The Australian National University
Centre for Economic Policy Research
DISCUSSION PAPER

Birth Order Matters:
The Effect of Family Size and Birth Order on Educational Attainment

Alison Booth* and Hiau Joo Kee*

DISCUSSION PAPER NO. 506
December 2005

ISSN: 1442-8636
ISBN: 0 7315 3576 6

---

*Economics Program, Research School of Social Sciences, Australian National University, ACT 0200 Australia

Acknowledgements
We are grateful to Tim Hatton for very helpful discussions, to seminar participants at the Australian National University and Melbourne University for useful comments, and to Margi Wood and Jeta Vedi for data assistance. The data were made available through the UK Data Archive. The data were originally collected by the ESRC Research Centre on Micro-social Change at the University of Essex, now incorporated within the Institute for Social and Economic Research. Neither the original collectors of the data nor the Archive bear any responsibility for the analyses or interpretations presented here.

ABSTRACT

We use unique retrospective family background data from the 2003 wave of the British Household Panel Survey to explore the degree to which family size and birth order affect a child's subsequent educational attainment. Theory suggests a trade off between child quantity and 'quality'. Family size might adversely affect the production of child quality within a family. A number of arguments also suggest that siblings are unlikely to receive equal shares of the resources devoted by parents to their children's education. We construct a composite birth order index that effectively purges family size from birth order and use this to test if siblings are assigned equal shares in the family's educational resources. We find that they are not, and that the shares are decreasing with birth order. Controlling for parental education, parental age at birth and family level attributes, we find that children from larger families have lower levels of education, that there is a separate negative birth order effect, and that the family size effect does not vanish once we control for birth order. Our findings are robust to a number of specification checks.

Keywords: family size, birth order, education, inter-generational effects

JEL Classifications: I2, J1

I. INTRODUCTION

The promotion of educational attainment is an important priority of policy makers. The economics of the family suggests that children's educational achievement is related to family size, and that there is a trade off between child quantity and 'quality' (Becker, 1960; Becker and Lewis, 1973), where child 'quality' is proxied by educational outcomes. A number of arguments also suggest that siblings are unlikely to receive equal shares of the resources devoted by parents to their children's education.

There are various hypotheses in the literature about the impact of birth order. Those predicting negative effects relate to greater parental time endowments for lower birth order children; greater devolvement of responsibility to lower birth order children; and the simple fact that mothers are older when they have higher than lower birth order children. Those hypotheses predicting positive effects of birth order on education are: the growth of family income over the life cycle; the possibility that older siblings may be encouraged to leave school early to assist in providing resources for the younger members of the family; parental child-raising experience that might advantage younger siblings; and finally the possibility that younger children may benefit from time inputs both from parents and older siblings.

A challenge in estimation of birth order and family size effects is that birth order relates to family size. The first born in any family always has a higher probability of being in a small family than those children born later in the birth order. Studies estimating separate birth order and family size effects typically include dummy variables for birth order and a separate continuous variable for family size. But this does not appropriately purge the family size effect from the birth order effect. In this paper we put forward a simple specification of a *birth order index* that improves on the methods used in the literature to date, and which we utilize in our estimation. An additional advantage of this is its parsimony.

We use unique retrospective family background data from wave 13 of the British Household Panel Survey to explore the degree to which family size and birth order affect a child's subsequent educational attainment. We construct a test of whether or not siblings are assigned equal shares in the family's educational resources. We show that they are not, and that the shares are decreasing with birth order. Controlling for parental family income, parental age at birth and family level attributes, we find that children from larger families have lower levels of education and that there is in addition a separate negative birth order effect. Our findings are robust to a number of specification checks. In contrast to Black, Devereux and Salvanes (2005), the family size effect does not vanish once we control more appropriately for birth order.

There have been many studies estimating the impact of family composition of educational attainment (see Ejrnaes and Portner (2004) and Black *et al* (2005) for recent analyses). These typically do not convincingly disentangle birth order from family size effects, as noted by Hanushek (1992), although Ejrnaes and Portner (2004) employ a measure of relative birth order to try to overcome this problem.[1] More recently, Black *et al* (2005) used data for the entire Norwegian population to estimate the impact of family size and birth order on education, employing dummy variables for birth order. They found that their negative correlation between family size and children's educational attainment became negligible once they included dummy variable indicators for birth order.[2] This finding was robust to the use of twin births as an instrument for family size (twins being an exogenous variation in family size) and also to estimating birth order effects separately by family size. There is, to our knowledge, only one similar study for Britain. Iacovou (2001) used the National Child Development Study, a longitudinal study of all children born in the first week of March 1958, in order to estimate the impact of family composition on educational attainment up to age 23. She finds a statistically significant

[1] Their measure of relative birth order is [$(p-1)/(n-1)$], where p is birth order and n the number of children in the family.

[2] Thus their birth order effects are not purged of family size effects.

negative correlation between educational attainment on the one hand and higher birth order and larger family size on the other. She disentangles birth order effects from family size to a considerable degree by using dummy variables picking up a variety of family patterns.[3] We build on this approach by constructing a composite birth order index that effectively purges family size from birth order, and which allows parsimonious estimation of birth order effects.

The paper is set out as follows. In Section II we summarize the main hypotheses about the impact of family size and birth order on children's education. Section III describes the data and explanatory variables, while an appendix provides more details of the British educational system. Section IV outlines the test and presents the main estimates. Section V discusses the results of a number of robustness checks. The final section concludes.

II. BACKGROUND

There are a number of hypotheses suggesting that family size and birth order might affect educational investments, even apart from income effects. For a given level of parental income, family size is likely to reduce the per capita resources that can be spent on educational investments. But the shares of family resources that each child will receive are likely to differ across birth order for a number of reasons. First, given that parents have a fixed time endowment, the first born will receive a greater time endowment than subsequent children who have to compete for parental attention. To the extent that greater parental time inputs translate into higher educational achievement, first born children may fare better than subsequent children. However this argument also serves to emphasise the role of gaps between children; if children are widely spaced, then the last born child might benefit more as older children leave the family nest or through the expansion of time

[3] Iacavou (2001) included dummy variables for the younger of 2 kids, the middle of 3 kids, the younger of 3 kids, the middle of 4 kids, the youngest of 4 kids, the middle of 5 kids, the youngest of 5 kids, the middle of 6+ kids, and the youngest of 6+ kids.

inputs as both parents and older siblings spend time with the last born child (Behrman and Taubman, 1986; Birdsall, 1991; Hanushek, 1992).

Life cycle effects can also matter. If parents are young at first birth they may also be poorer than they will be later in the life cycle, and hence resources might be lower for first born children of young – and possibly immature – parents. Hence younger siblings might benefit through the growth of family income over the life cycle (Parish and Willis, 1993).

Other factors can also work in both directions. If older children are expected to assume more responsibility in assisting with younger siblings, this training may lead them to perform more responsibly at school and become higher achievers. On the other hand, older siblings may be encouraged to leave school early to assist in providing resources for the family, giving an advantage to later birth order siblings with respect to educational attainment.

Biological factors may also matter. By definition, mothers having higher birth order children are older than when they have lower birth order children. To the extent that older mothers have lower birth weight children and birth weight is correlated with ability and/or access to resources, then later children may fare worse.[4] But on the other hand parents may learn with practice and experience, and hence later children might be advantaged relative to earlier ones. Finally cultural and legal factors may also play a part. If there is land or an estate to be passed on and inheritance customs favour the first born, parents may choose to invest more in the formal education of subsequent children to compensate.[5]

In summary, we would *a priori* expect family size to have a negative effect on educational attainment, as found in the bulk of the literature. *A priori* birth order might have a positive or a negative effect, depending on the degree to which the various

---

[4] There is clearly a need to disentangle birth order effects from parental cohort effects. Some mothers have their first born when they are teenagers whereas others have their first birth in their late thirties. As we discuss later, these maternal age differences might translate into different inputs of time, energy and experience, which may affect children's educational attainment quite distinctly from birth order effects.

[5] Ejrnaes and Portner (2004) hypothesise that parental fertility choices induce a birth order effect quite separate from the above hypotheses, owing to an optimal stopping calculus based on heterogeneity in degrees of parental inequality aversion.

influences outlined above affect children who are otherwise similar. Ultimately it is an empirical question as to which dominates. We might also expect birth order effects on education to vary across countries depending on their stages of development, their patterns of birth spacing and fertility, and their inheritance practices.[6] And our analysis does indeed suggest that British family size and birth order effects on education are different from those found in Norway by Black et al (2005).[7]

III. THE DATA AND VARIABLES

Our data source is wave 13 of the British Household Panel Survey (BHPS), conducted in 2003-4. The BHPS is a nationally representative random-sample survey of private households in Britain. Although limited information on family background was collected in earlier waves, the questionnaire was expanded in the 13th wave to elicit additional information about family and parental background, and the childhood home. Of particular interest are the new variables about sibling numbers and birth order. We use these to investigate the degree to which family size and birth order within the family affect an individual's subsequent educational attainment.[8] Other family background variables allow us to control for family-level heterogeneity.

Highest educational qualifications

The BHPS reports each individual's highest educational qualification and not years of education. The dependent variable for most of our analysis is an indicator comprising six

---

[6] Capital market imperfections may affect family resources devoted to education. In Britain primary and secondary schooling is paid for by the state and a grants and loans system is in place for higher education (although not further education). British children are thus more likely to become independent from their parents and their educational choices might be less constrained by parental resources and birth order than in developing countries without such a long-established system of subsidized education.

[7] Bjorklund et al. (2004) find, using administrative data, separate effects of birth order and family size on young adults' *earnings* in Norway, Finland and Sweden.

[8] These variables are retrospective and with retrospective data there are always issues about potential recall error. However, the variables in which we are interested relate to attributes that are unlikely to be forgotten; it is hard to imagine that anyone within our sample of interest – 28-55 year olds – would be likely to forget the number of siblings or their own birth order.

ordered categories, ranging from highest educational level to the lowest. The proportions of our estimating sub-sample falling into each group are given in Table 1(a).[9] We also imputed average years of schooling for each highest educational qualification and use the log of this as the dependent variable when undertaking some robustness checks of our main results. Appendix A provides a brief summary of the British educational system. School is compulsory between the ages of 5 and 16 and is free. Schooling beyond that can continue for two more years in secondary schools, or be more vocationally based in the further education sector, or can – beyond the age of 18 – take place in universities.

Family Size and Birth Order

Respondents in wave 13 were asked (question D108): "How many brothers and sisters have you ever had?" This was immediately followed by the question: "So including yourself, there were (D108+1) children in your family?" We used this information to construct a variable for the total number of children in the family. The next question asked "Where were you born in relation to your brother(s) and sister(s), that is, were you the first, second, third or subsequent child?" There followed a list of up to 10 possibilities, with the 10th top-coded as "tenth (or later)."[10]

Table 1(b) cross-tabulates family size by birth order. For the moment, we combine first-born and only children into the one category, although later we disaggregate them. Each cell of Table 1(b) reports the birth-order means for respondents in each family size. The second row shows that our sample comprises 2267 respondents from 2-child families, and approximately half of these are first born and half are last born. The third row shows

---

[9] The highest educational attainment measure is ordered as follows: (1) No defined qualification; (2) Vocational or low-level academic qualification(s) (eg. commercial or clerical qualifications, CSE grades 2-5, apprenticeship); (3) One or more Ordinary level or equivalent qualifications taken at age 16 at end of compulsory schooling (and forming the selection mechanism into Advanced-level courses); (4) One or more Advanced level qualifications (or equivalent) representing university entrance-level qualification typically taken at age 18; (5) Teaching, nursing or other higher qualifications (eg. technical, professional qualifications); (6) University first or higher degree.

[10] Unfortunately the BHPS does not provide information about the gaps between siblings.

that, of those 1890 respondents from 3-child families, 35.6% are first born, 32.9% are second born, and 31.5% are last born. The table also reveals that, for larger families in our sample, there are relatively few observations. Moreover there are obviously a greater number of birth order categories within each of the larger family sizes; consequently cell sizes for birth order are quite small in the larger families. For example, consider the 133 respondents from 8-child families, shown in the eighth row of the table. The smallest cell size in this row is for the fifth-born, for whom we have just 12 observations (0.09x133). The largest cell size – for the seventh-born – comprises 23 cases. For respondents from 9-child families, we have 94 observations, and the smallest cell size in this row is for the fourth-born, representing 5.3% of individuals from 9-child families and comprising 5 cases. The largest cell size is for the 6th born, comprising 16 cases. The last row of the table gives the distribution of the 170 individuals from families of ten or more children across birth order. Here the smallest cell size is for the third born (5 cases).

The fact that cell sizes across birth order categories are relatively small for some of our larger families suggests that it is important to find a parsimonious way of representing the data. To this end, in Section IV.1 we convert responses to the birth order question into a birth order index.[11] This index not only parsimoniously represents the data but also has the advantage of reducing almost to zero the correlation between family size and birth order.

Heterogeneity across Families

Since the wave 13 data are cross-sectional, albeit with a longitudinal element, we do not use panel techniques. But wave 13 of the BHPS does provide unique information about family attributes that allows us to control for family-specific heterogeneity. The presence

[11] Black *et al.* (2005) had the entire Norwegian population in their data set and were therefore able to estimate the effects of birth order separately for each family size. We are unable to do this across all birth orders owing to very small cell sizes, as illustrated in Table 1(b). However, as reported later in this paper, we did experiment with this form of specification up to birth order of seven and above.

of books in the parental home when the respondent was a child forms a proxy for family-specific attitudes to education. Households with many books are likely to have a more positive attitude to learning through the written word than are households with few or no books.[12] We proxy parental wealth by dummy variables taking the value one if the mother had a university degree or a teaching, nursing or other higher qualifications, and zero otherwise, and likewise for the father. We also use a dummy variable indicating whether or not the mother worked when the respondent was aged 14 as a proxy for available maternal time and parental wealth. Area-specific factors are captured by a set of variables indicating the type of area in which the family mostly lived when the respondent was a child.[13]

Section II summarised hypotheses advanced in the literature suggesting that parental age at first birth matters for children's educational attainment. Children born to younger parents – controlling for family income, family size and birth order - might have different educational opportunities. On the one hand, younger parents may be less patient, less experienced, and less willing to give up career or social concerns to spend the time with children that might develop their learning potential. But on the other hand, younger parents might not only have higher birth weight children but also have more energy and a greater willingness to spend quality time with their children, time that might enhance their learning. The 13th wave of the BHPS asks about the age of each of the parents when the child was born. Thus we are able to include age cohort dummies for each parent.

---

[12] Respondents were asked: "Thinking about the time from when you were a baby until the age of ten, which of the following statements best describes your family home: There were a lot of books in the house; There were quite a few books in the house; There were not very many books in the house; Don't know." We constructed dummy variables for "a lot of books in the house" and "quite a few books in the house". The base in the regressions is "not many books in the house".

[13] The precise question about area of residence was: "Please look at this card and tell me which best describes the type of area you mostly lived in from when you were a baby to 15 years." Responses are described in Appendix Table A.1. The base for the regressions is "lived in a suburban area".

Estimating Subsample

Our estimating sub-sample consists of 7,510 individuals (3,435 men and 4,075 women) aged between 28 and 55 years, and with valid information on the three main variables (education, family size and birth order). We excluded from the sample individuals aged less than 28 in order to ensure that respondents had completed their education. We also dropped seven cases whose mothers were still potentially fertile at the interview date, in order to ensure that birth order was complete from the mother's perspective.[14]

Table 1(a) gives the means of the variables used in our analysis, with a brief description of each. Thus of our estimating sample, 21.1% are between the ages of 28 and 33, 24.2% are 34 to 39, 23% are 40 to 45, 15.9% are 46 to 50, and 15.7% are between 51 and 55 years old. The sample is 54.3% female, 18% has a degree or above, and the average number of years of education is 13. The mean number of children is 3.45 and the standard deviation is 1.95. First born children account for 31.7% of the sample, second born 29.8%, third born 15.4%, fourth born 6.8%, fifth born 3.5% and the remainder are as shown in the table. Note that the first born comprise 1,130 men and 1,251 women and thus males outnumber females in this group.

Table 2 cross-tabulates the number of children (including the respondent) by the respondent's highest educational qualification, while Table 3 cross-tabulates the child's birth order by the respondent's highest educational qualification. The figures in parentheses in the tables give the column percentages. The mean family size (including the respondent) is 3.45 while median family size (including the respondent) is two children. The mean educational level is one or more O levels, while the median educational level is 'other higher qualification'.

[14] These seven cases were individuals whose mothers were aged less than 45 at the interview date. Of course there might still be subsequent births of half brothers and sisters if the father has re-partnered, but we cannot do anything about this possibility. However we do control for parental birth cohorts in addition to child cohorts. This is potentially important since – controlling for child cohort - the parents of first-born children are likely to be younger than parents of third or fourth born.

The first column of Table 2 shows educational attainment in one-child families, and reveals that just under 10% of children from one-child families had no qualification, 10% had Vocational or low-level academic qualification(s); 21% had one or more O-levels; 10% had one or more A-levels; just over 37% had other higher qualifications, and 16% have degree or above. The second column shows highest educational achievement in two child families, the median family type for our sample. This family type has the largest percentage – 24% - of any family type with a degree or above, followed by 19% for the three-child family (compared with 16% for the one child family).

There are two main points to draw from inspection of the cross-tabulations in Table 2. First, larger families are relatively rare in Britain. Second, education achievement is typically declining in family size. In sum, Table 2 suggests a tradeoff to "quality" as measured by education achievement and quantity as measured by family size, as first suggested by Becker (1960). It remains to be seen in subsequent sections of this paper if this remains the case after controlling for other important education-enhancing variables.

Table 3 cross-tabulates the child's birth order by the respondent's highest educational qualification. It shows that 16% of only children have a degree or above, compared with 23% of the first born.

Tables 4 and 5 present respondent's parents educational qualification by total number of children (including respondent) in the family. By comparing Table 4 to Table 5, notice that respondent's fathers are better educated than mothers. Furthermore, Tables 4 and 5 suggest that highly educated parents tend to have lower fertility. For example, of children from 4-child families, some 46% have fathers who left school with no qualifications while 61% had mothers leaving school with no qualifications. In contrast, of children from 2-child families, only 34% have fathers who left school with no qualifications while 38% had mothers leaving school with no qualifications.

IV. THE ESTIMATES

IV.1. Specifying a Birth Order Index

A challenge in estimation of birth order and family size effects is that birth order is related to family size. The first born in any family always has a higher probability of being in a small family than those children born later in the birth order. And conversely, the last born has a higher probability of being in a large family than the first born. Indeed, in the BHPS data, the simple correlation coefficient between family size and birth order is 0.7047. Although studies estimating separate birth order and family size effects typically include dummy variables for birth order and a separate continuous variable for family size, this does not completely purge the family size effect from the birth order effect. Below we put forward a simple specification of a birth order index that improves on most of the methods used in the literature to date, and which we subsequently utilize in our estimation. By construction, our index effectively purges family size from birth order and consequently the simple correlation coefficient between family size and the birth order *index* is just 0.0697. This compares very favourably with the high correlation between family size and birth order of 0.7047.

Suppose W denotes total family resources available for investment in all the siblings' education, N is total number of siblings in the respondent's family including the respondent, ϕ is the absolute birth order of the respondent and A denotes average birth order in each family.[15] Thus the absolute birth order variable ϕ takes the value 1 for the first born, 2 for the 2nd born, and so on, up to a top value of 10 for the 10th born and above. "Only" children are assigned the same birth order as first born children. Average birth

[15] It is well known that the children of wealthy parents receive more and better quality schooling than children of poorer families, and that the family environment is also important (see *inter alia* the survey by Bowles and Gintis, 2002, and references therein). Our goal here is additionally to look at *intra-family* differences while controlling for family wealth and the family environment. These factors are encapsulated in W.

order A is calculated as $(N+1)/2$ and is clearly increasing in family size and bounded between 1 and 5.5.[16]

If siblings were assigned equal shares in the family's educational resources (which might be both psychological and pecuniary), then the amount available for each sibling's education would be W/N. However, as noted earlier, there are a number of arguments in the literature suggesting that equal shares are unlikely. For this reason we wish to introduce a *birth order index* to capture the fact that resources assigned to siblings of different birth order may be different. Let B denote this index, where $B=\phi/A$; that is, B is the ratio of the respondent's birth order to the average birth order of her family and for our data $B \in (0.18, \quad 1.82)$.[17] Importantly, notice that, by construction, the within-family mean of B=1 is the same across all family types. Thus B=1 represents both the within-family and across family mean. Deflating birth order ϕ by average birth order within the family A ensures that our constructed birth order index B is independent of family size.

Let an individual's educational level be denoted as E. Suppose that a child's education is affected by per-sibling family resources (W_k / N_k) weighted by the birth order index B_i^{β} determining the share given to each child, such that

$$E_i = \left[(W_{ik} / N_{ik}) B_i^{\beta}\right]^{\alpha} \qquad (1)$$

where the subscript k denotes the *k-th* family, $k=1,\dots,K$ and the subscript i denotes the individual child, $i=1,\dots,N$. Notice that this specification nests within it the possibility of equal shares since, if $\beta = 0$, $E_i = (W_{ik} / N_{ik})^{\alpha}$ and resources are shared equally between siblings regardless of birth order. However if $\beta < 0$, the first born sibling will receive a

[16] For a one-child family, average birth order A = 1, for a 2-child family, A = 1.5, for a 3-child family A = (3+1)/2=2, and so on, up to a total value for the 10-child family of A = (10+1)/2=5.5.

[17] To illustrate, consider four family types: 1-child, 2-child, 3-child and 10-child. For the only child from a one-child family, B_{11}=1, where the first subscript denotes birth order and the second family size. Now consider the first born child from a 2-child family. Her index is B_{12}=1/1.5=0.666. For the 2nd born child, B_{22}=2/1.5=1.333. Next, take a 3-child family. The first born has B_{13}= 0.5, the 2nd born has B_{23}=1 , while the 3rd born has B_{33}=3/2=1.5. Finally, consider a 10-child family. Here the first born has $B_{1,10}$ = 1/(5.5)=0.182, the 2nd born has $B_{2,10}$=2/(5.5)= 0.364, the 3rd born has $B_{3,10}$=3/(5.5)= 0.545, the 9th born has $B_{9,10}$=9/(5.5)=1.636, while the 10th born has $B_{10,10}$=10/(5.5)=1.818.

greater share than subsequent children, while if $\beta > 0$, the last born sibling will receive a greater share than earlier children. Of course, this specification does impose the restriction that the sharing rule is monotonic.[18] Below we relax this restriction and allow the sharing rule to be non-monotonic.

Taking natural logs of the right hand side of (1) we obtain

$$\alpha \; ln(W_i/N_i) + \alpha\beta \; ln\, B_i$$

Since we do not have a measure of family wealth when the respondent was living at home, we instead use whether or not the father and mother each had a degree as a proxy for family wealth, and also whether or not the mother was in work when the child was 14 as well as other family background variables. So our estimating specification will be

$$ln\, E_i = x_i'\beta + \alpha n_i + \alpha\beta b_i + \varepsilon_i \qquad (2)$$

where included in the *x* vector are the demographics (age cohorts, gender dummy, ethnic background dummies) plus family resources variables, and note that $n=lnN$ and $b=lnB$.[19] The sign of α is expected to be negative and the sign of β will be revealed by the data and will tell us whether shares are larger for children born earlier or later in the birth ordering. We estimate two broad variants of (2) - first an ordered probit of highest educational attainment, and second, OLS estimates of the natural logarithm of years of education.

Appendix B reports the predicted and actual means and variances of *B*, broken down by the ten family size categories. The actual means from our data are all very close to one. Since estimation of the average birth order effect purged of family size relies on the fact that the average value of *B* is one, this is reassuring. Appendix B shows that the

---

[18] For example in a 3-children family with $\beta<0$, the first born will receive the biggest share, the 2nd born the 2nd biggest share, and the 3rd born the smallest share. If $\beta>0$, the ordering is reversed.

[19] This is analogous to fixed effects estimation, in that the birth order effect is estimated as deviations from the within-family-size mean of unity. Thus in, for example, a 10-child family, half of the observations will be above the mean and half below the mean. Deviations from the mean yield the birth order effect.

actual variances for each size of family are typically slightly less than the predicted variances.

It is possible that the 'sharing rule' described above is non-monotonic, and in this case estimation of a functional form such as that implied by (1) may be inappropriate. To test for this, we also wish to estimate a more flexible functional form. We do this by dropping from our estimating subsample all those children who are from an only child family. We then include, instead of the birth order index *lnB*, two dummy variables, which we denote by D_1 and D_2. The first, D_1, takes the value one for all individuals whose birth order index *B*<0.8 and zero otherwise. The second dummy, D_2, takes the value one for all individuals whose birth order index *B*>1.2, and zero otherwise. Thus the base group is the middle child in an odd-numbered family and the two middle children in an even-numbered family (except for the 2-child family in which there is no child in the base group). A simple test of the monotonic specification is that γ_1 and γ_2 in the following equation are of opposite sign:

$$\ln E_i = x_i'\beta + \alpha n_i + \gamma_1 D_1 + \gamma_2 D_{2i} + \varepsilon_i \qquad (3)$$

IV.2. The Initial Estimates

Table 6 presents estimated coefficients from an ordered probit of educational attainment, where the dependent variable is categorical (1 denotes the lowest educational category and 6 denotes the highest). The means for each level of education are given in Table 1(a). We present four specifications in Table 6. Specification [1] does not include any family composition variables, while Specification [2] adds in the natural log of family size.[20] Specification [3] estimates equation (2) above, and thus includes both family size and the birth order index. Specification [4] re-estimates [3] over a sub-sample excluding

[20] We also estimated all of our specifications replacing the natural log of family size by family size, and found it made little difference to our results. Since the natural log relates more clearly to the model of equation (2), we report these results in the text. The others are available on request.

respondents from only-child families. All four specifications include dummy variables for the child's age cohort (with the base being 28-33 years old), female, parental family resources (father had a degree; mother had a degree, whether or not mother worked when child was aged 14) and eight additional dummy variables representing the ages of the mother and father respectively at the child's birth. Also included is a set of variables picking up family level attributes (presence of books when the child was young and area of the parental home).[21]

Some mothers have their first born when they are teenagers whereas others have their first birth in their late thirties. These maternal age differences might translate into different inputs of time, energy and experience, which may affect children's educational attainment quite distinctly from birth order effects. The inclusion of parental age cohorts at child's birth allows us to investigate this issue. We find in Specification [1] in Table 6 that these parental age cohort variables are individually[22] and jointly statistically significant. Relative to the base group of mothers or fathers aged less than 21 at the child's birth, children whose parents were older at their birth have increasingly higher levels of educational attainment.

The estimates show that the child's educational attainment is declining with age. The fact that younger cohorts have higher educational attainment is expected, owing to the relatively recent expansion of education in Britain. Note that the cohort effects are also likely to capture some family size effects if families in Britain have become smaller over time. But the age cohorts should not affect the coefficient on the birth order index, since the mean value of this index will not be correlated with cohort (its mean is always 1).

---

[21] We also experimented with including a dummy variable taking the value one if the child lived with both biological parents from birth to age 16. Since this was insignificantly different from zero, we dropped this from our reported models in Tables 6 and 7. Children who grew up with both parents are no different in terms of educational attainment from those who did not, for our sample of British children.

[22] The only exception is the dummy variable for mother aged between 21-25 years old at the respondent's birth.

Specification [1] also shows that the child's educational attainment is lower if the child is female, and is increasing in the parents' educational level, especially so if the mother had a degree. Educational attainment is increasing with the presence of books in the parental home (the base is not many books in the house when the child was between zero and 10), and is declining if the child did not live in suburbia (this probably proxies parental wealth).[23] Furthermore, respondents from a non-white ethnic group have higher education attainment, and this is highly statistically significant.

Specification [2] augments Specification [1] with the inclusion of the log of family size. The estimates show that, as expected, a child's educational attainment is declining in family size. The estimated coefficient is -0.316 (t-statistic 13.03). Specification [3] replicates Specification [2] but with the addition of the log of birth order index. The estimated coefficient to family size is now -0.332 (t-statistic 13.63) and the coefficient to birth order is -0.233 (t-statistic –7.56). As discussed below equation (1), the statistically significant negative coefficient to the latter suggests that lower birth order children receive a greater share of family resources than higher birth order siblings. The fact that we cannot accept the hypothesis that $\beta = 0$ suggests that family resources are not shared equally across all siblings. The coefficient to family size is very similar to that found in Specification [2].

Respondents from single-child families are included in estimation of Specifications [1] to Specification [3]. However it might be argued that our variables of interest affect educational outcomes differently for children from single-child families compared with

[23] In order to avoid throwing out cases with missing information on family background variables, we constructed dummy variables for missing information for each relevant variable. It is possible, eg, that children whose mother had a low level qualification might be less likely to know what it was, and we control for this. Thus, for the maternal highest educational qualification, the respondent was first asked if they knew their mother's qualification. If they did not, we included a dummy reflecting this. The respondent was then – conditional on knowing their mother's qualification – asked what it was. We therefore constructed another dummy for this. We do not however report the coefficients to these missing information variables in the tables, in the interests of space. Note that all the variables for parental qualifications and numbers of books in the house are conditional on reporting information, and the coefficients should be interpreted in line with this. There is, however, no missing information for area of childhood home.
.

those from multiple children families. To examine this issue we exclude respondents from a single-child family in Specification [4]. The sample size reduces from 7,510 to 6,918. Notice that after the exclusion of single-child respondent the family size effect becomes larger, as expected. The coefficient of the log of family size is now –0.474 (t-statistic 15.12). In addition, we find that the coefficient to the log of birth order index remains unchanged compared to Specification [3]. This supports our finding that lower birth order children receive a greater share of family resources than higher birth order siblings; the inclusion of single-child families in our sample does not alter the estimates.

The coefficients of the ordered probit model cannot be translated directly. To facilitate interpretation, predicted probabilities of individual's education outcome and marginal effects are reported in Table 7. This table – based on Specification [4] that excludes only-child families - compares the differences in predicted educational outcomes of being the middle child and first born in the family. Our model predicts that a middle child has a 14.75% probability of obtaining 'undefined' qualifications, and an 11.62% probability of obtaining a 'degree or above' qualification. In contrast, being first born in the family is associated with a 10.90% probability of obtaining an 'undefined' qualification, and a 15.62% probability of obtaining a degree or higher qualification, as compared to the middle child. Marginal effects from Specification [3] are reported in Table 8, which shows the marginal effect of having parents with higher education, parental age when respondent was born, living area during respondent's childhood, gender and ethnic group on respondent's education outcome. *Ceteris paribus*, having older – or more educated parents – increases the educational attainment, as does being male, non-white, and being brought up in suburbia.

In summary, our results suggest that birth order matters. But so too does family size, in contrast to the results of Black *et al* (2005). It is also interesting that a child whose mother was in work when the child was aged 14 has significantly higher educational attainment, as do the two variables for the highest level of mother's and father's education. These variables are likely to pick up family wealth effects but probably also reflect family-level effects, such a supportive background for education. But the biggest single determinant of children's educational attainment remains our proxy for family fixed effects – the presence of many books in the household when the child was aged between zero and 10 years. In the next section we report the results from a number of extensions to the basic models.

IV.3. Checking for Non-monotonicity

In this section, we conduct a monotonic specification test as discussed in Section IV.1. Results are presented in Table 9. Recall that $\gamma_1 > 0$ implies children with a relatively lower birth order in their family receive a larger share; whereas $\gamma_2 < 0$ implies children with a relatively higher birth order in their family receive a smaller share of resources. The base group is the middle child in an odd-numbered family and the two middle children in an even-numbered family (but for the 2-child family there is no child in the base group). Our estimating subsample excludes single-child families and thus comprises 6,918 cases.

Our estimates show that $\hat{\gamma}_1$ = 0.106 (t-statistic 2.81); while $\hat{\gamma}_2$ = –0.113 (t-statistic 2.99), and these are both statistically significant at the 1% level. In other words, we cannot accept the null hypothesis that the sharing rule is non-monotonic. The results imply that, not only are available educational resources not shared equally among children within a family, but that first born and elder children tend to receive greater share of resources compared to their subsequent siblings in the family. Consequently, we find statistical evidence from our sample that respondents with lower birth order achieve better education attainment.[24]

[24] We also experimented with estimating this model using the entire sample of 7,510 cases. Here the children from only-child families are include in the base group (since their birth order index takes the value 1). The estimates from this specification were that $\gamma_1 > 0$ but that γ_2 is insignificantly different from zero.

V. ROBUSTNESS CHECKS

V.1. Years of Education as the Dependent Variable

We now replace the ordered dependent variable with the natural logarithm of years of education and replicate, using ordinary least squares (OLS), all four specifications reported in Table 6. These results are reported in Table 10 as Specifications [1a] to [4a]. Our preferred specifications are, as for the ordered probit models, Specifications [3] and [4a].

The estimates show that years of education are significantly lower for children in the age group 51-55 than in the younger age groups, are lower for women than for men, and are higher for people of non-white ethnic background. Years of education are significantly increasing in the parents' educational level (especially so if the mother had a degree), with the presence of many books in the parental home, and if the child's family moved around, and are declining if the child did not live in suburbia (suburbia is the base). Importantly, years of education of the child are significantly declining in family size, and lower birth order children receive a greater share of family resources than do higher birth order siblings. Thus the results are consistent with those reported in the previous section.

V.2. Other Extensions

We next return to our ordered probit model of highest educational attainment and estimate a number of extensions. The results are presented in Table 11. Specification [3] is repeated for ease of comparison.

This was the case regardless of how we specified family size (ie as logarithm, linear or inverse). These results suggest that 'only children' may do worse than the first or high born in multi-children families, a result that Iacavou (2001) also found. This could arise if sibling input matters. But if so, it matters asymmetrically across family members.

Gender

First, we test the hypothesis that there are significant gender differences for men and women by interacting all of our variables with female. The results are reported in the second column of Table 11 as Specification [5]. Only a few of the interactions are individually statistically significant, although they are jointly statistically significant as a group. A comparison of Specification [3] with Specification [5] reveals that the coefficient of the log of family size remains virtually unchanged and is still statistically significant. However, the negative effect of birth order has reduced to –0.175 (t-statistic 3.87) in Specification [5]. The negative coefficient of the interaction term suggests that higher birth order disadvantages females' educational attainment more than males. This also implies that birth order is a more important factor in explaining females' educational outcomes, although this is not statistically significant individually.

Non-white

We next experiment with including interactions of the dummy variable for non-white. Only 2.6 % of the sample is non-white, as Table 1(a) shows. They are a very heterogeneous group, but the cell sizes when we disaggregate this variable into its component ethnic groups are too small for us to include as separate variables. We initially experimented with interacting non-white with all of the explanatory variables, but the interactions were neither individually nor jointly statistically significant. We then included non-white as a single explanatory variable, and found that it significantly increased the probability of higher educational attainment, as reported earlier in Tables 6 and 9. But this had no effect on the magnitude of the family composition variables: family size and birth order remain statistically significant and negative.

Lived with both biological parents from birth to age 16

We now test the hypothesis that family size and birth order effects might differ might for children being brought up in a 'normal' family home (where both natural parents are present at least until the child was aged 16) as compared with the base group of the rest.[25] It is possible that children from very small families are more likely to be from broken homes, and children with separated parents might have lower educational attainment. We investigated this hypothesis, as reported in Specifications [6] and [7] of Table 11. This 'family normal' group represents 82% of the sample, as shown in Table 1(a). Specification [6] presents the estimates of educational attainment when we include a dummy variable taking the value one when the child grew up with both biological parents and zero otherwise. The estimated coefficient is positive but not statistically significant, and its inclusion has little appreciable impact on our estimated family size and birth order effects. Finally, we interact 'family normal' with all the explanatory variables, and the results for our variables of interest are shown in Specification [7]. We find that these interactions are neither jointly nor individually significant, and our family size and birth order effects have a slightly less negative effect on education outcomes as compared to Specification [3].

Working mother

We next experiment with interacting all our explanatory variables with whether or not the child's mother was working when the child was aged 14. Table 1(a) shows that 56% of our sample had mothers in this category. Working mothers may be less financially constrained than non-working mothers - but on other hand maternal input into child 'quality' may be lower. These results are reported in Table 11 as Specification [8]. Again we find that the inclusion of additional interaction terms does not make much differences to the magnitude, sign and statistical significance of the family composition variables

[25] The question takes the form: "Did you live with BOTH your biological mother AND biological father from the time you were born until you were 16?"

family size and birth order. The positive coefficient of the interaction of family size suggests that respondents from larger families are less disadvantaged if their mother has been working. Nevertheless most of the interaction terms are statistically insignificant individually (although they are significant as a group). We find that working mothers affect children's educational outcome positively. This finding is perhaps driven by the less binding financial constraints of families with two income sources.[26]

Mother with higher education or further education qualification

Mothers with higher educational qualifications might give their children's educational attainment greater attention and priority. Following Specification [8], we also test the hypothesis that more educated mothers might affect children's educational outcomes differently. The estimates are presented in Specification [9] in Table 11. From Table 1(a), 19.7% respondent reported their mother as having higher education or further education qualifications. As found with all the other interaction models, the inclusion of mother's education interaction terms does not alter the sign, magnitude and significance of the family size and birth order variables. Again most of the interaction terms are not statistically significantly, but they are significant as a group. We conclude that mothers with higher education are likely to influence their children's educational attainment positively.

Black et al. specification

We next estimated a model including a set of explanatory variables similar to those found in Black *et al* (2005: Table 4b) as a comparison. The estimates are presented in Table 12 as Specification [10]. Estimates from the Black *et al* model are also listed for convenience, but note that they report SEs in parentheses. In contrast to Black *et al.* (2005), our estimates in Specification [10] show that the British family size effect does not vanish

[26] The simple correlation coefficient between mother working and mother with a degree is quite low, at 0.1206.

even after we control for birth order using their procedure. Our family size variable has a much bigger negative effect on children's educational outcomes compared to Black *et al.*'s estimates, a coefficient of –0.122 (t-statistic 7.22). In addition, birth order dummy variables in Black *et al*'s model become systematically more negative as we move towards higher birth order ranking. We find only four out of nine birth order dummy variables are statistically significant in Specification [10]. Furthermore, while our birth order dummy variables do become more negative at higher birth order, the effect is not systematic.

Estimating the birth order effects separately by family size

As a final robustness check, we estimated the birth order effect by running separate regressions for each family size, which Black et al. (2005) also did using their Norwegian data. We experimented with including as controls (i) dummy variables for each level of birth order, and then separately (ii) including as a control the birth order index. For case (i) there are extremely small cell sizes for the larger families, as we highlighted in discussion of Table 1(b) in Section III above. We therefore top-coded family size at seven or more children in the family. The mean of this new family size dummy variable is 0.027. For case (i), we omit from the sample only-child families, and the base or omitted birth order category for each of the six regressions is first born. The estimates are presented in Table 13. For respondents from families ranging between two and four children, the birth order effect is similar to that found in our earlier estimation: children who are of higher birth order receive significantly less education than their older siblings. For children from larger families (five of more children), the birth order effect is always negative, with the exception of 2^{nd} born children from families of six or more children. However, these effects are typically not statistically significantly, possibly owing to the small cell sizes involved in estimation.

For the six separate regressions for case (ii) - in the bottom panel of Table 13 - we estimate the birth order effect from deviations from the mean, using the birth order index. Once more the estimated coefficient to the birth order index is always negative, although for respondents from five and six-child families the coefficient is not statistically significant.

V.3 Summary of Our Main Results

In summary, our results show that, *ceteris paribus*, educational attainment is declining in family size and in birth order.[27] In terms of our model specification, higher birth order children receive a lower share of family resources in the form of educational attainment. These results were found for both our measures of educational attainment: highest level of qualification and years of schooling. The first finding, of the negative effect of family size, might be viewed as reinforcing the child quality-quantity approach. Parents trade off higher 'quality', as proxied by educational outcomes, against greater numbers of children. For a given level of parental income, family size is likely to reduce the per capita resources that can be spent on educational investments.

The second finding – that educational attainment is declining in birth order – could arise for a number of reasons. In Section II we noted some candidate hypotheses about the impact of birth order, some of which are expected to have a negative effect and some a positive effect on children who are otherwise identical. Those predicting *negative* effects relate to greater parental time endowments for lower birth order children; greater devolvement of responsibility to lower birth order children; and the simple fact that mothers are older when they have higher than lower birth order children. Those hypotheses predicting *positive* effects of birth order on education are: the growth of family income over the life cycle; the possibility that older siblings may be encouraged to leave

---

[27] Iacovou (2001) also found, using British data from a 1958 birth cohort, that children from larger families have lower levels of educational attainment at ages 7 to age 23, and that there is an additional negative birth order effect.

school early to assist in providing resources for the younger members of the family; parental child-raising experience that might advantage younger siblings; and finally the possibility that younger children may benefit from time inputs both from parents and older siblings. Our data suggest that it is the negative effects that dominate in Britain.

VI. CONCLUSIONS

We used unique retrospective family background data from wave 13 of the British Household Panel Survey to explore the degree to which family size and birth order affect a child's subsequent educational attainment. There are a number of arguments in the literature suggesting that siblings are unlikely to receive equal shares of the resources devoted by parents to their children's education. We constructed a composite birth order index that effectively purges family size from birth order and used this to test whether or not siblings are assigned equal shares in the family's educational resources.[28] We found that sibling shares are decreasing with birth order. Controlling for parental family income, parental age at birth and family level attributes, we found that children from larger families have lower levels of education and that there is an additional negative birth order effect. In contrast to Black, Devereux and Salvanes (2005), our family size effect did not vanish once we control for birth order. Our findings were robust to a number of specification checks.

Although fertility is an important research area - especially so given the recent plethora of reports and papers suggesting a coming 'generational storm' following declining fertility rates - modeling it is beyond the scope of this paper.[29] Nonetheless our results do have some relevance in this regard, since they show unambiguously that on

---

[28] The correlation coefficient between family size and birth order is 0.7047, while the correlation coefficient between family size and our birth order *index* is just 0.0697, as discussed in Section IV.1.

[29] Conley and Glauber (2005) employ instrumental variable estimation to control for endogenous family size, using a sex-mix instrument. We do not have this information in our data. Using 1990 US Census data for children still living in the parental home, they find that children from larger families are less likely to attend private school, more likely to be held back in school, and that there is a birth order effect.

average children from smaller families achieve higher educational qualifications. To the extent that smaller families increasingly become the norm, this may be associated with a growth in the country's stock of human capital. And high levels of parental human capital will also – as our estimates show - have an impact on the educational attainment of their children. Since it is well known that higher levels of human capital translate into higher growth rates, then lower fertility rates could well be associated with higher per capita GDP growth rates through their impact on educational attainment.

References

Becker, Gary S., (1960). "An Economic Analysis of Fertility," *Demographic and Economic Change in Developed Countries*, Gary S. Becker, (ed.) Princeton, NJ: Princeton University Press.

Becker, Gary S., and Robert J. Barro, (1988). "A Reformulation of the Economic Theory of Fertility," *Quarterly Journal of Economics*, pp. 103, 1-25.

Becker, Gary S., and H. Gregg Lewis, (1973). "On the Interaction Between the Quantity and Quality of Children," *Journal of Political Economy*, 81, S279-S288.

Becker, Gary S., and Nigel Tomes, (1976). "Child Endowments and the Quantity and Quality of Children," *Journal of Political Economy*, 84(4) Part 2, S143-S162.

Behrman, Jere R., and Paul Taubman, (1986). "Birth Order, Schooling, and Earnings," *Journal of Labor Economics*, 4(3), Part 2, S121-145.

Birdsall, Nancy. (1991). "Birth Order Effects and Time Allocation," pp. 191-213 in TP Schultz (ed) *Research in Population Economics: A Research Annual".* Greenwich: JAI Press.

Bjorklund, Anders, Tor Eriksson, Markus Jantti, Oddbjorn Raaum and Eva Osterbacka (2004). "Family Structure and Labor Market Success: The Influence of Siblings and Birth Order on the Earnings of Young Adults in Norway, Finland and Sweden". Chapter 9 in Miles Corak (ed) *Generational Income Mobility in North America and Europe.* Cambridge University Press.

Black, Sandra E, Paul J Devereux and Kjell G. Salvanes (2005). "The More the Merrier? The Effect of Family Size and Birth Order on Children's Education". *Quarterly Journal of Economics*, 120(2), May.

Conley, Dalton, (2000). "Sibling Sex Composition: Effects on Educational Attainment," *Social Science Research*, 24, pp. 441-457.

Conley, Dalton and Rebecca Glauber (2005). "Parental Educational Investment and Children's Academic Risk: Estimates of the Impact of Sibship Size and Birth Order from Exogenous Variation in Fertility". NBER Working Paper 11302, April.

Ejrnaes Mette and Claus C Portner (2004). "Birth Order and the Intrahousehold Allocation of Time and Education". *Review of Economics and Statistics. LXXXVI*(4), Nov. 1008-19.

Bowles, S and H Gintis (2002). "The Inheritance of Inequality". *Journal of Economic Perspectives*, Vol. 16(3), pp. 3-30, Summer.

Hanushek, Eric A., (1992). "The Trade-off between Child Quantity and Quality," *Journal of Political Economy*, Vol. 100, No. 1. (Feb., 1992), pp. 84-117.

Hauser, Robert M., and Hsiang-Hui Daphne Kuo, (1998). "Does the Gender Composition of Sibships affect Women's Educational Attainment?," *Journal of Human Resources*, Vol 33, pp. 644-657.

Hauser, Robert M., and William H. Sewell, (1985). "Birth Order and Educational Attainment in Full Sibships," *American Educational Research Journal*, 22, pp.1-23.

Iacovou, Maria, (2001). "Family Composition and Children's Educational Outcomes," *Working Paper of Institute for Social and Economic Research*, paper 2001-12 (PDF). Colchester: University of Essex. (June).

Kaestner, Robert, (1997). "Are Brothers Really Better? Sibling Sex Composition and Educational Attainment Revisited," *Journal of Human Resources,* 32, pp. 250-284.

Kessler, Daniel, (1991). "Birth Order, Family Size, and Achievement: Family Structure and Wage Determination," *Journal of Labor Economics*, Vol. 9, No. 4. (Oct., 1991), pp. 413-426.

Appendix A: The British Educational System

The brief summary below covers England, Wales and Northern Ireland. It was obtained from "British education system" (http://www.essex.ac.uk/ip/aclife/british.htm). Note that the system in Scotland differs slightly.

Education in Britain is compulsory between the ages of 5 and 16 (11 years of schooling). Prior to 1972, the minimum school leaving age was 15 years, and we have allowed for this when constructing our measure of years of completed schooling. At the age of 16, students wishing to continue academic study take examinations in a number of subjects in the General Certificate of Secondary Education (GCSE). Following GCSE, students take two further years of study, following between two and four subjects (usually three). The number of subjects is small and the range of disciplines followed is generally narrow. It is common for example to take either all arts-based subjects or all science-based subjects. It is less common to mix them. Each subject is studied to a high level of specialization and coursework and examinations involve a considerable amount of essay writing. At the end of this two-year period students take the examinations for the Advanced level of the General Certificate of Education ('A' levels).

Students in the United Kingdom have therefore normally completed thirteen years of full-time education before entering university. This is one year more than most US high school students have on entering a US college. Admission to universities in the United Kingdom is competitive and around 35% of the age group now normally expect to go on to higher education. Universities in Britain are autonomous bodies, empowered under their Charters or other acts of incorporation to award their own degrees. Undergraduate degrees normally take three years – one year less than most Bachelor degree schemes in the United States. Although the two systems are not completely comparable, the following table provides a useful comparison.

Comparison of the UK and US Education Systems	
UNITED STATES	**UNITED KINGDOM**
School Grades 1-12 (age 5-17)	School Grades 1-11 (age 5-16) At Age 16 GCSE School 'Sixth Form' - 2 years
University Freshman Year	A- level at age 18
Sophomore Year Junior Year Senior Year and Graduation	University 1st Year 2nd Year 3rd Year and Graduation

Appendix B: Variance of Birth Order Index *B*

It is interesting to see if the predicted means and variances of *B* for each family size are similar to what we find in the sample. The following table gives the actual mean and variances of *B* and the predicted variances, by family sizes.

	Actual Mean	Actual Variance	Predicted Variance
Family size=1	1	0	0
Family size=2	0.996	0.111	0.22
Family size=3	0.980	0.167	0.25
Family size=4	0.978	0.200	0.27
Family size=5	1.023	0.223	0.27
Family size=6	1.021	0.240	0.28
Family size=7	1.008	0.303	0.29
Family size=8	1.074	0.246	0.29
Family size=9	1.104	0.295	0.30
Family size=10	1.217	0.248	0.30

Generally, we find that the actual means and variances in our sample are very close to the predicted values. Notice also the actual variances are less than the predicted variances in most cases.

The predicted variances were calculated as follows. The general formula for variance is $\sigma^2 = \frac{\Sigma(X_i - \overline{X})^2}{N-1}$, where $\overline{X}$ is the mean and N is the number of scores.

In Section IV.1, we noted that, by construction, the mean of birth order index is $\overline{B} = 1$ across and within all family sizes. The variance of *B* can be obtained by plugging the value of *B* into the above formula. To illustrate, for example:

$$\sigma^2_{familysize=2} = \frac{(0.67-1)^2 + (1.33-1)^2}{2-1} = 0.22$$

$$\sigma^2_{familysize=3} = \frac{(0.5-1)^2 + (1-1)^2 + (1.5-1)^2}{3-1} = 0.25$$

$$\sigma^2_{familysize=4} = \frac{(0.4-1)^2 + (0.8-1)^2 + (1.2-1)^2 + (1.6-1)^2}{4-1} = 0.27$$

$$\sigma^2_{familysize=5} = \frac{(0.33-1)^2 + (0.67-1)^2 + (1-1)^2 + (1.33-1)^2 + (1.67-1)^2}{5-1} = 0.27$$

Repeat this exercise for all the family sizes (up to 10) in our sample, the rest of the variances of *B* can be summarised as follows,

$$\sigma^2_{familysize=6} = 0.28$$

$$\sigma^2_{familysize=7} = 0.29$$

$$\sigma^2_{familysize=8} = 0.29$$

$$\sigma^2_{familysize=9} = 0.30$$

$$\sigma^2_{familysize=10} = 0.30$$

Table 1(a): Variable Means and Descriptions

Variable Name	Description	Women n=4,075	Men n=3,435	Total N=7,510
Age2833	Age cohort between 28-33 years old	0.212	0.211	0.211
Age3439	Age cohort between 34-39 years old	0.249	0.235	0.242
Age4045	Age cohort between 40-45 years old	0.229	0.230	0.230
Age4650	Age cohort between 46-50 years old	0.154	0.166	0.159
Age5155	Age cohort between 51-55 years old	0.157	0.157	0.157
female	Dummy=1 if respondent is female	0.543	0.457	
edu1	no defined qualification	0.143	0.128	0.136
edu2	other qualification	0.080	0.062	0.072
edu3	O level	0.196	0.166	0.183
edu4	A level	0.112	0.122	0.117
edu5	other higher qualification	0.300	0.337	0.317
edu6	degree or above	0.168	0.185	0.176
edu_yr	Education in years	12.980	13.199	13.080
mum20	mum <20 when respondent was born	0.085	0.096	0.090
mum2125	mum between 21-25 when respondent was born	0.283	0.265	0.275
mum2630	mum between 26-30 when respondent was born	0.274	0.271	0.273
mum3140	mum between 31-40 when respondent was born	0.255	0.229	0.243
mum41up	mum >41 when respondent was born	0.025	0.021	0.023
dad20	dad <20 when respondent was born	0.027	0.036	0.031
dad2125	dad between 21-25 when respondent was born	0.178	0.171	0.175
dad2630	dad between 26-30 when respondent was born	0.279	0.279	0.279
dad3140	dad between 31-40 when respondent was born	0.332	0.299	0.317
dad41up	dad >41 when respondent was born	0.062	0.065	0.063
kidinner	Lived in inner city as child	0.096	0.107	0.101
kidsubu	Lived in a suburban area as child	0.227	0.222	0.225
kidtown	Lived in a town as a child	0.290	0.284	0.287
kidvilla	Lived in a village as a child	0.203	0.209	0.206
kidrural	Lived in a rural or country area as a child	0.133	0.131	0.132
kidmob	Moved around as a child	0.050	0.047	0.049
less_bk	D=1 if respondent had not many books during childhood	0.256	0.330	0.290
more_bk	D=1 if respondent had quite a few books during childhood	0.346	0.381	0.362
lots_bk	D=1 if respondent had lots of books during childhood	0.388	0.280	0.339
mum_deg	mother has further ed qf, degree, or further qf	0.205	0.186	0.197
dad_deg	father has further ed qf, degree, or further qf	0.351	0.334	0.343
workmum	mother working when 14 yrs old	0.571	0.552	0.562
nonwhite	ethnic group is non-white	0.024	0.027	0.026
famnorm	living with both biological parents from birth till age 16	0.815	0.825	0.820
fam size	number of children in respondent's own family, top coded at 10	3.517	3.370	3.449
firstborn	Dummy=1 if respondent is the eldest in the family	0.307	0.329	0.317
bo2	birth order is second	0.294	0.303	0.298
bo3	birth order is third	0.160	0.146	0.154
bo4	birth order is fourth	0.074	0.060	0.068
bo5	birth order is fifth	0.033	0.037	0.035
bo6	birth order is sixth	0.022	0.019	0.020
bo7	birth order is seventh	0.016	0.009	0.013
bo8	birth order is eighth	0.008	0.006	0.007
bo9	birth order is ninth	0.005	0.004	0.005
bo10	birth order is tenth	0.005	0.005	0.005
onlychild	Dummy=1 if respondent is the only child in the family	0.076	0.082	0.079

Table 1(b): Distribution of Birth Order across Family Size (age 28-55)

	Birth order										
Family size	Eldest	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth	Ninth	>=Tenth	Number of observations
Only child	1.0										592
2-children	0.506	0.494									2267
3-children	0.356	0.329	0.315								1890
4-children	0.272	0.239	0.260	0.229							1121
5-children	0.191	0.177	0.221	0.191	0.218						649
6-children	0.162	0.144	0.175	0.178	0.155	0.186					388
7-children	0.165	0.175	0.117	0.102	0.102	0.126	0.214				206
8-children	0.090	0.083	0.150	0.143	0.090	0.135	0.173	0.135			133
9-children	0.149	0.043	0.074	0.053	0.106	0.170	0.096	0.149	0.160		94
10+-children	0.059	0.053	0.029	0.076	0.100	0.118	0.118	0.124	0.118	0.206	170
Number of observations	2974	2240	1155	508	262	152	96	53	35	35	7510

Source: British Household Panel Study, Wave 13. (Row figures may not add to 1 owing to rounding.)

Table 2: Education Level by Total Number of Children in the Family (age 28-55)

	Total number of children (including the respondent) in the family, for those aged 28-55 in 2003										
Education Level	1	2	3	4	5	6	7	8	9	>=10	Total
No defined qf	55	163	186	171	139	93	65	45	33	73	1,023
	(9.3%)	(7.2%)	(9.8%)	(15.3%)	(21.4%)	(24.0%)	(31.6%)	(33.8%)	(35.1%)	(42.9%)	(13.6%)
Other qf	37	120	142	98	50	31	19	15	8	18	538
	(6.3%)	(5.3%)	(7.5%)	(8.7%)	(7.7%)	(8.0%)	(9.2%)	(11.3%)	(8.5%)	(10.6%)	(7.2%)
O Levels	126	375	336	234	131	72	32	25	14	26	1,371
	(21.3%)	(16.5%)	(17.8%)	(20.9%)	(20.2%)	(18.6%)	(15.5%)	(18.8%)	(14.9%)	(15.3%)	(18.3%)
A Levels	59	299	247	106	81	37	16	11	9	11	876
	(10.0%)	(13.2%)	(13.1%)	(9.5%)	(12.5%)	(9.5%)	(7.8%)	(8.3%)	(9.6%)	(6.5%)	(11.7%)
Other higher qf	221	772	611	358	179	108	52	24	24	32	2,381
	(37.3%)	(34.1%)	(32.3%)	(31.9%)	(27.6%)	(27.8%)	(25.2%)	(18.1%)	(25.5%)	(18.8%)	(31.7%)
Degree or above	94	538	368	154	69	47	22	13	6	10	1,321
	(15.9%)	(23.7%)	(19.5%)	(13.7%)	(10.6%)	(12.1%)	(10.7%)	(9.8%)	(6.4%)	(5.9%)	(17.6%)
Total	592	2,267	1,890	1,121	649	388	206	133	94	170	7,510

Source: British Household Panel Study, Wave 13. (Percentages may not add to 100 owing to rounding.)

Table 3: Education Level by Respondent's Birth Order (age 28-55)

	Respondent's birth order within the family, for all individuals aged 28-55 in 2003											
Education level	Only child	Eldest	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth	Ninth	Tenth	Total
No defined qf	55	237	242	200	105	51	49	36	16	12	20	1,023
	(9.3%)	(10.0%)	(10.8%)	(17.3%)	(20.7%)	(19.5%)	(32.2%)	(37.5%)	(30.2%)	(34.3%)	(57.1%)	(13.6%)
Other qf	37	162	149	86	44	24	12	10	6	6	2	538
	(6.3%)	(6.8%)	(6.7%)	(7.5%)	(8.7%)	(9.2%)	(7.9%)	(10.4%)	(11.3%)	(17.1%)	(5.7%)	(7.2%)
O Levels	126	394	407	218	115	48	24	14	15	4	6	1,371
	(21.3%)	(16.5%)	(18.2%)	(18.9%)	(22.6%)	(18.3%)	(15.8%)	(14.6%)	(28.3%)	(11.4%)	(17.1%)	(18.3%)
A Levels	59	289	279	147	54	23	13	3	2	6	1	876
	(10.0%)	(12.1%)	(12.5%)	(12.7%)	(10.6%)	(8.8%)	(8.6%)	(3.1%)	(3.8%)	(17.1%)	(2.9%)	(11.7%)
Other higher qf	221	763	738	345	135	91	45	22	10	6	5	2,381
	(37.3%)	(32.0%)	(33.0%)	(29.9%)	(26.6%)	(34.7%)	(29.6%)	(22.9%)	(18.9%)	(17.1%)	(14.3%)	(31.7%)
Degree or above	94	537	425	159	55	25	9	11	4	1	1	1,321
	(15.9%)	(22.5%)	(19.0%)	(13.8%)	(10.8%)	(9.5%)	(5.9%)	(11.5%)	(7.6%)	(2.9%)	(2.9%)	(17.6%)
Total	592	2,382	2,240	1,155	508	262	152	96	53	35	35	7,510

Source: British Household Panel Study, Wave 13. (Percentages may not add to 100 owing to rounding.)

Table 4: Father's Education Qualification by Total Children in Family

	Total number of children (including the respondent) in the family, for those aged 28-55 in 2003										
Father's educational qf	1	2	3	4	5	6	7	8	9	>=10	Total
refused	1	1									2
	(0.2%)	(0.04%)									(0.03%)
don't know	99	185	160	125	60	37	19	4	7	20	716
	(16.7%)	(8.2%)	(8.5%)	(11.2%)	(9.2%)	(9.5%)	(9.2%)	(3.0%)	(7.5%)	(11.8%)	(9.5%)
Never went to school	4	18	16	8	9	8	4		1	3	71
	(0.7%)	(0.8%)	(0.9%)	(0.7%)	(1.4%)	(2.1%)	(1.9%)	(0.0%)	(1.1%)	(1.8%)	(1.0%)
left school no quals	201	773	711	519	351	220	135	94	63	114	3,181
	(34.0%)	(34.1%)	(37.6%)	(46.3%)	(54.1%)	(56.7%)	(65.5%)	(70.7%)	(67.0%)	(67.1%)	(42.4%)
left sch w some qual	105	424	333	174	82	43	14	12	8	15	1,210
	(17.7%)	(18.7%)	(17.6%)	(15.5%)	(12.6%)	(11.1%)	(6.8%)	(9.0%)	(8.5%)	(8.8%)	(16.1%)
got further ed quals	151	703	517	241	121	70	27	21	14	17	1,882
	(25.5%)	(31.0%)	(27.4%)	(21.5%)	(18.6%)	(18.0%)	(13.1%)	(15.8%)	(14.9%)	(10.0%)	(25.1%)
got uni/higher degree	31	163	153	54	26	10	7	2	1	1	448
	(5.2%)	(7.2%)	(8.1%)	(4.8%)	(4.0%)	(2.6%)	(3.4%)	(1.5%)	(1.0%)	(0.6%)	(6.0%)
Total	592	2,267	1,890	1,121	649	388	206	133	94	170	7,510

Source: British Household Panel Study, Wave 13. (Percentages may not add to 100 owing to rounding.)

Table 5: Mother's Education Qualification by Total Children in Family

	Total number of children (including the respondent) in the family, for those aged 28-55 in 2003										
Mother's educational qf	1	2	3	4	5	6	7	8	9	>=10	Total
refused	1										1
	(0.2%)										(0.01%)
don't know	65	156	128	96	43	36	14	5	6	13	562
	(11.0%)	(6.9%)	(6.8%)	(8.6%)	(6.6%)	(9.3%)	(6.8%)	(3.8%)	(6.4%)	(7.7%)	(7.5%)
never went to school	2	15	15	7	13	8	4	2	4	3	73
	(0.3%)	(0.7%)	(0.8%)	(0.6%)	(2.0%)	(2.1%)	(1.9%)	(1.5%)	(4.3%)	(1.8%)	(1.0%)
left school no quals	269	862	803	579	399	246	147	106	66	125	3,602
	(45.4%)	(38.0%)	(42.5%)	(51.7%)	(61.5%)	(63.4%)	(71.4%)	(79.7%)	(70.2%)	(73.5%)	(48.0%)
left sch w some qual	149	717	539	273	117	55	21	10	9	16	1,906
	(25.2%)	(31.6%)	(28.5%)	(24.4%)	(18.0%)	(14.2%)	(10.2%)	(7.5%)	(9.6%)	(9.4%)	(25.4%)
got further ed quals	91	406	314	137	68	34	19	9	8	8	1,094
	(15.4%)	(17.9%)	(16.6%)	(12.2%)	(10.5%)	(8.8%)	(9.2%)	(6.8%)	(8.5%)	(4.7%)	(14.6%)
got uni/higher degree	15	111	91	29	9	9	1	1	1	5	272
	(2.5%)	(4.9%)	(4.8%)	(2.6%)	(1.4%)	(2.3%)	(0.5%)	(0.8%)	(1.1%)	(2.9%)	(3.6%)
Total	592	2,267	1,890	1,121	649	388	206	133	94	170	7,510

Source: British Household Panel Study, Wave 13. (Percentages may not add to 100 owing to rounding.)

Table 6: Specifications [1] to [4], Highest Educational Attainment
(Categorical Education Qualification as Dependent Variable)

	Spec [1]	Spec [2]	Spec [3]	Spec [4]
Demographics				
age 34-39	-0.068	-0.05	-0.05	-0.034
	(1.87)*	(-1.38)	(-1.38)	(-0.88)
age 40-45	-0.13	-0.085	-0.099	-0.073
	(3.49)***	(2.29)**	(2.64)***	(1.87)*
age 46-50	-0.122	-0.083	-0.108	-0.074
	(2.96)***	(2.00)**	(2.60)***	(1.71)*
age 51-55	-0.339	-0.32	-0.344	-0.31
	(8.02)***	(7.55)***	(8.09)***	(6.91)***
female	-0.192	-0.178	-0.176	-0.173
	(7.74)***	(7.15)***	(7.06)***	(6.67)***
nonwhite	0.433	0.506	0.491	0.509
	(5.39)***	(6.28)***	(6.10)***	(6.13)***
Family Attributes				
mum degree	0.526	0.526	0.52	0.561
	(10.27)***	(10.24)***	(9.91)***	(9.58)***
dad degree	0.286	0.317	0.306	0.255
	(8.56)***	(7.72)***	(7.60)***	(7.21)***
quite a few books	0.394	0.432	0.425	0.337
	(8.16)***	(7.09)***	(6.93)***	(6.45)***
lots of books	0.608	0.646	0.639	0.551
	(14.08)***	(12.68)***	(12.40)***	(11.67)***
kid inner	-0.199	-0.171	-0.168	-0.166
	(4.25)***	(3.65)***	(3.58)***	(3.39)***
kid town	-0.168	-0.155	-0.148	-0.143
	(4.87)***	(4.46)***	(4.28)***	(3.96)***
kid village	-0.185	-0.177	-0.17	-0.157
	(4.93)***	(4.71)***	(4.54)***	(4.00)***
kid rural	-0.225	-0.174	-0.183	-0.169
	(5.24)***	(4.03)***	(4.23)***	(3.77)***
kid mobile	0.082	0.09	0.086	0.097
	(-1.33)	(-1.45)	(-1.39)	(-1.49)
working mum	0.155	0.21	0.181	0.182
	(4.93)***	(2.45)**	(3.21)***	(2.25)**
Family Composition				
log family size		-0.316	-0.332	-0.474
		(13.03)***	(-13.63)***	(15.12)***
log birth order index			-0.233	-0.231
			(-7.56)***	(7.38)***
Parental Cohorts	Yes	Yes	Yes	Yes
Observations	7510	7510	7510	6918
Wald chi2	1210.62	1380.66	1437.83	1413.91
Log likelihood	-12096.908	-12011.887	-11983.302	-11028.945
Pseudo R2	0.0477	0.0543	0.0566	0.0602

Source: British Household Panel Study, Wave 13

Note: 1. Absolute value of z statistics in parentheses. 2 * significant at 10%; ** significant at 5%; *** significant at 1%.
3 Parental age cohorts include mum2125-mum 41up, dad2125- dad41up, with mum20 and dad20 as control groups respectively.

Table 7: Predicted Probabilities

Education level	Middle child[2]	First born
No defined qf	14.75%	10.90%
Other qf	8.70%	7.28%
O levels	21.26%	19.37%
A levels	13.10%	12.96%
Other higher qf	30.58%	33.87%
Degree or above	11.62%	15.62%

Note: 1.Estimated probability are based on the coefficients obtained from Specification [4]. 2. Middle child is defined as the middle child in an odd-numbered family, and the two middle children in an even-numbered family.

Table 8: Marginal Effects

Education Level	Educated Parents	Younger Parents[3]	Older Parents[4]	Suburban Area	Male	Non white
No defined qf	-11.21%	8.02%	-6.18%	-3.12%	-3.64%	-8.45%
Other qf	-5.41%	2.15%	-2.48%	-1.14%	-1.35%	-3.67%
O levels	-9.95%	1.87%	-3.69%	-1.52%	-1.83%	-5.95%
A levels	-3.15%	-0.67%	-0.55%	-0.09%	-0.14%	-1.31%
Other higher qf	7.46%	-6.47%	5.29%	2.71%	3.17%	6.89%
Degree or above	22.26%	-4.90%	7.61%	3.16%	3.80%	12.48%

Note: 1. Estimated probabilities are based on the coefficients obtained from Specification [3].
2. Estimated marginal effects are relative to the base group, in which the base group is set to the mean of the sample. In other words, base group is a respondent between the age of 34-39, a female, parents with no higher education, had quite a few books at home, lived in town area, mother worked, dad aged between 34-40 when respondent was born, mum's age was 21-25 when respondent was born, is white.3. "Younger parents" means respondent's parents are less than or equal to 21 years old when respondent was born. 4. "Older parents" means respondent's parents are older or equal to 41 years old when respondent was born.

Table 9: Test for Non-Monotonicity

	Dependent variable: Categorical Highest Education Qualification (only-child respondents excluded)
Demographics	
Age 34-39	-0.036
	(-0.94)
Age 40-45	-0.071
	(1.81)*
Age 46-50	-0.07
	(-1.61)
Age 51-55	-0.305
	(6.80)***
Female	-0.173
	(6.67)***
Nonwhite	0.519
	(6.25)***
Family Attributes	
Mum degree	0.549
	(9.57)***
Dad degree	0.228
	(7.26)***
Quite a few books	0.296
	(6.48)***
Lots of books	0.494
	(11.65)***
Kid inner	-0.166
	(3.39)***
Kid town	-0.143
	(3.96)***
Kid village	-0.158
	(4.03)***
Kid rural	-0.167
	(3.71)***
Kid mob	0.099
	(-1.52)
Working mum	0.117
	(2.11)**
Family Composition	
Log family size	-0.452
	(14.13)***
$\gamma_1 D_1$	0.106
	(2.81)***
$\gamma_2 D_2$	-0.113
	(2.99)***
Parental Cohorts	Yes
Observations	6918
Wald chi2	1404.14
Log likelihood	-11033.826
Pseudo R2	0.0598

Note: 1. Absolute value of z statistics in parentheses. 2 * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 10: Ln of Years of Schooling

	Spec [1a]	Spec [2a]	Spec [3a]	Spec [4a]
Demographics				
Age 34-39	-0.006	-0.004	-0.004	-0.002
	(-1.25)	(-0.83)	(-0.81)	(-0.42)
Age 40-45	-0.01	-0.005	-0.006	-0.003
	(1.94)*	(-0.92)	(-1.23)	(-0.55)
Age 46-50	-0.018	-0.013	-0.016	-0.013
	(3.12)***	(-0.92)	(2.83)***	(2.09)**
Age 51-55	-0.051	-0.048	-0.051	-0.047
	(8.53)***	(8.11)***	(8.61)***	(7.57)***
Female	-0.028	-0.026	-0.025	-0.025
	(7.96)***	(7.42)***	(7.35)***	(7.02)***
Nonwhite	0.063	0.071	0.069	0.07
	(5.71)***	(6.49)***	(6.32)***	(6.24)***
Family Attributes				
Mum degree	0.073	0.074	0.073	0.077
	(9.56)***	(9.54)***	(9.21)***	(9.02)***
Dad degree	0.036	0.04	0.038	0.031
	(12.14)***	(7.37)***	(7.26)***	(6.73)***
Quite a few books	0.039	0.043	0.042	0.028
	(6.94)***	(5.99)***	(5.84)***	(5.46)***
Lots of books	0.071	0.075	0.074	0.06
	(13.40)***	(12.16)***	(11.90)***	(11.28)***
Kid inner	-0.028	-0.025	-0.024	-0.023
	(4.25)***	(3.74)***	(3.68)***	(3.40)***
Kid town	-0.021	-0.019	-0.018	-0.017
	(4.25)***	(3.90)***	(3.72)***	(3.37)***
Kid village	-0.022	-0.021	-0.02	-0.017
	(4.22)***	(4.02)***	(3.86)***	(3.20)***
Kid rural	-0.03	-0.023	-0.024	-0.022
	(4.88)***	(3.85)***	(4.03)***	(3.59)***
Kid mobile	0.016	0.017	0.016	0.018
	(1.83)*	(1.94)*	(1.89)*	(2.06)**
Working mother	0.012	0.019	0.015	0.016
	(3.72)***	(-1.57)	(2.28)**	(-1.33)
Family Composition				
Log family size		-0.038	-0.04	-0.058
		(11.18)***	(11.77)***	(13.50)***
Log birth order index			-0.03	-0.03
			(7.09)***	(-7.01)***
Constant	2.505	2.534	2.536	2.572
	(116.31)***	(117.77)***	(118.24)***	(109.79)***
Parental Cohorts	Yes	Yes	Yes	Yes
Observations	7510	7510	7510	6918
F-stat	42.03	45.56	46.01	45.68
R-sq	0.1359	0.1501	0.1558	0.1660
Adj R-sq	0.1327	0.1468	0.1524	0.1623

Note: 1. Absolute value of z statistics in parentheses. 2 * significant at 10%; ** significant at 5%; *** significant at 1%. 3 Parental age cohorts include mum2125-mum 41up, dad2125- dad41up, with mum20 and dad20 as control groups respectively.

Table 11: Models with Interaction Terms
(Categorical Education Qualification as Dependent Variable)

	Spec [3]	Spec [5]	Spec [6]	Spec [7]	Spec [8]	Spec [9]
	Preferred Model	**Gender Interaction**	**Famnorm Dummy**	**Famnorm Interaction**	**Workmum Interaction**	**Mum_deg Interaction**
Log family size	-0.332	-0.334	-.332	-0.243	-0.361	-0.349
	(-13.63)***	(9.20)***	(-13.62)***	(4.58)***	(10.49)***	(13.24)***
Log birth order index B	-0.233	-0.175	-.233	-0.195	-0.204	-0.184
	(-7.56)***	(3.87)***	(-7.55)***	(2.67)***	(4.64)***	(5.49)***
Log family size*female		0.003				
		-0.06				
logB*female		-0.11				
		(1.78)*				
Famnorm			.006	0.223		
			(0.18)	(-0.67)		
Log fam size*famnorm				-0.112		
				(1.87)*		
logB*famnorm				-0.044		
				(-0.55)		
Workmum					0.288	
					(-0.99)	
Log fam size*workmum					0.064	
					(-1.31)	
logB*workmum					-0.063	
					(-1.01)	
Mumdeg						0.184
						(3.26)***
Log fam size*mumdeg						0.11
						(-1.58)
logB*mumdeg						-0.295
						(3.46)***
Observations	7510	7510	7510	7510	7510	7510
Wald/LR chi2	1437.83	1497.64	1437.86	1471.97	1485.67	1484.16
Log likelihood	-11983.302	-11953.39	-11983.286	-11966.233	-11959.385	-11960.14
Pseudo R2	0.0566	0.0590	0.0566	0.0579	0.0585	0.0584

Note: 1. Absolute value of z statistics in parentheses. 2 * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 12: Comparison of Black et al (2005) Model
(Dependent Variable: Education in Years)

OLS	**Black et al**	**Spec [10]**
Family size	-0.012	-0.122
	(0.002)**	(7.22)***
Birth order –second	-0.29	-0.088
	(0.004)**	(-1.59)
Birth order –third	-0.49	-0.288
	(0.007)**	(4.01)***
Birth order –fourth	-0.63	-0.404
	(0.10)**	(3.92)***
Birth order –fifth	-0.72	-0.076
	(0.015)**	(-0.54)
Birth order –sixth	-0.78	-0.361
	(0.023)**	(1.99)**
Birth order –seventh	-0.85	-0.248
	(0.037)**	(-1.11)
Birth order –eighth	-0.75	-0.423
	(0.059)**	(-1.45)
Birth order –ninth	-0.94	-0.557
	(0.081)**	(-1.57)
Birth order –tenth	-1.13	-0.734
	(0.116)**	(2.06)**
Additional Control	Yes	Yes
Observations	1,427,107	7,510
R-squared	0.1989	0.1203

Note: 1. Absolute value of z statistics in parentheses. * denotes significant at 10%; ** significant at 5%; *** significant at 1%. 2. Additional controls include age, mother's age, sex, mum_deg, dad_deg, father's age.

Table 13: Birth Order Effect Stratified by Family Sizes
(Categorical Education Qualification as Dependent Variable)

Case (i)						
	Family size					
Birth order	2-children	3-children	4-children	5-children	6-children	7+ -children
2nd	-0.145	-0.24	-0.068	-0.039	0.131	0.146
	(2.98)***	(3.92)***	(-0.75)	(-0.28)	(-0.64)	(-0.72)
3rd		-0.398	-0.323	-0.131	-0.109	-0.341
		(5.51)***	(3.29)***	(-0.92)	(-0.54)	(-1.58)
4th			-0.419	-0.171	-0.288	-0.314
			(3.77)***	(-1.13)	(-1.4)	(-1.46)
5th				-0.169	0.196	0.05
				(-1.05)	(-0.89)	(-0.24)
6th					-0.264	-0.229
					(-1.2)	(-1.08)
>=7th						-0.335
						(1.74)*
Parental Cohorts	Yes	Yes	Yes	Yes	Yes	Yes
Demographics	Yes	Yes	Yes	Yes	Yes	Yes
Family Attributes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2267	1890	1121	649	388	603
LR-chi2	313.17	362.47	170.49	102.23	98.24	125.7
Pseudo R2	0.0427	0.0571	0.0451	0.0462	0.0748	0.0639
Log Likelihood	-3511.043	-2992.668	-1806.046	-1054.651	-607.616	-921.031

Case (ii)						
	Family size					
	2-children	3-children	4-children	5-children	6-children	7+ -children
Log birth order index	-0.209	-0.358	-0.295	-0.115	-0.11	-0.184
	(2.98)***	(5.67)***	(3.97)***	(-1.25)	(-0.98)	(2.00)**
Parental Cohorts	Yes	Yes	Yes	Yes	Yes	Yes
Demographics	Yes	Yes	Yes	Yes	Yes	Yes
Family Attributes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2267	1890	1121	649	388	603
LR-chi2	313.17	362.43	167.21	102.06	88.86	117.09
Pseudo R2	0.0427	0.0571	0.0442	0.0461	0.0677	0.0595
Log Likelihood	-3511.043	-2992.688	-1807.689	-1054.739	-612.304	-925.333

Source: British Household Panel Study, Wave 13

Note: 1. Absolute value of z statistics in parentheses. 2 * significant at 10%; ** significant at 5%; *** significant at 1%.