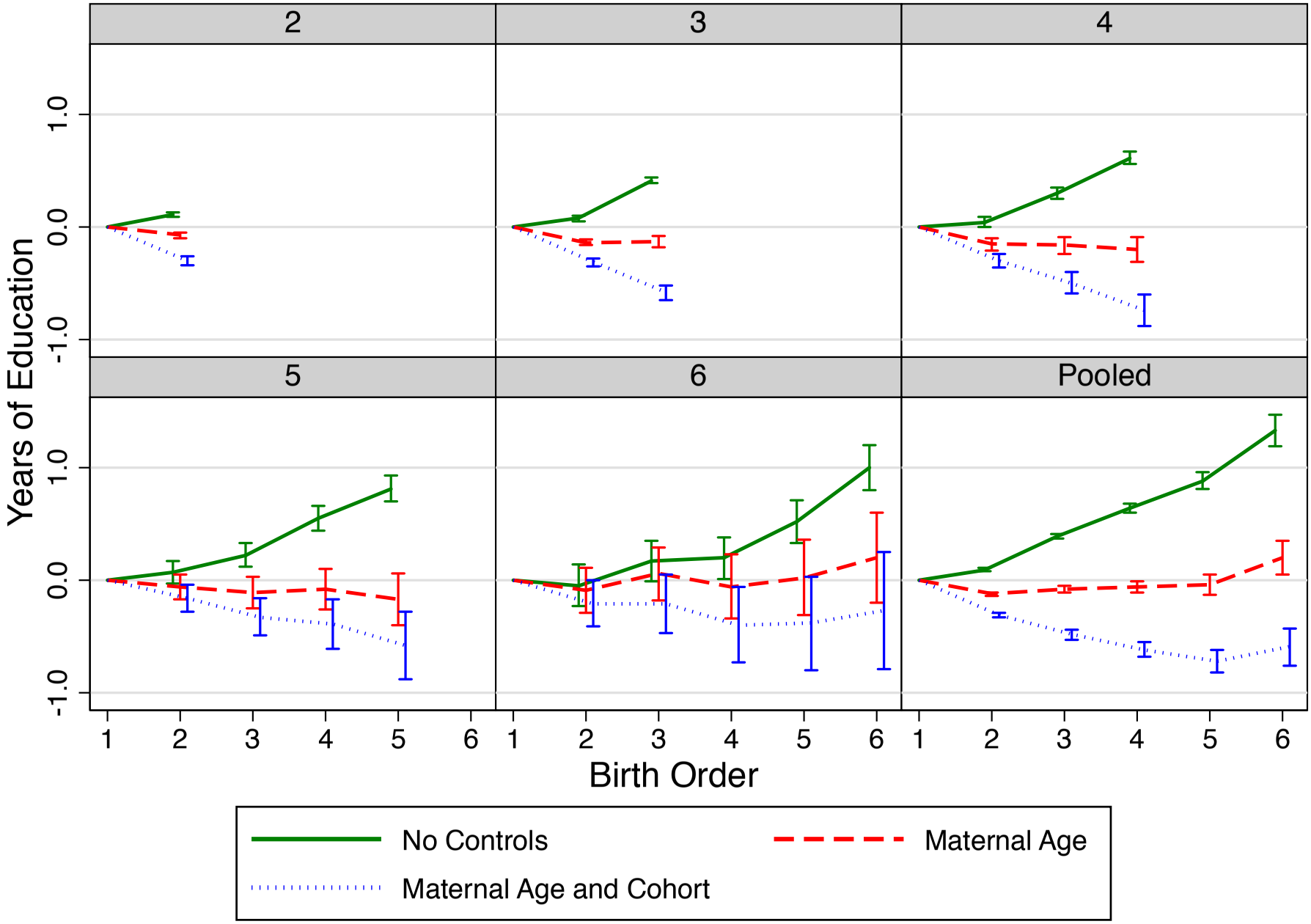


FIGURE 8. Women in Sibling Groups without Half Siblings: Years of Education

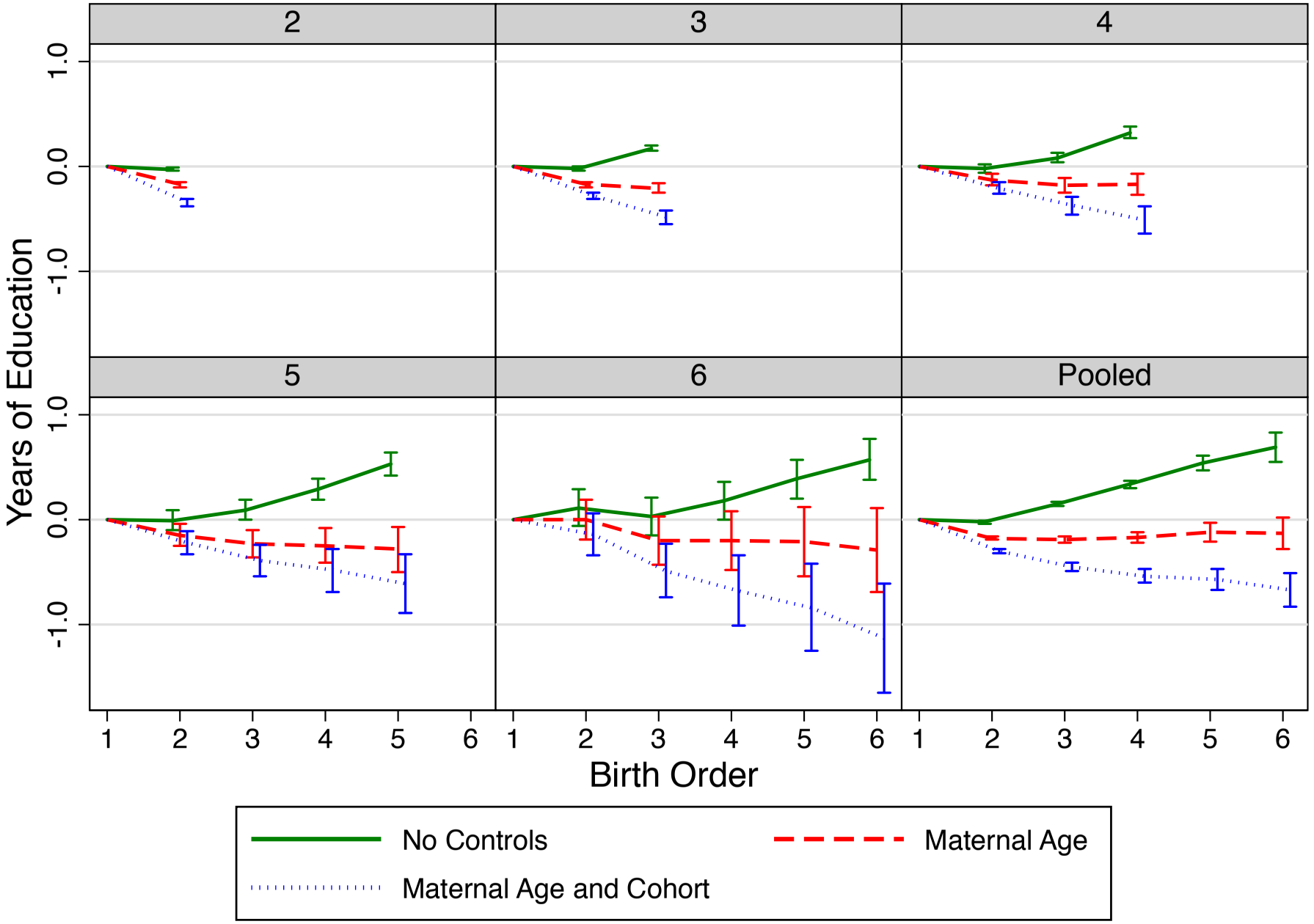


FIGURE 9. Men in Sibling Groups without Half Siblings: Years of Education

TABLE 7. Within-Family Comparison Results in Sibling Groups without Half Siblings: Analyses of the Relationship between Birth Order and the Transition to Tertiary Education by Age 30 from Fixed Effect Linear Regressions.

		Women						Men					
		OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Birth Order	1	1.00		1.00		1.00		1.00		1.00		1.00	
	2	1.02	1.00 - 1.04	0.82	0.80 - 0.84	0.68	0.66 - 0.71	0.84	0.82 - 0.85	0.73	0.71 - 0.75	0.65	0.63 - 0.67
	3	1.31	1.27 - 1.35	0.81	0.77 - 0.85	0.55	0.51 - 0.59	0.90	0.87 - 0.93	0.67	0.64 - 0.71	0.53	0.49 - 0.56
	4	1.65	1.55 - 1.76	0.81	0.75 - 0.89	0.47	0.43 - 0.53	1.08	1.01 - 1.15	0.70	0.65 - 0.77	0.49	0.44 - 0.55
	5	2.23	1.96 - 2.54	0.89	0.77 - 1.04	0.46	0.39 - 0.55	1.33	1.16 - 1.53	0.77	0.66 - 0.90	0.50	0.41 - 0.59
	6	3.52	2.73 - 4.53	1.16	0.88 - 1.53	0.53	0.40 - 0.71	1.38	1.05 - 1.82	0.70	0.52 - 0.94	0.41	0.30 - 0.56
Maternal Age	<20			0.53	0.49 - 0.58	0.92	0.84 - 1.01			0.67	0.62 - 0.73	0.90	0.82 - 0.99
	20-24			0.72	0.69 - 0.75	0.97	0.93 - 1.02			0.83	0.80 - 0.86	0.97	0.92 - 1.01
	25-29			1.00		1.00				1.00		1.00	
	30-34			1.38	1.33 - 1.44	0.99	0.94 - 1.04			1.22	1.18 - 1.27	1.02	0.97 - 1.07
	35-39			1.92	1.79 - 2.06	0.96	0.87 - 1.06			1.50	1.40 - 1.61	1.01	0.92 - 1.11
	40-44			2.45	2.11 - 2.85	0.87	0.73 - 1.05			1.75	1.51 - 2.02	0.96	0.80 - 1.14
	>44			3.19	1.69 - 6.02	0.89	0.46 - 1.71			1.77	0.94 - 3.32	0.75	0.39 - 1.45
Cohort	1960					0.46	0.40 - 0.54					0.57	0.49 - 0.65
	1961					0.46	0.40 - 0.52					0.55	0.49 - 0.63
	1962					0.49	0.44 - 0.56					0.59	0.52 - 0.67
	1963					0.53	0.48 - 0.59					0.64	0.58 - 0.72
	1964					0.54	0.49 - 0.60					0.64	0.58 - 0.70
	1965					0.57	0.52 - 0.63					0.72	0.65 - 0.78
	1966					0.63	0.58 - 0.69					0.76	0.70 - 0.83
	1967					0.69	0.64 - 0.74					0.79	0.73 - 0.85
	1968					0.73	0.67 - 0.78					0.80	0.74 - 0.86
	1969					0.81	0.75 - 0.87					0.85	0.79 - 0.92
	1970					1.00						1.00	
	1971					1.21	1.13 - 1.31					1.05	0.98 - 1.13
	1972					1.48	1.37 - 1.59					1.23	1.15 - 1.32
	1973					1.66	1.54 - 1.79					1.34	1.24 - 1.44
	1974					2.05	1.88 - 2.23					1.34	1.23 - 1.45
	1975					2.31	2.10 - 2.53					1.48	1.36 - 1.62
	1976					2.68	2.42 - 2.97					1.69	1.53 - 1.86
	1977					2.88	2.58 - 3.22					1.53	1.38 - 1.70
	1978					3.09	2.74 - 3.48					1.68	1.49 - 1.88
	1979					3.43	3.01 - 3.90					1.87	1.65 - 2.12
	1980					4.01	3.48 - 4.61					2.20	1.92 - 2.52
	1981					4.01	3.44 - 4.67					2.15	1.86 - 2.49
	1982					4.40	3.74 - 5.18					2.30	1.97 - 2.70
N		115,281		115,281		115,281		120,404		120,404		120,404	

Source: Swedish administrative register data, compiled by the author.

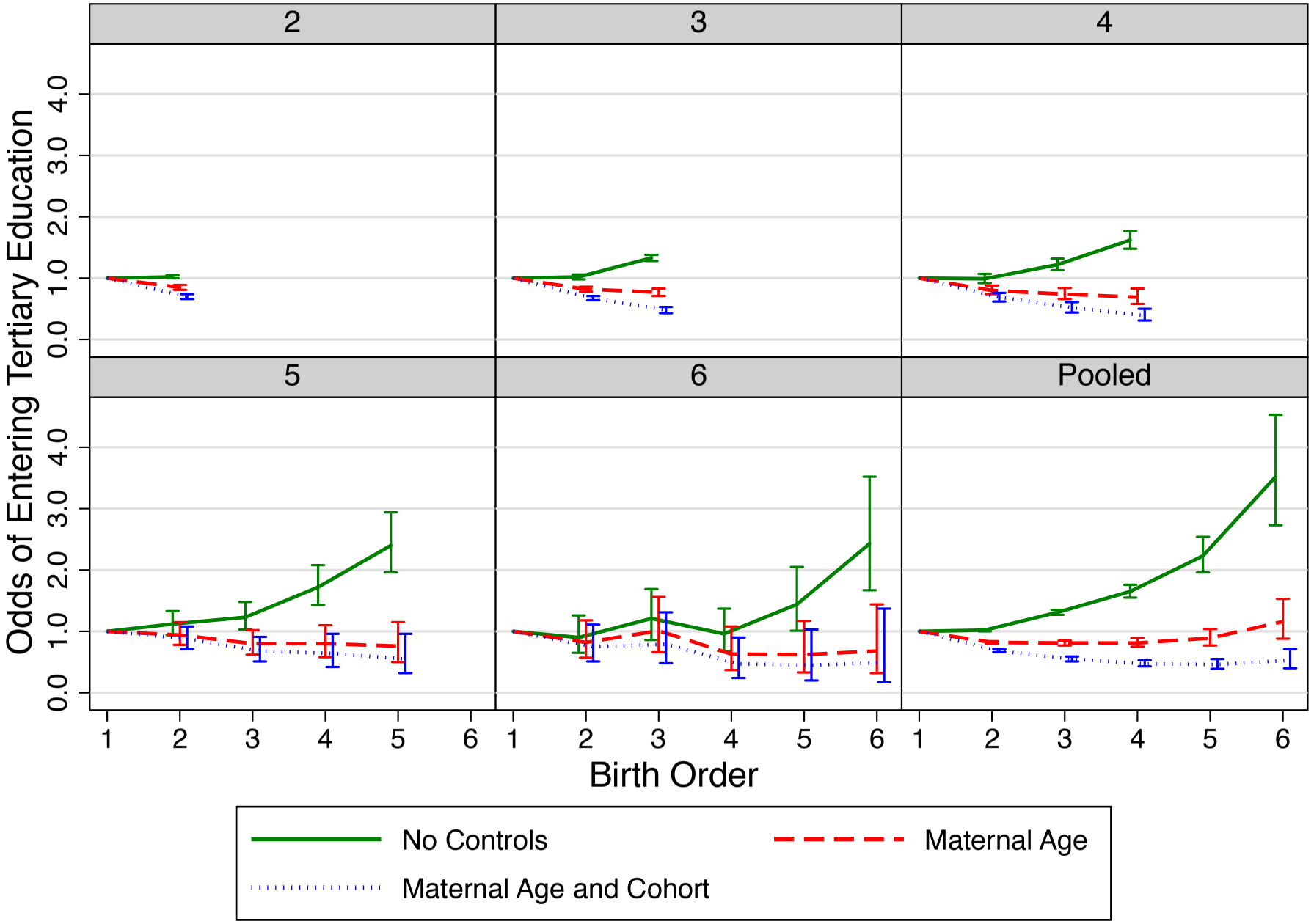


FIGURE 10. Women in Sibling Groups without Half Siblings: Transition to Tertiary Education

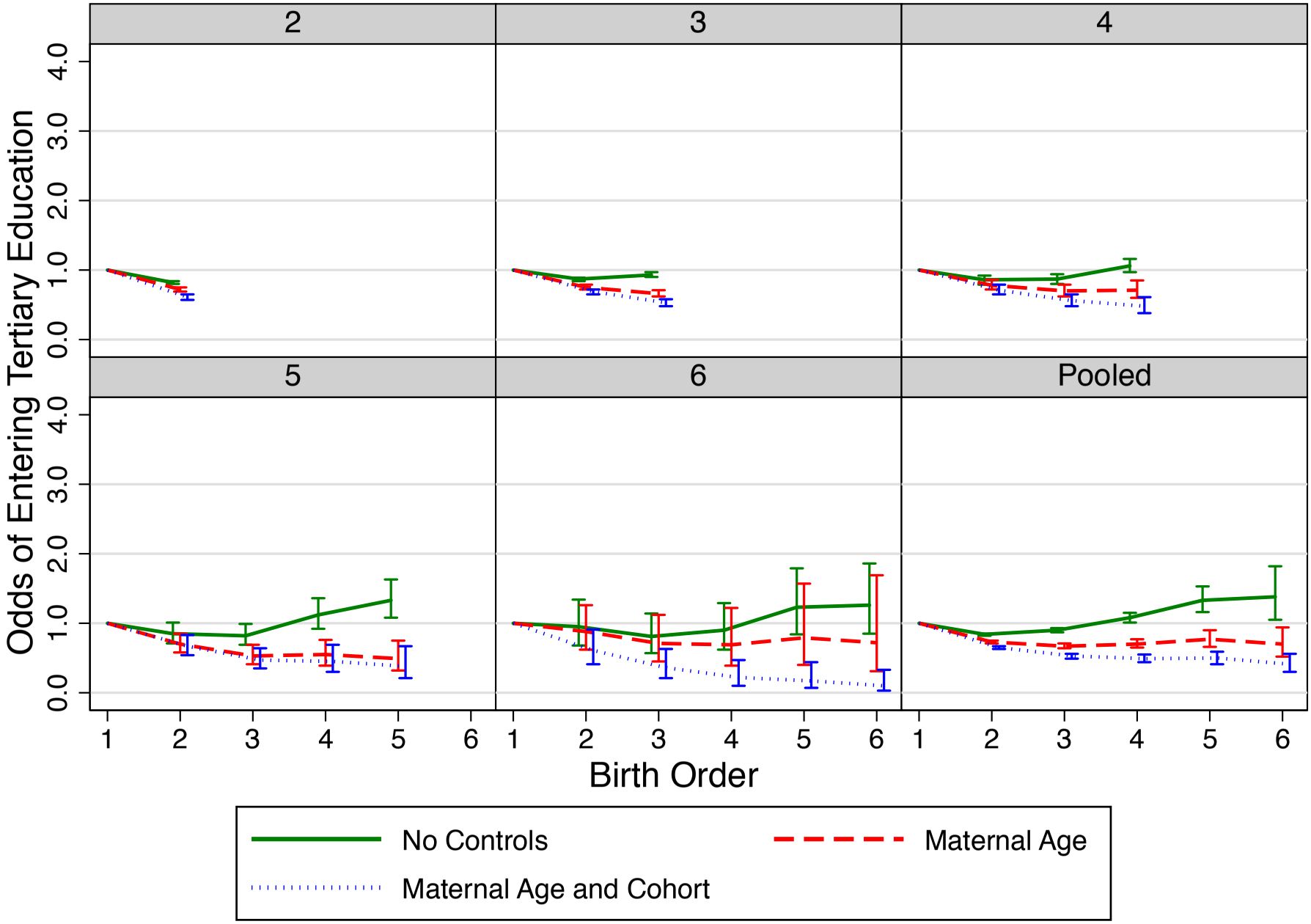
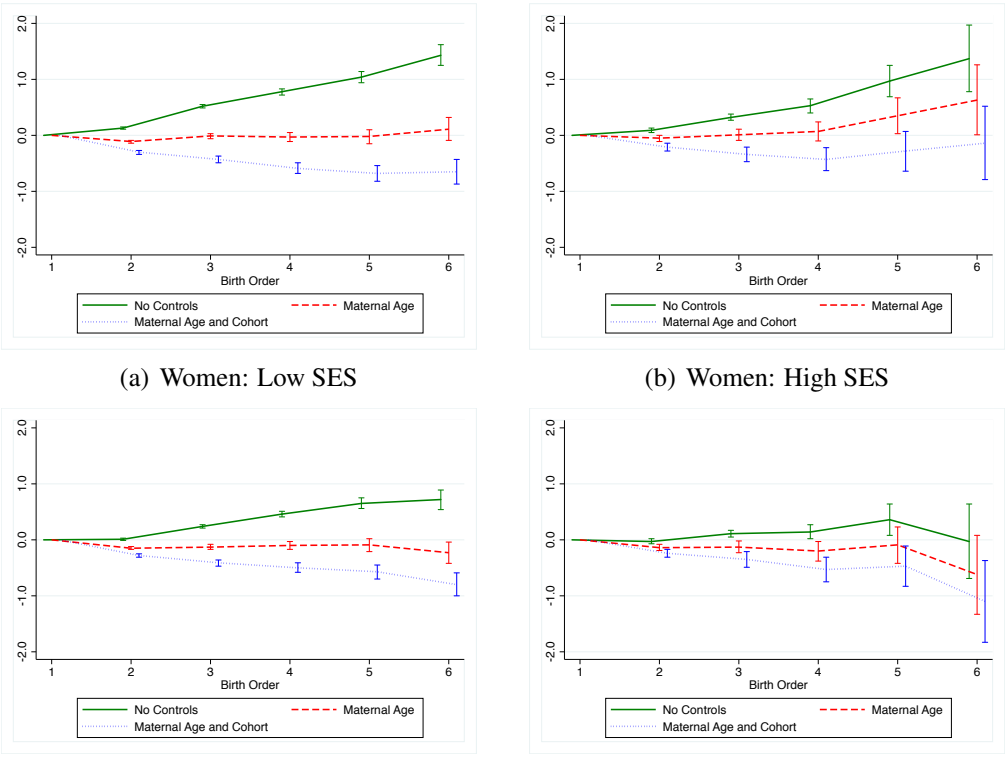


FIGURE 11. Men in Sibling Groups without Half Siblings: Transition to Tertiary Education



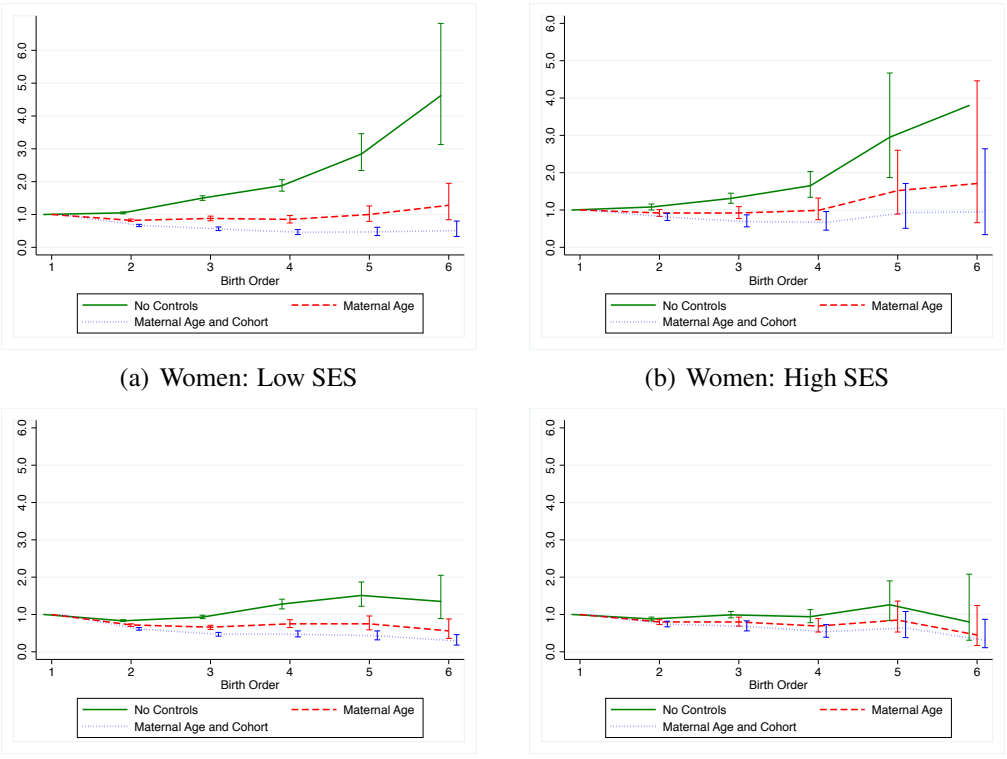
(a) Women: Low SES

(b) Women: High SES

(c) Men: Low SES

(d) Men: High SES

FIGURE 12. Swedish Men and Women in Sibling Groups without Half Siblings, born 1960-1982: Years of Education by Age 30 by Socioeconomic Background.



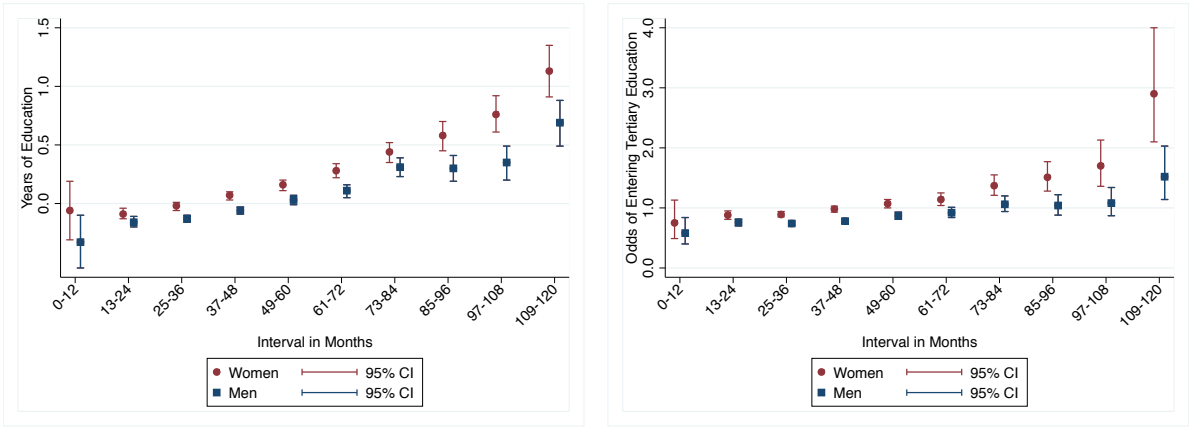
(a) Women: Low SES

(b) Women: High SES

(c) Men: Low SES

(d) Men: High SES

FIGURE 13. Swedish Men and Women in Sibling Groups without Half Siblings, born 1960-1982: Odds of Entering Tertiary Education by Age 30 by Socioeconomic Background.



(a) Years of Education

(b) Odds of Entering Tertiary Education

FIGURE 14. Interval Analyses for Men and Women in Sibling Groups without Half Siblings