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Are there effects of mothers' post-16 education on the next generation? Effects on children's development and mothers' parenting

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Centre for Research
on the Wider
Benefits of Learning

ARE THERE EFFECTS OF MOTHERS' POST-16 EDUCATION ON THE NEXT GENERATION?

EFFECTS ON CHILDREN'S DEVELOPMENT AND MOTHERS' PARENTING

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Executive summary

Introduction and background

There is an extensive body of research which shows that children of parents with longer participation in education do better in standard tests of school attainment than those whose parents have had less education. Much of the literature that attempts to explain the mechanisms for this inter-generational transmission of educational success takes for granted that there is a causal relationship between parental education and children's positive development. However, there are reasons to believe that this assumption may be incorrect and instead arise from underlying differences between those who gain higher levels of education and those who do not.

There are thus two competing general sets of explanations for the link between children's educational attainment and the education of their parents:

- Increased participation in education by parents causes, through a range of processes (e.g. income, family size and structure, parental well-being, beliefs and aspirations and the quality of the parent-child relationship), greater educational attainment for children (a causal relationship).

- Parents with more education are more likely to have children who will do well academically irrespective of the parents' education because those who stay on longer in education also have other advantages to pass on to their children such as genetic endowments, ambition and other personality attributes (selection effects);

Our aim was to establish whether the strong correlation between mothers' participation in education and their children's attainment indicated a causal relationship or a selection effect. To do so we looked at the decision of mothers to stay on in education using a rich, longitudinal dataset (the 1958 National Child Development Study) covering data across generations to identify and condition out other factors that might influence the decision to stay on in education, post-16. To the extent that we have been able to do so, our estimates of education effects can be considered, in terms of the model used here, causal. However, we remain cautious because we cannot rule out the possibility that unobserved factors remain a source of potential bias.

Further detail on the selection of the measures used is outlined in the methodology.

Key findings

A mother's education, defined in terms of her staying on decision at 16, can have benefits for a measure of her child's general verbal ability but the size of the effect is small – much smaller than would be presumed from consideration of the raw correlation of a mother's length of participation in education and this measure of verbal ability – and less important than the effects of other factors, such as her aspirations, motivation and prior achievement.

Moreover, mothers' staying on in education did not have any causal effect on a wider measure of their children's academic achievement across reading and maths**.**

There was no effect of mothers' staying on in education on their children's sense of socio-emotional beliefs and behaviours, including an assessment of their own ability.

Participation in post-compulsory education was found to influence mothers' parenting in terms of the provision of a cognitively stimulating home environment for their children. This finding can be compared to that of previous research done by the Centre for the Wider Benefits of Learning on this topic, where no effect was found for this measure. There are several reasons why this may be the case, including changes across time (the previous study examined the effects of parental education on the previous generation), differences in methodology and differences in the way parental behaviours were measured.

There was no effect of a mother's staying on in education on her parenting in terms of emotional warmth towards her children.

Some uncertainties about the precise size of these causal effects remain because our sample was biased towards mothers who had their first child at a relatively young age. We show in additional analysis that the size of the effect does vary with the age at which the mother had her first child. This suggests that the sampling bias in these data may be important. However, it is unlikely to substantially alter the key finding which is that the association of staying on in education post-16 and the attainment of children of the next generation is more to do with selection effects than with causal effects of post-16 participation.

Methodology

The data used in this study come from the National Child Development Study (NCDS), a longitudinal survey of over 17,000 people born in Britain between the 3rd and 9th March, 1958. To date six follow-up sweeps have taken place, at ages 7, 11, 16, 23, 33 and 42 years. In addition to the information gathered for the cohort member at age 33 (in 1991), information was also obtained about the children of one in three randomly sampled cohort members. It is data for this sub-sample which we analyse. The measure of mother's education which we have used in this study is defined in terms of her "staying on" decision at age 16. We selected this measure because it is shown to correlate strongly with children's educational attainment and is one for which data are readily available. However, it is a measure only of the length of educational participation, not of its quality or content and does not distinguish between full- and part-time participation.

In this study we use two broad outcomes: 1) developmental measures of the child of the cohort member; and 2) the quality of parenting of that child by the cohort member. The first is assessed by two specific measures of cognitive ability (general verbal ability assessed by the Peabody Picture Vocabulary Test (PPVT) and a wide-range measure of academic achievement across reading and maths, the Peabody Individual Achievement Test (PIAT)) and two socio-emotional measures (sense of general self-worth and self-competence in academic skills). These four outcomes assessed here are

very specific measures of child development and not global constructs of ability or self-concept and should not be interpreted as such.

The parenting outcome is measured by the Home Observation Measurement of the Environment (HOME). The HOME is a consistently used measure of the quality of parenting and the child's home environment and has two sub-scales: Emotional Supportiveness (a composite estimate of the warmth of the mother's relationship with her child, obtained through maternal report measures of the quality of mother-child relationship and independent observations of affection shown during the interview) and Cognitive Stimulation (an estimate of the degree to which parents provide educational stimulation for their children, obtained through measures such as the frequency with which they read to their child).

To test our hypothesis that mothers' education has a causal effect on children's development, we use stepwise Ordinary Least Squares regression analysis to highlight the impact on the estimates of education effects as more comprehensive control sets are introduced. In the first stage of this we only account for the effects of the age and gender of the child on the outcome. In later stages we take into account additional influences of the mother, her childhood contexts and her development and aspirations prior to and contemporaneous with the age 16 staying on decision.

Data on the children of the NCDS sample were collected in 1991, when cohort members were 33 years old with children of cohort member mothers ranging in age from 0 to 18 years old. Our sample is therefore over-representative of mothers who gave birth at a relatively young age. Mothers who had children after the age of 33 are omitted from the analysis. We consider whether this bias affects our results by conducting additional analysis for different groups of mothers, depending on the age at which they had their children.

Findings

Children's development

- We found that children of mothers who stayed on in education after age 16, scored more highly on the measure of verbal ability (PPVT) and that this effect persisted – albeit much reduced – even after influences that might otherwise explain this association (mother's own ability, socio-economic factors) were taken into account. We conclude therefore that staying on in education after the age of 16 may have a small, positive causal effect on this measure of child development. However, this effect is much less than suggested by the raw correlation and less than that generated by other underlying factors such as mothers' aspirations and beliefs and socio-economic factors. So selection effects are very important here.

- We also find that there are only statistically significant effects for sons and not for daughters. We have not investigated the causes of this difference here, but it suggests that the processes underlying the inter-generational transmission of parents' education may be affected by child gender as well as mother's (or child's) age and points to a possibly important area of future research.

- Although a causal effect of mothers' education on the measure used to assess verbal ability persists even with many control measures introduced, this is not the case for a wider ranging measure of academic achievement which assesses abilities across reading and maths. We are somewhat puzzled by this finding but suggest some possible explanations for this result. For example, it is consistent with some other developmental literature wherein the former has been shown to be more related to family characteristics such as parental education and SES; the effect on a narrower, more specific measure such as verbal ability may persist because there is a particularly substantive impact of mothers' education on this particular feature of cognitive ability and/or that its effect is more easily isolated and identified. Other possible explanations for this result are also put forward and include the breadth of achievement assessed by the measures and issues of when and where the test was standardised.

- We find that the education of the mother has no causal effect on her children's self perception of general self-worth or assessments of their scholastic competence. Rather, the correlation between these outcomes and mothers' education is entirely due to selection effects.

- There is some uncertainty as to the size of the effects of educational participation in the general population because younger mothers were over-represented in our sample and the effect size was greater for this group. Moreover, because these are data for an age-bound cohort of mothers, it is also the case that the children of mothers who had children relatively early in the sample were older than the children of the mothers who had their children later. There are thus two possible interpretations of the results: 1) that the benefits to children of their mothers staying on in education are greater for mothers who had children when they were still relatively young; or 2) that the benefits of mothers staying on are greater for older children – i.e. do not manifest themselves fully until children reach a certain age. If case 1) is true, then the effect size in this study will be greater than for the population generally. If, alternatively, case 2 is true, then the effect size is likely to grow as the younger children mature.

Parenting

- Our results suggest that mothers' participation in post-compulsory education may have small positive causal effects on the extent to which they provide an educationally stimulating environment for their children. Again, this effect persists, although reduced in size, even after other influencing factors are taken into account.

- However, a mother's participation in post-compulsory education does not appear to have any effect on her emotional warmth towards her child.

- The age of the mother at the birth of her first child, appears to substantively influence the extent to which education affects her provision of a cognitively stimulating home environment. However, in contrast to the relationship with child attainment, here the education effect operates such that participating in post-compulsory education has more influence on the older mothers in our

sample than the younger ones. This would suggest that the true causal effects may in fact be greater than we found for this sample. Alternatively the causal effect of mothers' participation in post-compulsory may be stronger for younger children than for older children.

- Mirroring the pattern for children's attainment, mothers' participation in post-compulsory education appears to have a significant causal effect on the provision of a cognitively stimulating home environment by mothers of sons, but not of daughters. Again, this suggests that the parenting processes underlying this education effect may be affected by child gender as well as mother's (or child's) age.

Conclusions

These results suggest that, while mothers' participation in post-compulsory education does indeed have small positive causal effects, much of the apparent relationship between a mother's post-16 education and children's cognitive ability and her parenting is driven by the selection bias – i.e. it is largely other factors, such as her aspirations, which determine her child's attainment, but also determine her decision to stay on in education. Much of the developmental literature tends to a causal interpretation of the relationship between parents' education, the development and ability of their children and some of the mechanisms put forward to explain this association. The results of the current two studies, however, suggest that such assumptions should be drawn with considerable caution.

Taking the findings together, the effect of mothers' participation in post-compulsory education on both cognitive stimulation in the home and the small effect on actual child achievement may be *thought* to suggest that a stimulating cognitive home environment has relatively little effect on attainment. However, we cannot actually infer this from these findings as the analysis does not provide a test of that hypothesis. And the small effect sizes make it impossible to use this approach and data to do so.

This research adds to a developing body of work by the Centre for Research the Wider Benefits of Learning exploring issues of parenting and parenting behaviours. A recent Research Report by the Centre (WBL Research Report No. 16) also examined the effects of mothers' educational participation on the parenting style, using different generational information from the same dataset, and found that there was no effect of mothers' post-compulsory educational participation on their own parental behaviours. However, there are important differences between the two studies. In the earlier study, we looked at the parenting experienced by the 1958 cohort members in terms of their mothers' educational attitudes and behaviours at home and the effects of their mothers' education upon these attitudes and behaviours. Here we consider the education of the 1958 cohort members themselves and the effects it had on their own parenting and separately on their children's development. There is therefore a generational difference between the two studies. In addition, there are differences in both methodology and measurement; the previous report uses instrumental variable analysis – a technique considered more robust than the regression analysis used here, but which was unavailable to us for this generation. However, both reports indicate that the effects of spending additional time in education post-16 may be less direct and causal than other research suggests and that much of the association reported

between educational participation and its various associations arises from underlying parental characteristics.

Importantly, however, both studies focus on specific elements of the pathways implicated in the inter-generational transmission of educational success, particularly parenting style, and do not examine the wide range of mechanisms or complex processes involved in how education might affect children. This broader context is explored in a literature review undertaken by the Centre (WBL Research Report No. 10). There we find that parenting style is one mechanism among many: for instance, childcare and school settings, neighbourhoods and peers. Further, parenting itself is more complex than our model in this, or the previous, study has been able to represent, not only comprising a complex array of skills and beliefs that shape children's development through diverse pathways, but changing over time as parents learn through experience and as they also adapt their parenting to the behaviour and response of their children.

Furthermore, the proxy used here for education – a measure of post-compulsory participation – was relatively narrow. Simply extending the time mothers-to-be spent in education appears to have little effect on their parenting or on the subsequent attainment of their children. Therefore any larger effects which we may expect parents' education to have on their children are more likely to reside in the quality and nature of that education

The picture of the relationships between education, parenting and the transmission of educational success between generations is far from complete. In this research we are puzzled by the finding that the impact on both child attainment and for provision of a cognitively stimulating home environment is present for sons but not for daughters. These issues require additional exploration. Modelling pathways by child gender as well as including the possible mediating role of parents' cognitions is an important next step in our investigation of the inter-generational transmission of educational success in these multi-generation longitudinal datasets.

Implications

These findings suggest that, in and of itself, simply extending the amount of time which mothers spend in education does little to directly affect the educational attainment of their children: rather it is the ability, prior achievement, motivation and aspirations of women which inform their participation in education post-16, their parenting and the attainment of their children. Thus inequalities in educational success may be transmitted through the generations. This suggests that supporting children in learning through early and continued investment in quality education and developmental opportunities is key to addressing this issue. Further, education does not provide a universal panacea of positive unintended consequences: if parental education is to have an effect on parenting and, it is to be hoped, on the subsequent achievements of children, it is not simply to participation we must look, but to the pedagogy, objectives, ethos, forms of assessment and curricula of learning.

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Overview

This report uses data from the child supplement of the UK 1958 cohort to test the level of causality involved in the effect of the educational participation of females after the age of 16 years and i) the developmental outcomes of children born subsequently and ii) the parenting of these children. Although these two questions are linked, we treat them separately here in order to get the best estimates of education effects. First, we investigate the size of the effect of maternal education on measures of children's attainment and consider whether this association is causal. Secondly, we assume that parenting matters and again examine effect size and whether its association with the education of parents reflects a causal effect of education. Similar data and methods are used for both parts but we do not attempt to model parenting as the pathway for education effects on child outcomes as that is outside the scope of this report which is the estimation of the causal effect of post-16 participation.

A very wide range of control variables are applied in order to condition out associations between mothers' post-16 participation and the outcomes that are due to the ability and context of the mother rather than to the effects of staying on in education after the age of 16. We are particularly concerned about this selection bias in the light of concerns about the role of education as an element in the inter-generational transmission of social advantage, one of the means by which middle class families maintain their social class advantages. This is a related but distinct chain of associations to that by which education may be a causal factor in its own right, as opposed to being a proxy indicator of social ambition.

The particular strength of the 1958 Cohort data in this context is that the sample mothers have been surveyed since birth so that we are able to control for wide-ranging, pre-determined factors in the regression to explain the outcomes of the children of the next generation. These factors include control sets in relation to: i) distal and proximal factors in the home environment of the mother during her childhood; ii) her own childhood capabilities and aspirations up to the age of 16 at which the post-16 educational participation decision is made; and iii) the wider school and area in which she grew up.

This paper is organised as follows: in Part 1, we first review the existing literature on the relationship between parents' education and children's achievement. Section 1.2 lays out the data, the main variables of interest and our analytic strategy as well as some methodological issues. Section 1.3 provides an interpretation of our results and Section 1.4 discusses these empirical analyses in more detail. In Part 2, we again begin with a brief review of the literature on the relationship between parents' education and parenting. Section 2.2 introduces the main variables of interest for this part of the empirical analysis and reviews the data for the current study. Results are presented in Section 2.3 and we conclude in 2.4 with a discussion of these results. Finally in Section 3 we draw together the findings from both parts of the report with a more general discussion of the results, providing some conclusions, implications for future research and policy relevance.

1. Estimating the effects of mothers' prior education on children's development

1.1 Introduction

It is commonly observed that children of parents with higher levels of education do better in standard tests of school attainment than those of parents with less education (Bynner and Joshi, 2002; Feinstein, Robertson and Symons, 1999; Gregg and Machin, 2000; Haveman and Wolfe, 1995; Klebanov, Brooks-Gunn and Duncan, 1994; Smith, Brooks-Gunn and Klebanov, 1989). Positive correlations between the educational attainment of mothers' and children's cognitive outcomes are among the most replicated results from developmental studies. Higher levels of maternal education have been consistently linked to their children's tests of academic attainment and school grades (Alexander, Entwistle and Bedinger, 1994; Davis-Kean and Schnabel, 2002; Dauber, Alexander and Entwistle, 1996; Ensminger and Slusarick, 1992; Haveman and Wolfe, 1995; Smith, 1989) and young children's school readiness (Christian, Morrison, and Bryant, 1996; Seefeldt et al., 1999). Moreover, Magnuson (2003) finds increases in maternal education are also associated with increases in children's academic achievement. For the UK, Feinstein (2003) reports that this social class gradient kicks in before children enter school. Others report positive associations as early as three months of age (Roe and Bronstein, 1995) and as late as mid-adulthood (Huesman, Moise-Titus, Podolski and Eron, 2003).

There are a number of possible explanations for this relationship and the social science literature is abundant with studies attempting to explain the mechanisms through which this inter-generational transmission of educational success occurs. Possible factors through which educational effects may be transmitted include income, family size and structure, parental well-being, parental beliefs and aspirations, parenting itself and the quality of the parent-child relationship. However, parental education may also be correlated with children's attainments because of selection bias in that those who stay on longer in education also have other advantages to pass on inter-generationally, such as genetic endowments, prior cognitive and developmental capabilities, ambition and other personality attributes that may act as confounding factors. There are thus two competing general sets of explanations for the link between children's educational attainment and the education of their parents:

- Increased participation in education by parents causes, through a range of processes, greater educational attainment for children (causal effects).

- Parents with more education would have children who will do well academically irrespective of the parents' education (selection effects).

The theoretical basis for claims of causality is strong. Bronfenbrenner (1986) notes that parents' education takes on special significance from an ecological systems perspective because it offers a unique advantage for the analysis of causal pathways. Unlike either occupational status or income, it typically precedes both family formation and the birth of children and so provides an index of social background that is less likely to be influenced by subsequent family processes. He argues that it can therefore be more confidently interpreted primarily as unidirectional in its effects.

Based on such theoretical reasoning and the wealth of correlational evidence supporting this strong association, much of the developmental literature takes for granted a causal relationship between parental education and children's development, typically modelling it as either a mediating factor or, more often, a control (for a review, see Feinstein, Duckworth and Sabates, 2004). These issues of selection versus causality, however, often make it inappropriate to draw strong conclusions from this rapidly increasing area of research.

The first part of this report aims to address some of these problems of selection versus causality and estimates the direct effect of mothers' education on measures of children's cognitive ability and socio-emotional development. By considering rich, longitudinal data across generations, our dataset allows us to identify and condition out other factors that might influence the decision to stay on in education post-16 and so estimate the size of the bias in the relationship between education and children's developmental outcomes from failing to account for background characteristics, earlier cognitive achievement, aspirations and the parenting mothers experienced during their own childhood. To the extent that we can condition out such potentially confounding influences then, our estimates of education effects can be considered unbiased and, in terms of the current model specification, causal. However, we remain cautious because we cannot rule out the possibility that unobserved factors remain a source of potential bias.

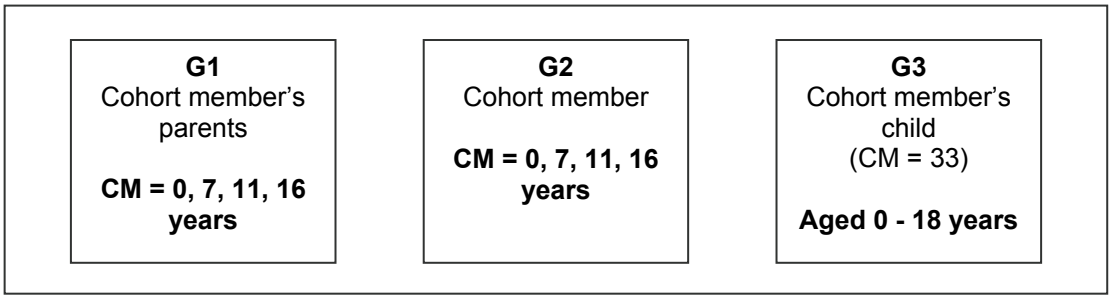
We do not attempt to model the complex processes or pathways involved in *how* education might affect child outcomes here. Rather we aim to identify robust estimates for one part of a pathway implicated in the inter-generational transmission of educational success.

1.2 Method

1.2.1 Participants

The data analysed come from the National Child Development Study (NCDS), a longitudinal survey of over 17,000 people born in Britain between the 3rd and 9th March, 1958. To date six follow-up sweeps have taken place, at ages 7, 11, 16, 23, 33 and 42 years. In addition to the information gathered for the cohort member at age 33, information was also obtained for, and from, the children of one in three randomly sampled cohort members and their mothers (Ferri, 1993). Thus when the cohort member was 33, there are three generational levels of information and so to structure this longitudinal data we denote G1 to refer to the cohort member's parents, G2 to the cohort member and G3 to the child of the cohort member. This structure is summarised in Figure 1 below.

Figure 1: Structure of the NCDS data



We restrict the analyses in this section of the report to G3 children, aged 4 years or over (N = 1752) living at home with an NCDS cohort member mother (N = 1116) as this is the sub-sample for which we have sufficient information both for the parent and for the child. This excludes a small number of children who were not resident with their cohort mothers (see Joshi et al., 1999) and children for whom the study cohort member was the father (N = 971 children aged 4 years or over, of N = 558 fathers). Given that much of the developmental literature on the inter-generational transmission of educational success has tended to focus on the role of mothers' education, such restraints within these data are not considered to be overly problematic. Nevertheless, we do recognise the important roles that fathers play in their children's development and hope to redress this balance in future research of the Centre.

1.2.2 Education variable

Our measure of mother's education is defined here in terms of her "staying on" decision at age 16, examined using a binary variable indicating whether or not the G2 woman stayed on in post-compulsory education. We selected this measure because it is shown to correlate strongly with children's educational attainment and is one for which data are readily available. This transition between compulsory and post-compulsory schooling is also of interest because reducing the proportion of pupils with a low level of schooling and raising 16 – 18 participation in education has been a recent policy priority in trying to break cycles of disadvantage and enhancing skills.

The staying on decision indicates a mixture of input and output effects of education.

Inputs

The decision to stay on is a measure only of the length of educational participation so in that sense is a measure of additional school experience, but is not necessarily an indicator of learning nor a measure of the quality or nature of those inputs. Readers should note that throughout the report when we refer to *mother's education* and *mother's education decision*, we do so with reference to this narrow definition of education. As different types of educational input may impact differently, both in nature and degree on individuals and, through these impacts, also differentially affect their future children, this is an important limitation. We should also note that the education that these women experienced was not set up with the objective of enhancing parenting skills or the attainment of the next generation and so the use of this measure is a test of whether or not a positive and unintended externality resulted

from the extra receipt of educational inputs. Deliberate or explicit recognition of the possible consequences of learning and training for inter-generational outcomes may lead to different types of curricula and teaching styles which would have different potential impacts than the inputs assessed using this measure in this context, so this study cannot comment on the possible effects of education specifically focussed on parenting and improving outcomes for the next generation. Moreover, this measure is taken from the information provided by the cohort member (G2) at age 33 and includes both part- and full-time participation in post-16 education. Therefore, we do not make any further distinction between part- and full-time education.

Outputs

The measure is also a proxy for qualifications gained as the majority of those staying on at 16 will go on to attain Further or Higher Education qualifications. Thus the hypothesised effect of education may result from the benefits gained through the signalling advantage of the credentials gained rather than from any specific absolute individual effect of learning.

As stated above we do not test hypotheses here about the mechanism or process for an effect of education, testing rather the hypothesis that the effect is causal in the sense defined above. Nonetheless, we recognise that with this measure of education we cannot discriminate between the input and output effect of education or test the relative importance of each. In summary, use of this measure enables us to test only a narrow hypothesis, i.e. that the experience of post-16 education has a causal effect on parenting and the achievement of the next generation. By controlling for as many individual, family and contextual characteristics up to this point as possible we hope to identify and condition out any confounding bias. The extent to which we can do this depends on the richness of our measures. Under our assumption that we have removed all possible confounding bias through the introduction of comprehensive controls, any residual association represents the causal effect of staying on in education on children's development.

However, we cannot test the causal role of the quality of education or of its nature in terms of perhaps crucial features such as curricula, teaching styles, peer groups and social networks in school, school ethos and assessment regimes, all of which may be important as influences on the capability of education to impact on the outcomes under consideration.

1.2.3 Child outcomes

We consider effects on four specific measures of children's cognitive and self-rated socio-emotional development in our analyses. Cognitive development is assessed by: i) a wide-range measure of academic achievement across reading and maths taken from the Peabody Individual Achievement Test (PIAT) scales; and ii) a measure of general verbal ability and intelligence, the Peabody Picture Vocabulary Test - Revised (PPVT).

The PIAT is widely known and used in research and is a measure of broad academic achievement in children 5 years old and over, assessed on three sub-scales: maths, reading recognition and reading comprehension. The reading recognition sub-scale is

a measure of children's ability in word recognition and pronunciation, the reading comprehension sub-scale is a measure of children's understanding of words read silently and the mathematics sub-scale is a measure of child attainment in mathematics as taught in mainstream education. Preliminary analyses, however, suggest that the determinants of the separate measures were very similar with respect to our current definition of maternal education effects and so to simplify the presentation of results a dependent variable of *achievement* is created as the first factor of the three PIAT sub-scales.

The PPVT is a measure of general verbal ability. It assesses the receptive (i.e. aural) vocabulary for standard American English (normed for UK samples) of children 4 years old and over with 175 items arranged in ascending order of difficulty. On hearing each word the child selects one of four pictures which best matches the stimulus word's meaning. The PPVT is among the most established indicators of verbal intelligence across childhood (Chase-Lansdale et al., 1991). For example, verbal ability measured between 4 and 6 years using the PPVT has been shown to be predictive of literacy scores in late adolescence as much as 15 years later, even after controlling for the effects of educational, social and economic characteristics (Baydar, Brooks-Gunn and Furstenburg, 1993).

For both cognitive outcomes we use age standardised scores. We also include age (in months) in the regression analyses to unpack any age level effects that may operate within the age-blocked standardised scores. Completion rates are approximately 96% for PPVT and range between 92-98% for the three sub-scales of the PIAT assessment. Both tests were normed for use on UK samples, but it should be noted that for the PIAT scores these norming procedures were carried out in the late 1960s and that social changes affecting the maths and reading knowledge of small children in recent years have undoubtedly altered over this time. It is possible that factors such as pre-school education, changes in curricula and television viewing patterns have changed and improved younger children's readiness for maths and reading and that these achievement tests are slightly weaker than they once were.

Children's socio-emotional adjustment is assessed by the child's own ratings on the Self-Perception Profile for Children (SPPC). This is a self-report scale that measures children's self-perception on two sub-scales: global self-worth and scholastic competence (self-perceived academic ability) (Harter, 1982), and is completed by children age 8 and over. Statements include the following items such as: "some children feel they are very good at their school work but other children worry about whether they can do the school work assigned to them" or "some children are often unhappy with themselves but other children are pretty pleased with themselves". Individuals are asked to respond to a statement read by the interviewer in terms of "which kind of child" they are more like. This is followed by asking whether or not the given response is "really true for you" or "only sort of true for you".

Raw scores are used in the analyses with a higher score representing greater scholastic competence or greater global self-worth. Completion rates for this assessment are approximately 94%. There is some evidence from the US that younger children, those under age 10, may have greater difficulty in understanding some of the items and that consequently scores for younger children may be somewhat less reliable and valid. However, preliminary analyses showed no substantive differences if those younger

than 10 years old were excluded from the analyses and so we use the full sample of children for which these data are available, i.e. those aged 8 and over.

Readers should note that we are restricted by the data that were gathered in 1991 to assess the importance of mothers' education in relation to children's development. The four outcomes assessed here are very specific measures of child development and not global constructs of ability or self-concept and should not be interpreted as such. We therefore refer to these outcomes using their technical names (e.g. *PPVT*) throughout the report. The exception is for the grouped PIAT scores which are referred to as *PIAT achievement* for the reasons outlined above.

Table 1 reports the summary statistics for our education variable and four child development outcomes.

Table 1: Summary statistics for mothers' education and child development outcomes

Variable	Obs	Mean	Std. Dev.	Min	Max
Education variable					
Staying on decision at 16	1116	0.18	0.38	0	1
Cognitive outcomes					
PIAT achievement score	1583	0.00	0.93	-3.58	3.70
PPVT score	1747	100.28	14.66	1	155
Socio-emotional development outcomes					
Global Self-worth score	1021	184.82	34.61	60	266.31
Scholastic Competence score	1021	159.59	38.55	43.70	271.02

1.2.4 The endogeneity of the education measure and rationale for choice of control variables

The methodology used in this paper takes seriously the important call in Duncan, Magnuson, and Ludwig (2004) for studies on developmental themes to take into account the bias introduced by endogeneity problems in the estimation of causal effects. The endogeneity problem is important here because, as noted above, decisions about staying on and investing in education are likely to be made on the basis of unobserved features of the individual, their background and social context that may also predict their children's achievement. For example, an individual's own aspirations will likely predict their own investment in education as well as their subsequent aspirations for their child and, in turn, that child's educational success. To that extent, therefore, an observed association of staying on in school and children's developmental outcomes may be the result of the confounding influence of aspirations. Estimates of the effects of mothers' education as assessed by her staying on decision are biased to the extent they fail to take such factors into account and

merely reflect underlying differences between those who gain higher levels of education and those who do not.

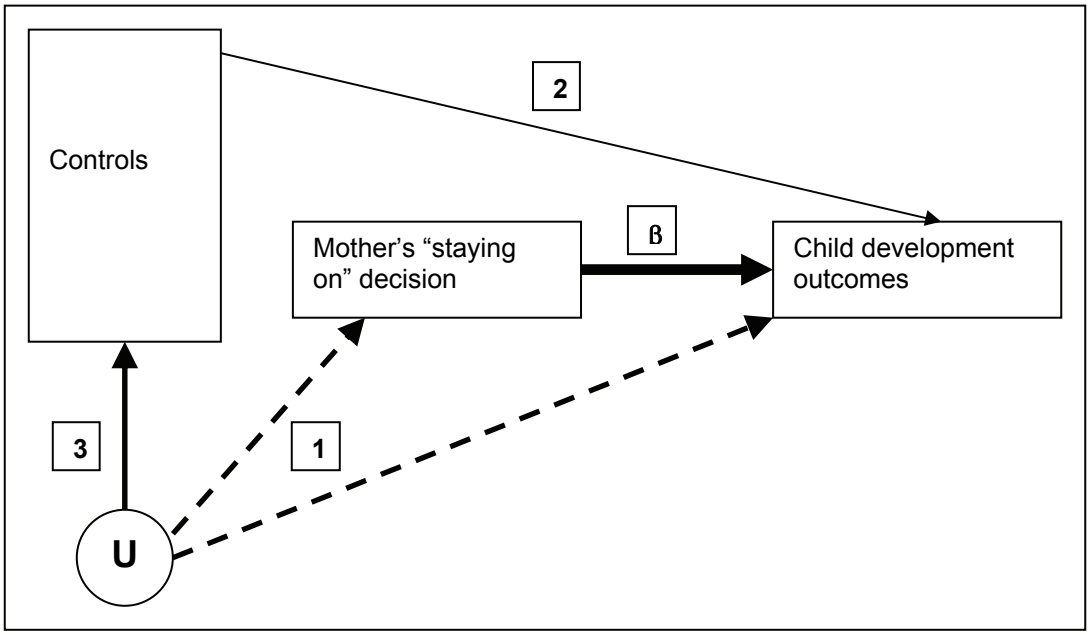
There are a number of ways to counter problems of endogeneity, for example: through the use of randomised control trials (RCTs) or using research designs that make use of natural experiments. Other authors address this problem by modelling trajectories in relation to changes in education or use instrumental variable (IV) estimation to identify exogenous variation in the variables of interest and so assess causality more robustly.

Magnuson (2003), for example, draws on the randomly assigned treatment design of a welfare-to-work program in the US to estimate IV models of changes in maternal education. Findings suggest that increases in maternal education were positively associated with children's academic school readiness and negatively associated with mothers' reports of their children's academic problems. Using the variability from experimentally induced differences in educational activities, she also showed that increases in mothers' educational participation were associated with improvements in the quality of home learning environments as assessed by mothers' reports of how often they engaged in different stimulating activities their child, such as playing guessing games, playing with puzzles or going to the library.

This type of data, however, is not always available. And so in the absence of experimental studies or viable instruments we adopt the standard next best approach and control for as many covariates as possible in order to condition out any potential confounding bias in multivariate regression. In our rich, nationally representative, longitudinal dataset the mother is surveyed from birth, enabling us to control for a great many features of her development, achievement and proximal environment that precede participation in post-compulsory education. This estimation strategy is graphically represented in Figure 2 below.

"U" represents unobserved features of the G2 female which may be associated with the subsequent developmental outcomes of her child and with the staying on decision (arrows marked 1). By controlling for features of the G2 female (arrow marked 2), all measured prior to or contemporaneous with her staying on decision, we hope to condition out the influence of such potentially confounding biases; arrows 1 then become arrow 3 and so removing the endogeneity of mothers' education decision. Therefore, subject to the assumptions of the model any residual association represents the direct and causal effect of staying on in education on children's development (arrow marked β).

Figure 2: Conceptual model for analytic strategy: removing the endogeneity of mothers' education decision



While our ability to identify causality is less than that of an experimental situation, this multivariate approach has considerable merits when the control set is as strong and longitudinal as it is here, drawing on data from three generations.

1.2.5 Covariates

Based on this estimation approach, we control for a range of measures of G2 child and her G1 family characteristics collected at four time points: birth, 7, 11 and 16 years old. All summary statistics (observations, mean, standard deviation and range) are reported in Table A1 in the Appendix. This baseline information includes family level distal characteristics such as G1's and G2's parents' socio-economic status (SES), G1's parents' age at birth of G2, family size and structure, the presence of a foreign language being spoken in the home, whether the G2's own parents stayed on in school at age 16 as well as additional income proxy measures such as persons per room and having free school meals at age 11. Information on the presence or absence of local amenities such as parks, libraries and swimming pools was also gathered to proxy for economic status.

Information about the mothers' own childhood home environment (proximal family factors) including teacher-rated G1 parental interest in the G2's education, G1 educational behaviours at home such as reading to their G2 child, going on outings and using local amenities such as parks and libraries and G1 educational aspirations for their G2 child were collected at age 7 and 11 interviews. G2 school and area level factors were also collected during these sweeps.

G2 child-level covariates were again collected at all four time points and cover whether the child reads, the activities they pursue in their spare time, their anticipated post-16 plans at age 11, social and behavioural development including physical health as well as maths and reading test scores, other measures of cognitive achievement and

teacher ratings of general academic ability. Mother- and teacher-rated internalising and externalising behaviour problems were also gathered at ages 7 and 11. These are measures of children's ability to self-regulate their emotions so as not to either become excessively withdrawn (internalising) or naughty (externalising). See Rutter, Tizard and Whitmore (1970) for more detail here.

1.2.6 Estimation strategy

To test our hypothesis that mothers' education has a causal effect on children's development, we use stepwise OLS regression analysis to highlight the impact on the estimates of education effects as more comprehensive control sets are introduced.

The first step in this stepwise procedure gives the raw effect of education for each outcome assessed, controlling for the age and gender of the G3 child (set 1 controls). The second step adds in sets of family level demographic controls (set 2) such as whether the G2 mother's own parents stayed on in post-compulsory education, her parents' SES and ages, her family size, structure and proxy measures of familial income. In step 3 we introduce controls of G2's own family level developmental context, for example, whether or not she was read to regularly, presence of educational toys and resources, G1 parenting attitudes and aspirations and teacher ratings of parental involvement. Step 4 adds G2 school factors into the model and includes the percentages studying for and achieving GCE O Level/CSE and A-levels, as well as the SES makeup of the school and whether the school was independent, and step 5 adds in which geographical area G2 grew up in.

The final model introduces the control sets (set 6) contributing the most to G2's earlier academic success, namely features of G2's own childhood development and achievement, including test scores and measures of general and personal development from birth up to and including age 16. These control sets are chronological, such that steps 2 and 3 are mostly determined before or at birth. School and area level covariates are relatively fixed and unaffected by G2's own development per se but nevertheless influence educational choices and outcomes and the final step introduces features of G2 as she develops and progresses though her compulsory education. In total, almost 200 comprehensive cohort member (i.e. G2) control variables, measured prior to the staying on decision, are entered into the regression.

Note that we expect to see the greatest attenuation in the size of any education effect on the introduction of G2 development and aspirations controls (set 6), since these covariates (which include many measures of G2's own achievement at 7, 11 and 16 as well as teacher ratings of general ability) are most highly correlated with her decision to stay on in education.

We first conduct the regression analyses on the full sample of G3 children. Then, to further explore any subtleties in the relationship between maternal education and child outcomes, we carry out the analyses separately for G3 sons and daughters and by age of mother (see discussion below). Any differences in the results would suggest moderation effects.

1.2.7 Methodological issues

Fertility selection bias

Data on the children of the NCDS sample were collected in 1991, when cohort members were 33 years old; children of cohort member mothers ranged in age from 0 to 18 years old. Our sample is therefore more representative of younger mothers. This issue is illustrated in Figure 3 which shows the distribution in these data of mothers' age at the birth of her first child. We show the distributions of mothers' age for those who stayed on at school and, separately, for those who did not, i.e. in terms of our education variable.

Figure 3: Distribution of mothers' age at birth of first child by staying on decision

Figure 3 shows strong evidence for a systematic relationship between the age of the mother at the birth of her first child and her staying on decision. For mothers who chose not to stay on in education past the age of 16, the peak age of first child's birth is about 22 years and by age 33 their distribution has tailed off quite strongly. However, for those mothers who chose to stay on past the minimum school leaving age, the distribution of age at first birth peaks around 28 and there is a considerable number of more educated women who may go on to have children but who have not yet done so. These "missing" mothers may differ from those in the sample in non-random ways that impact on the education effect. The estimated effect is based on a comparison of the outcomes of those who stayed on relative to those who didn't. This difference may be different for different age groups of mothers. Omission of the oldest mothers may lead to a biased estimate.

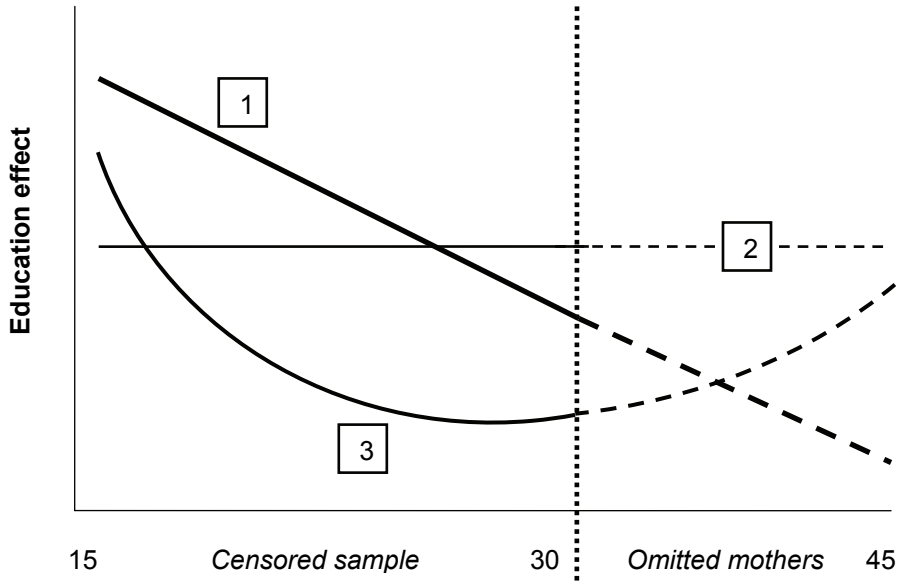
Consider, for example, teenage mothers some of whom who stayed on in school post-16 and some of whom did not. The education effect for this group may reflect the extra benefit for young mothers of getting a good start in the labour market, financial autonomy and social inclusion. Therefore, the education effect may be larger for young mothers than for older mothers if education has these complementary effects that emphasise the importance of education in the first transitions to adulthood. Since older mothers are omitted because of the fertility selection bias, this consideration would lead to the conclusion that the estimated effect in this sample is an over-estimate of the full population effect of education.

We also recognise that the education endogeneity may be different for different ages of mothers. This introduces an extra layer of complexity to the consideration of estimation bias. More educated mothers who have children relatively early are likely to differ in important ways to mothers with similar levels of education who have children later. Thus there may be an interaction between education and fertility "decisions" that biases our censored sample estimates in important but unpredictable ways. Therefore, we are concerned about a fertility-based sample selection bias.

We consider whether fertility selection bias affects our results by conducting sensitivity analysis by mothers' age at first birth. For mothers in our censored data, we split the distribution of mothers' age at the birth of first child into quintile dummies and interact each with our education variable. In the sensitivity analysis, these interaction terms are entered into the regression equation in order to estimate different education effects for the different groups of mothers. Any differences would suggest that there is age moderation within our sample, i.e. differences in the effect of education for women who became mothers at different ages. This would reduce our confidence that the results from this censored sample represent the true population effect of education. The direction of difference also provides clues about the likely direction of the fertility-based sample selection bias.

For example, see Figure 4. This shows a hypothetical graph of the relationship between mothers' age at birth of first child on the x-axis and the effect of education on the y-axis. A linear downward sloping relationship (1) suggests that as mothers get older at age of first birth the education effect becomes smaller. If we assume that this linearity continues past the censoring point for the sample (mothers aged 30 years and over) and that the diminution of effect size is even greater for the omitted older mothers then we can infer that the bias introduced by the sample selection is upwards and that the estimated effect in our sample is an over-estimate of the true effect.

Figure 4: Hypothetical graph showing possible relationships between mothers' age at birth of first child and education effects



Other types of relationship between age of mother and education effect are possible (lines marked 2 and 3) and it is also important to note that we do not observe the effect sizes for mothers after the censoring point and can only infer from what we do observe about the shape of this relationship for the omitted mothers. Therefore, this sensitivity exercise provides clues about the likely direction of bias but does not remove the bias or provide definitive answers about it.

Another problem with the method is that just as mothers are censored by age at first birth in the sample, so are children censored by age. Although there are children in our sample up to age 18, there is a strong negative correlation in the sample between mothers' age at first birth and the age of the observed child. Mothers who had children earlier have children in the study who are older than those of mothers who had children later. Thus the shape of the observed, empirical graph equivalent to Figure 4 above, may in fact be due to or biased by the impact of children's age on the education effect. It is possible that the estimated education effect for mothers who had children younger is not due to the age of the mother at first birth but to the fact that these children are older in the sample. In fact, we find a very similar mirrored pattern of interaction effects by age of child as we do by age of mothers' first birth. We return to this issue in the discussion of the results and in the conclusions. The key point is that the sensitivity analysis can only be indicative of the likely direction of bias that results from exclusion from the sample of older mothers. Note that this sample also over-represents first born children and under-represents larger families with later born children.

We are thus concerned that the age of mother at first birth will bias effect sizes in the full sample analysis. However, as this measure is both endogenous and a potential mechanism for education effects it is not appropriate to include it in the regression analysis. The same is true of the measure of the number of children in the family. It may be a channel for education effects and is endogenous so we do not include it in

the regressions. Both of these measures occur post-education in the majority of cases and are therefore omitted. It is important to note however, that inclusion of these measures does not substantively change the results presented.

Clustering

As noted above, in addition to the information gathered for the cohort member at age 33, information was also obtained about the children of one in three randomly sampled cohort members and their mothers. This sample is made up of 1182 mothers who, between them, have a total of 1879 children: 672 of these mothers had only one child, 360 had two children, 118 had three children, 29 had four children and three women had five children. Therefore in order to estimate the effects of mothers' education only once for each mother, we conduct the regression analysis recognising the clustering of children from the same mother[1].

Missing data

Data may be missing for a number of reasons and may occur at one or more time points, on just some measures or a combination of both. Standard methods impute missing data using *regression substitution*: missing values are replaced by the predicted value of the variable from a regression analysis based only on the complete cases. In this method, the mean parameters are correctly estimated but the variance parameters are underestimated because this method assumes no residual error around the regression line[2]. This artificially deflates standard errors and the resulting inferences may be biased because uncertainty due to the nature of missing data has not been addressed (e.g. Little and Rubin, 1987, chapter 3).

To address this issue and correct for possible bias in our results, we impute missing information using *multiple imputation* (MI). In MI, the data are completed several times by imputing multiple random draws of the missing values from a predictive distribution (see Schafer, 1997). A standard complete-data analysis is applied to each imputed dataset separately and the results are combined to obtain overall estimates and standard errors that reflect variability across imputations, producing more robust and reliable inferences about the population of interest. Details of how these estimates were computed can be found in the Appendix.

1.3 Results

The means and standard deviations for each of the four child development outcomes are presented for each education group in Table 2. Children of mothers who stayed on in education achieved consistently higher scores in all four outcomes assessed, supporting the well-documented findings in the literature that children of mothers with more education outperform those from less educated backgrounds.

[1] We cluster by mothers' unique identifier using the cluster-analysis commands in Stata which take the form of generalised least squares.
[2] Mean parameters are correctly estimated under assumptions that the data are Missing Completely at Random, MCAR, see e.g. Schafer and Graham, 2002.

Table 2: Means and standard deviations of child development outcomes by mothers' education decision

Mothers' education decision	PIAT achievement		PPVT		Global self-worth		Scholastic competence	
	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.
Did not stay on	-0.10	(.92)	98.55	(14.60)	191.15	(36.93)	163.60	(40.26)
Stayed on	0.44	(.92)	107.03	(14.19)	198.91	(38.53)	174.54	(42.32)

Table 3 shows the summary results of the stepwise OLS regression models for all four G3 child outcomes. We give the β coefficient (and standard error in brackets) for our education variable conditional on the sets of stepwise controls included in that model (see section 1.1.6 for more detail here). For the overall PIAT achievement score the initial baseline model, i.e. the raw effect, the effect of mothers' education decision is reduced to .42 as our first set of controls, G1 family distal factors (column 2), are added into the regression model, but remains significant, $p< .01$. With the addition of further comprehensive control sets for G2 family proximal process, school and area factors, and G2 childhood development and aspirations, the initially large raw correlation of mothers' education is reduced further and becomes non-significant in the final model. As expected, the greatest attenuation of the education effect is seen on the introduction of information on the G2 mothers' own ability and development prior to age16 (column 6).

For PPVT scores, the raw effect of mothers' education is again reduced upon entry of the first control set (column 2). Similar attenuation emerges for each successive model, with the total effect of mothers' education reducing to approximately two thirds of the initial correlation in our final model specification (column 6). As with the PIAT achievement score, the introduction of G2 development and aspirations creates the greatest relative decrease in the estimated size of the education effect. However, the effect of mothers' education remains statistically significant at $p<0.01$ even after the introduction of all five sets of control variables, indicating a robust contribution of mothers' staying on decision on her child's verbal intelligence. For both cognitive outcomes considered the total variance accounted for is 32%.

No effects at all were found for either Global Self Worth or Scholastic Competence.

Table 3: Stepwise multilevel regression summary results for G3 child outcomes

	Additional control sets					
	No controls	G1 Family distal	G1 Family proximal	G2 area	G2 school	G2 Development and aspirations
PIAT achievement						
β	.58***	.42***	.37***	.36***	.32***	.11
se	(.07)	(.07)	(.07)	(.07)	(.07)	(.08)
N	1583	1583	1583	1583	1583	1583
R-squared	0.04	0.10	0.15	0.17	0.20	0.32
PPVT						
β	9.93***	7.50***	6.83***	6.89***	5.87***	3.52***
se	(1.06)	(1.08)	(1.06)	(1.08)	(1.07)	(1.16)
N	1747	1747	1747	1747	1747	1747
R-squared	0.06	0.12	0.19	0.19	0.23	0.32
Global self worth						
β	3.34	3.82	4.25	3.31	3.77	1.30
se	(4.10)	(4.58)	(4.85)	(4.85)	(5.00)	(5.27)
N	1021	1021	1021	1021	1021	1021
R-squared	0.01	0.06	0.09	0.11	0.14	0.31
Scholastic competence						
β	7.22	6.76	7.40	8.05	5.13	-3.91
se	(4.43)	(4.68)	(4.94)	(5.03)	(5.00)	(5.16)
N	1021	1021	1021	1021	1021	1021
R-squared	0.01	0.05	0.12	0.14	0.17	0.32

*** p<.01; ** p<.05; * p<.10
Standard errors in brackets.

Moderation by gender

In Table 4, we report results taking account of gender moderation, running separate models for G3 daughters and sons. The reduction in the estimated parameters upon inclusion of the control sets is larger for girls than for boys. For both cognitive outcomes for daughters, the introduction of controls for mothers' own ability prior to age 16 (column 6) removes the statistical significance of the education effect. The estimated effect of a mother's education on her daughter's PIAT achievement score is almost totally knocked out by the introduction of controls, reduced to 96% of the initial correlation to the final model. For PPVT scores the total reduction on the estimated parameter of mothers' education is 88%.

As for the overall regression analysis for all children: for sons, the education effect is knocked out after the introduction of covariates for mothers' own development, falling by a total of 88% in the final model (column 6), while, for PPVT scores, the strong relationship with mothers' staying on decision persists even with the full control set and remains significant at $p<0.01$. It is interesting to note that the total reduction on the estimated parameter for mothers' education is just 52%, considerably less than for daughters' PPVT scores and for the PIAT achievement scores for both sons and daughters.

Table 4: Stepwise multilevel regression summary results for cognitive outcomes: G3 gender

	Additional control sets					
	No controls	**G1 Family distal**	**G1 Family proximal**	**G2 area**	**G2 school**	**G2 Development and aspirations**
Daughters: PIAT achievement						
β	.56***	.47***	.37***	.33***	.28***	.02
se	(.09)	(.09)	(.10)	(.10)	(.10)	(.11)
N	770	770	770	770	770	770
R-squared	0.05	0.14	0.22	0.25	0.29	0.46
Sons: PIAT achievement						
β	.59***	.39***	.36***	.36***	.31***	.07
se	(.10)	(.10)	(.11)	(.11)	(.11)	(.12)
N	813	813	813	813	813	813
R-squared	0.04	0.12	0.19	0.20	0.24	0.41
Daughters: PPVT						
β	9.94***	7.36***	6.20***	6.03***	5.01***	1.19
se	(1.31)	(1.31)	(1.41)	(1.46)	(1.51)	(1.76)
N	847	847	847	847	847	847
R-squared	0.06	0.14	0.22	0.24	0.28	0.42
Sons: PPVT						
β	9.91***	7.67***	7.40***	7.73***	6.53***	4.78***
se	(1.46)	(1.58)	(1.52)	(1.57)	(1.57)	(1.73)
N	900	900	900	900	900	900
R-squared	0.06	0.12	0.22	0.22	0.27	0.39

*** p<.01; ** p<.05; * p<.10
Standard errors in brackets.

These results suggest that the pooled effect size in the full sample may mask differences in the mechanisms driving this inter-generational transmission of mothers' education. Alternatively, this result may reflect gender differences in tests of cognitive ability more generally. This finding will be discussed further below.

Sensitivity analysis: age of mother

As noted above our sample is likely to suffer from selection issues because we have a sample of young and therefore less educated mothers. For this reason, we split the sample of mothers into quintile groups according to the mother's age at the birth of her first child and interact these five groups with our binary education variable to explore possible age related differences in education effects for our sample. We entered these interaction terms into the regression equation and repeated the original analyses.

Tables 5 and 6 show some differences by mothers' age for PIAT achievement and PPVT outcomes respectively. For clarity, only the unconditional education effect, i.e. the raw correlation (column 1 in Tables 3 and 4 above) and the conditional education effect with the all control sets included (column 6 in Tables 3 and 4 above) are

presented. Both Tables show the interaction coefficients for the education effect sizes of mothers who stayed on in post-compulsory education for each quintile of mother's age at the birth of her first child, with respect to mothers who had their children earliest – i.e. those in the first quintile. These results are also represented graphically in Figures 4 and 5 as individual effect sizes for each age quintile, showing the trend across the five groups.

The estimates for the effect of mothers' staying on in education on both cognitive outcomes are larger for women who become mothers earlier and there is a general downward linear trend in the size of the education effect as mothers' age at first birth increases. There is slight discrepancy from this pattern for the second youngest quintile.

Thus both the unconditional and conditional estimates are lower for women who become mothers later. The full sample estimates are a weighted average of the split sample results. Under the assumption that the education effect in the "missing" oldest group of mothers is more like that for the older sample mothers than the younger sample mothers, we can deduce that our sample estimates are an upper bound of the true effect. The null effect for the PIAT achievement outcome would not be changed by the fertility-based sample selection unless the true age profile of the education effect were very non-linear such that the oldest mothers had an education effect similar to that of the youngest mothers. For the PPVT scores we did estimate an effect in our full but censored sample but this may be due to the sample selection bias.

Table 5: PIAT achievement: education effect sizes by mothers' age at birth of first child

	Unconditional education effect (Col 1)	Conditional education effect (Col 6)
Achievement:		
1st quint of mothers' age * stayed on post-16	.70***	.63*
	(.21)	(.25)
2nd quint of mothers' age * stayed on post-16	-.09	-.57
	(.39)	(.36)
3rd quint of mothers' age * stayed on post-16	-.01	-.40
	(.23)	(.28)
4th quint of mothers' age * stayed on post-16	-.10	-.46
	(.24)	(.27)
5th quint of mothers' age * stayed on post-16	-.17	-.66*
	(.23)	(.27)
N	1583	1583
R-squared	0.05	0.32

*** p<.01; ** p<.05; * p<.10
Standard errors in brackets.

Figure 5: PIAT achievement: education effect sizes by mothers' age at birth of first child

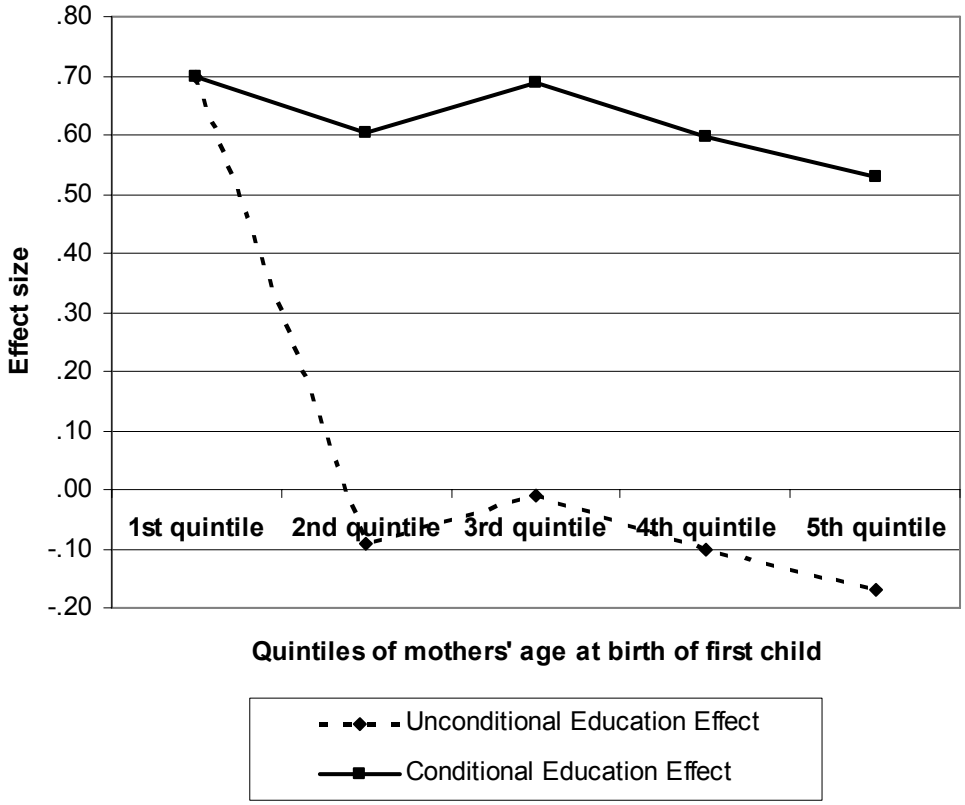
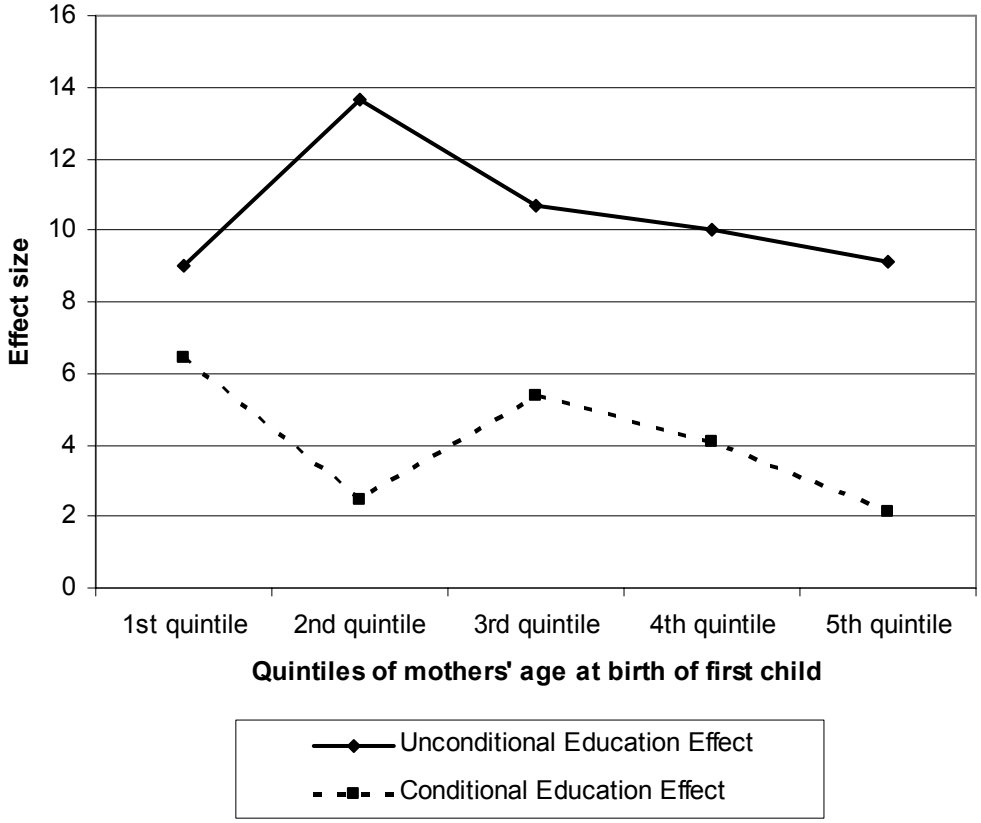


Table 6: PPVT: Education effect sizes by mothers' age at birth of first child

	Unconditional education effect (Col 1)	Conditional education effect (Col 6)
Achievement:		
1st quint of mothers' age * stayed on post-16	9.03***	6.46
	(3.31)	(3.52)
2nd quint of mothers' age * stayed on post-16	4.61	-4.01
	(6.58)	(5.83)
3rd quint of mothers' age * stayed on post-16	1.66	-1.07
	(4.25)	(4.26)
4th quint of mothers' age * stayed on post-16	1.01	-2.38
	(3.71)	(3.81)
5th quint of mothers' age * stayed on post-16	.09	-4.36
	(3.60)	(3.76)
N	1747	1747
R-squared	0.06	0.33

*** p<.01; ** p<.05; * p<.10
Standard errors in brackets.

Figure 6: PPVT: education effect sizes by mothers' age at birth of first child



1.4 Discussion

The first section of this report focuses on the effects of mothers' post-16 education decision on measures of children's development across both cognitive and socio-emotional domains. The analyses provide some support for the hypothesis of causal effects under the assumptions of our estimation model but only on one of the outcomes considered; children of mothers who stayed on in education after age 16, scored more highly in terms of their PPVT scores and this effect persisted - albeit much reduced - even after influences that might otherwise explain this association (mother's own ability, socio-economic factors) were taken into account. However, we also find that a very great deal of the raw relationship between mothers' education and children's cognitive ability is driven by the selection bias that more ambitious and cognitively capable women and women from more advantaged backgrounds are both more likely to stay on in school post-16 and to have children who attain more highly. This is not an effect of the extra educational participation but of these third factors.

As discussed above, issues of selection here are twofold here. Firstly, education and decisions about post-compulsory participation are likely to be endogenously determined. Secondly, the over-representation of young mothers in the current sample adds an extra element of bias. Our sensitivity analysis shows that the education effect does vary with the age of mothers which suggests that this latter bias may be important. Under the sensible assumption that the education effect for the missing mothers is more like that for the women who became mothers latest in the sample

than for those who have children earlier, we conclude that even that effect which remains after controls are introduced is likely to be an over-estimate of the true population effect of education. An alternative explanation is that the effect of education is stronger for older children, in which case if the sample were given time to mature, stronger effect sizes would result. We cannot test between these alternative hypotheses but find the former explanation more likely on the grounds that there is plenty of evidence that effects of family background are picked up in early development.

Although the effect of mothers' education on PPVT scores does persist even with many control measures introduced, this is not the case for a wider ranging measure of academic achievement which assesses abilities across reading and maths, the PIAT score. We find this result somewhat puzzling, but the result of stronger effects of mothers' education on PPVT scores than on PIAT achievement sub-scales is consistent with some other developmental literature wherein the measure of verbal ability assessed by the PPVT has been shown to be more related to distal features of the family such as parental education and SES and to some extent home environment than the PIAT tests or other achievement measures. In the U.S., PPVT is also consistently more related to race (see for example, Brooks-Gunn et al., 2003).

Though verbal ability as assessed by the PPVT is likely to be slightly more culturally bound, it is not definitively clear why this might be. One could argue that vocabulary is particularly related to cultural capital and therefore that tests of receptive vocabulary are more likely to be culturally biased. It has also been shown in some contexts that parents with higher levels of education use different, more complex language with their children who, in turn, have better vocabularies than children of less educated parents (e.g. Hoff, 2003). Thus the PPVT effect may persist because there is a particularly substantive impact of mothers' education on this feature of attainment and/or that its effect is more easily isolated and identified.

Similarly, the PPVT may simply be a better, more discriminatory measure of actual ability than the PIAT score, making it statistically easier to discern effects. Some authors have argued that the PIAT exams may be less able to distinguish among ability levels for children in middle childhood and early adolescence; the set of 74 questions has more questions at the very low and very high ability levels. The broad distribution of children's age in our sample might therefore mask small, but meaningful differences in achievement that the PIAT scales are not sensitive enough to pick up. Moreover, the PIAT scales attempt to measure far broader ranging abilities across maths and reading than the more narrow scope of the PPVT's assessment of general verbal ability. It should also be noted that the PIAT sub-scales were normed for use on UK samples in the late 1960s and so may have lower utility than they once did in assessing the wide range of academic achievement related skills they were designed to measure.

It is interesting to note that no effect of education was found for the socio-emotional development measures of global self-worth and scholastic competence; children of mothers who stayed on in post-compulsory education are doing better in terms of their verbal intelligence but they don't rate themselves as doing so. More subtle relationships between education, these "softer" outcomes and the controls used in our analyses might become clearer in more complex modelling of the data. Davis-Kean

(2005), for example, shows that children's beliefs in their own abilities mediate the effect of parents' beliefs and expectations on their performance in cognitive tasks. Our results suggest the possibility that over-estimation of capability is a negative determinant of subsequent achievement.

The effect of mothers' education appears to be smaller for daughters than for sons. For the PIAT achievement score, the introduction of controls for G2 development and aspirations prior to age 16 knocks out the initially large raw effect of education for all children. The same is true for daughters' PPVT scores. For sons, however, despite some attenuation in the size of the education effect after adding in our comprehensive controls, the strong relationship with mothers' staying on decision persists. This finding is unlikely to simply reflect differences in the distribution of PPVT scores: mean PPVT = 100.55 and 100.22 for males and females respectively; standard deviation = 14.47 and 14.42. Gendered differences in test scores are consistent with other standardised achievement outcomes (Halpern, 2000). It may also be that the processes through which parental education are transmitted are differentiated by child gender, another consistent finding in the gender socialisation literature (Jacobs and Eccles, 1992; Jacobs et al., 2002; see also Barocas, 1991; Baydar, Brooks-Gunn and Furstenburg, 1993; Eccles, 1984; Eccles et al., 1989). However, as noted above, we do not explore the complex pathways involved in how education might affect child outcomes and hope to address such questions in subsequent work.

We conclude that any assumptions of causality in the relationship of this measure of mothers' education and children's attainment should be made extremely tentatively. These results emphasise the problem of the endogeneity of education and the associated bias in the estimated size of education effects from failing to sufficiently account for background characteristics; it is possible that these effects would disappear altogether if we controlled for more potential sources of confounding bias or had a more representative sample of mothers. There may also be some small effect for older children, i.e. that the effect from the mother to child takes time in the life of the child to manifest and is not present in the early years or mid-childhood.

2. Estimating the effects of mothers' post-16 education on parenting

2.1 Introduction

The social science literature is abundant with studies examining the possible mechanisms within the family context that attempt to explain why children of parents with higher levels of education do better in standard tests of school attainment and show more positive social and behavioural development than those of parents with less education (Bee et al., 1982; Bynner and Joshi, 2002; Feinstein et al., 1999; 2004; Gregg and Machin, 2000; Wolfe and Haveman, 2002). As noted above and as detailed extensively in an earlier Research Report of the Centre (WBL Research Report 10), mechanisms by which educational effects may be transmitted include income, family size, parental well-being, beliefs and aspirations, parenting and the quality of the parent-child relationship. In the second part of this report we focus on the relationship between education and parenting.

In the field of child development, few would argue against the view that parents and family environments are among the most important influences. And, in recent years, changes in the demographics and dynamics of family life have fuelled the interest and debate in the topic of what constitutes responsible and effective parenting (ramey and Ramey, 2000). The importance of parenting and parenting style on children's development has been well documented. For example, an extensive literature documents connections between aspects of warmth in parent-child relationships and children's development and adjustment. In particular, the importance of parental warmth and secure attachment for the development of children's cognitive and behavioural competence is widely acknowledged (for example Baumrind, 1967, 1971; Bowlby, 1969, 1973; Masten and Coatsworth, 1998). Similarly, parents who use a proactive parenting style with their children, i.e. one that is affectionate, warm, structured and consistent, are more likely to promote pro-social behaviour and academic readiness (Maccoby and Martin, 1983; Masten and Coatsworth, 1998). A large number of studies also find correlations between the warmth of parent-child interactions and later cognitive outcomes (Barocas et al., 1991; Diaz, Neal and Vachio, 1991; Estrada et al., 1987; McGroder, 2000).

Theories considering the aetiologies of conduct problems and depression among children suggest that inconsistent, erratic and harsh parenting practices characterise a coercive cycle of conflict and parent-child interactions that lead to increased problem behaviour and depressive symptoms (for example, Patterson, 1986; Patterson, DeBaryshe and Ramsey, 1989). Parent-child interactions are also important for internalised behavioural outcomes such as social and emotional understanding (Dunn, 1988; Laible and Thompson, 2002), as well as academic success from early childhood through adolescence, independent of gender and socio-economic status (Egeland, Pianta and O'Brien, 1993; Fagot and Gauvain, 1997; Steinberg et al., 1995).

Why does parents' education matter for parenting and its impact on parent-child interaction? At first glance, one may not imagine that education would impact heavily on aspects of parenting such as warmth and affection which are more about enjoyment of relationships with children and parental well-being than about parental demographics. However, to the extent that education enhances efficacy and well-

being it may lead to increased parental warmth. And, as noted by Eccles and Davis-Kean (2005), proponents of this view argue that education may provide parents with important skills, values and knowledge that enable them to better support and facilitate their children's learning and development. In turn, these cognitive strategies may influence parents' own personal resources to provide an environment that presents greater opportunities and enables broader life chances.

Evidence consistently points to parental education as influencing multiple aspects of parenting and family functioning which, in turn, are strongly associated with measures of children's cognitive achievement, socio-emotional development and behavioural adjustment. For example, parents with higher levels of education show greater average levels of warmth and emotional supportiveness in parent-child interactions (Bradley et al., 1989; Klebanov et al., 1994) and lower levels of harsh and/or erratic discipline (Fox, Platz and Bentley, 1995). In comparison with parents with lower levels of education, parents with higher levels of education are more likely to provide cognitively stimulating learning environments, engage in educational behaviours (Davis-Kean, 2005; Kohl, Lengua and McMahon, 2000; Linver, Brooks-Gunn and Kohen, 2002) and adopt teaching strategies that promote skill and foster interest and motivation (Diaz et al., 1991; Laosa, 1983; Uribe, Levine and Levine, 1993).

Similarly, those parents with higher levels of education are more likely than those with less education to have high educational aspirations for their children (Alexander, Entwisle and Bedinger, 1994; Davis-Kean, 2005), lower levels of depression (Feinstein, 2002), fewer children (Ferri and Smith, 2003) and higher earnings (Dearden et al., 2000; Hobcraft, 1998; 2000; McIntosh, 2004). These elements, in turn, influence the quality of parenting and parent-child relations. However, as noted above, much of the evidence supporting this association remains correlational and uses methodologies which assume that educational attainment and the decisions therein are exogenous, an assumption which may be incorrect.

The aim of the second part of this report is to investigate the relationship between a mother's education and her parenting and attempt to establish an unbiased estimate of the size of the effect of mothers' education. As in Part 1, by considering data across generations, our data allow us to estimate the size of the bias in the relationship between education and parenting from failing to account for background characteristics, earlier cognitive achievement and the parenting mothers experienced during their own childhood. Again, we do not attempt to answer questions relating to *how* education might affect parenting, but to investigate more thoroughly one of the pathways consistently implicated in the inter-generational transmission of educational success.

2.2 Method

2.2.1 Participants

The data analysed come from the same sub-sample of the National Child Development Study (NCDS) used in Part 1 (see Figure 1 above). However, because for the parenting outcomes we have data for children aged 3 years and older, here we restrict the analyses to G3 children, aged 3 years or over (N = 1879) living at home

with an NCDS cohort member mother (N = 1172). Again, this excludes only a small number of children who were not resident with their cohort mothers and for children for whom the study cohort member was the father (N = 1068 children aged 3 years or over, of N = 626 fathers).

2.2.2 Education variable

As above, our measure of parental education is a binary variable indicating whether or not the G2 mother stayed on in post-compulsory education. The same considerations apply here as in Part 1, whereby this is a measure of the length of educational participation, not of its quality or content. For a more detailed discussion of this definition, see section 1.2.2.

2.2.3 Parenting

Parenting encompasses elements of parent-child interaction that include warmth and secure attachment as well as discipline and intrusiveness within a structured and consistent environment. Similarly, educational behaviours and parents' teaching strategies, such as reading to/with children and the provision of and engagement in a cognitively stimulating environment, have also been consistently associated with children's development. Therefore to measure parenting we use the Home Observation Measurement of the Environment – Short Form (HOME-SF); a consistently used measure of the quality of parenting and the child's home environment.

A modification of the HOME inventory (Caldwell and Bradley, 1984), the HOME-SF is a measure of the quality of parenting provided in a child's home. The HOME-SF assesses parenting on two sub-scales: *emotional support*, i.e. measures of warmth and discipline, as well as *cognitive stimulation*, i.e. nature and frequency of educational behaviours in the home such as age-appropriate teaching and reading, presence and use of household resources such as books and newspapers, and the physical space of the home and surrounding area. It is made up from both mother reported items such as "how often do you read to your child?" and "approximately how many books does your child have?" as well as interviewer observation of mother-child interaction both of which reflect the age of the child. Observations for the emotional supportiveness sub-scale include, for example, "did the mother caress, kiss or hug the child at least once during observation", "did the mother slap or spank the child at least once during observation" and for the cognitive stimulation sub-scale "is the child's play environment safe, clean and/or perceptually monotonous".

The HOME-SF is assessed with respect to developmental stages and comes in four age-appropriate versions: children under age 3, children aged 3-5, children aged 6-9 and those over 10 years old. Scores are standardised within each age-appropriate block to reflect developmental differences in these parenting constructs. Note however, that interviewer observations are missing for children under age 3 and so, to prevent bias resulting from only using the mother-reported information, we only consider complete assessments, i.e. for those children 3 years old and over. The overall score for each sub-scale is made up of the scores from these individual age-appropriate blocks. Overall, between 92 and 97 percent of children have a completed HOME-SF assessment.

Longitudinal research indicates that the HOME predicts later cognitive, social and physical development (Bee et al., 1982; Yeates et al., 1983). The HOME scale has also been shown as a useful early indicator of a variety of developmental risks and delays such as clinical malnutrition, failure-to-thrive, language delay, developmental delay and poor academic achievement (Elardo and Bradley, 1981). Summary statistics for our education variable and parenting outcomes are given in Table 7.

Table 7: Summary statistics for mothers' education and parenting outcomes

Variable	Obs	Mean	Std. Dev.	Min	Max
Education variable					
Staying on decision at 16	1172	0.19	0.39	0	1
Parenting outcomes					
HOME: Cognitive stimulation score	1879	100.79	15.91	24.00	140.64
HOME: Emotional Supportiveness score	1879	100.06	16.24	16.42	140.96

2.2.4 Covariates

We control for the same range of measures of G2 child and family characteristics collected at the four time points detailed above, namely birth, 7, 11 and 16 years. All summary statistics (observations, mean, standard deviation and range) are reported in Table A1 in the Appendix.

2.2.5 Estimation strategy

To test our hypothesis that a mother's education has a causal effect on her parenting, we use the same stepwise OLS regression analysis as in Part 1. As described above, our aim is to identify and control for as much information about the development of the G2 mother as possible prior to and including age 16, when the decision to stay on in post-compulsory education or not is made. Inasmuch as we condition out the potential influence of omitted variables, then our estimates of maternal education effects can be considered unbiased.

The methodological issues of endogeneity and selection bias discussed in Part 1 also apply here and we conduct the same sensitivity analysis according to mothers' age at first birth to explore the direction of any age moderation. See section 1.2.7 for a detailed discussion of all these issues.

2.3 Results

The means and standard deviations for both of the HOME sub-scales are presented by mothers' education decision in Table 8. Again, mothers who stayed on in education after age 16 are achieving consistently higher scores in both parenting outcomes assessed than those whose mothers did not.

Table 8: Means and standard deviations for parenting outcomes by mothers' education decision

Mothers' education decision	HOME: Cognitive Stimulation		HOME: Emotional Supportiveness	
	Mean	Std. Dev.	Mean	Std. Dev
Did not stay on	99.39	16.12	99.28	16.24
Stayed on	101.82	12.63	104.03	15.70

Table 9 shows the summary results of the stepwise OLS regression models separately for both sub-scales of the HOME score. In the full sample of G3 children, while the initially strong raw effect of maternal education is reduced by 73%, from 8.21 (column 1) to 2.26 (column 6), with the introduction of additional control sets, the effect of mothers' education remains statistically significant for cognitive stimulation (p<0.05). There is no effect of staying on in post-16 education on emotional supportiveness; the initially significant unconditional education effect is reduced from 4.70 to 0.56 falling by 88% once we introduce the full set of controls.

Table 9: Stepwise multilevel regression summary results for parenting outcomes

		Additional control sets				
	No controls	G1 Family distal	G1 Family Proximal	G2 Area	G2 School	G2 Development and aspirations
HOME: Cognitive stimulation						
β	8.21***	5.79***	3.97***	4.35***	4.19***	2.26*
se	(1.04)	(1.10)	(1.13)	(1.14)	(1.16)	(1.24)
N	1879	1879	1879	1879	1879	1879
R-squared	0.04	0.10	0.18	0.21	0.22	0.34
HOME: Emotional supportiveness						
β	4.70***	3.71***	2.65***	2.64***	2.00	0.56
se	(1.16)	(1.26)	(1.26)	(1.31)	(1.33)	(1.38)
N	1879	1879	1879	1879	1879	1879
R-squared	0.01	0.04	0.09	0.11	0.13	0.23

*** p<.01; ** p<.05; * p<.10
Standard errors in brackets.

Moderation by child gender

In Table 10, we report results taking account of gender moderation, running separate models for G3 daughters and sons. For both cognitive stimulation and emotional support there are large differences in the estimated parameters. For example, without the inclusion of any controls, the estimated parameter of mothers' education decision for G3 cognitive stimulation is 9.12 for daughters and 7.39 for sons (columns 1). For

emotional supportiveness, the unconditional estimated parameter of mothers' education decision on G3 daughters is 6.00 and for G3 sons 3.42 (columns 1).

As in Part 1, the bias in the estimated parameters from failing to account for background characteristics again appears larger for daughters than for sons. For daughters, the initial raw correlation of mothers' education for cognitive stimulation of 9.12 is reduced to 0.46, a reduction of 95%. For sons this reduction is 61%. For emotional support, the size of the bias for daughters is over 100% whereas for sons is 74%. Finally, the only estimated effect of mothers' education decision that remains significant at the 10% level with the inclusion of controls is G3 sons' cognitive stimulation. The initially statistically significant effect of maternal staying on in education on G3 daughters' cognitive stimulation is knocked out once G2 development and achievement measures are controlled for and for emotional supportiveness once G2 school area level covariates are entered into the stepwise model.

Table 10: Stepwise multilevel regression summary results for parenting outcomes: G3 gender

		Additional control sets				
	No controls	**G1 Family distal**	**G1 Family Proximal**	**G2 Area**	**G2 School**	**G2 Development and aspirations**
Daughters: HOME: Cognitive stimulation						
β	9.12***	6.50***	3.74***	4.28***	4.02**	0.46
se	(1.39)	(1.52)	(1.61)	(1.63)	(1.70)	(1.86)
N	915	915	915	915	915	915
R-squared	0.05	0.12	0.22	0.24	0.27	0.43
Sons: HOME: Cognitive stimulation						
β	7.39***	5.30***	4.11***	4.36***	4.48***	2.91*
se	(1.31)	(1.41)	(1.43)	(1.45)	(1.49)	(1.71)
N	964	964	964	964	964	964
R-squared	0.04	0.11	0.20	0.23	0.25	0.39
Daughters: HOME: Emotional supportiveness						
β	6.00***	4.51***	3.06*	2.51	2.25	-0.33
se	(1.50)	(1.68)	(1.71)	(1.76)	(1.81)	(1.97)
N	915	915	915	915	915	915
R-squared	0.02	0.05	0.12	0.14	0.17	0.33
Sons: HOME: Emotional supportiveness						
β	3.42**	3.13*	2.24	2.63	1.82	0.91
se	(1.51)	(1.64)	(1.68)	(1.76)	(1.84)	(1.99)
N	964	964	964	964	964	964
R-squared	0.01	0.07	0.13	0.15	0.18	0.32

*** p<.01; ** p<.05; * p<.10
Standard errors in brackets.

Sensitivity analysis: age of mother

Tables 11 and 12 (also represented graphically in Figures 7 and 8) show some interesting findings when we separate the sample by the age of the mother. As in Part 1, we only present the unconditional education effect and conditional education effect with all control sets included. Both Tables show interaction terms for the education effect sizes for the second to fifth quintiles of mothers' age at first birth for those who stayed on in post-16 education, with reference to mothers who had their first child earliest. Again, these results are represented graphically in Figures 7 and 8 as individual effect sizes for each age group, showing the trend across the five quintiles. In contrast to the sensitivity analysis presented in Part 1 of this report, the estimates for the effect of mothers' post-16 educational participation on both measures of parenting are larger for women who had their children later in adulthood. This is reflected in the general upward linear trend in the size of the education effect as mothers' age at first birth increases. This relationship is less marked for the outcome of emotional supportiveness. Thus, if our sample had not omitted older mothers the estimated effect for mothers' parenting in terms of their provision of a cognitively stimulating environment may have been larger. As in Part 1, there is an alternative interpretation of this result in that the education effect is stronger for younger children than for older children.

Table 11: HOME: Cognitive Stimulation: education effect sizes by mothers' age at birth of first child

	Unconditional education effect (Col 1)	Conditional education effect (Col 6)
Achievement:		
1st quint of mothers' age * stayed on post-16	2.81	-1.44
	(8.02)	(6.72)
2nd quint of mothers' age * stayed on post-16	4.95	3.69
	(8.43)	(7.30)
3rd quint of mothers' age * stayed on post-16	2.87	1.51
	(8.41)	(7.01)
4th quint of mothers' age * stayed on post-16	4.23	2.32
	(8.13)	(6.85)
5th quint of mothers' age * stayed on post-16	8.25	6.21
	(8.11)	(6.87)
N	1879	1879
R-squared	0.05	0.34

*** p<.01; ** p<.05; * p<.10
Standard errors in brackets.

Figure 7: HOME: Cognitive Stimulation: education effect sizes by mothers' age at birth of first child

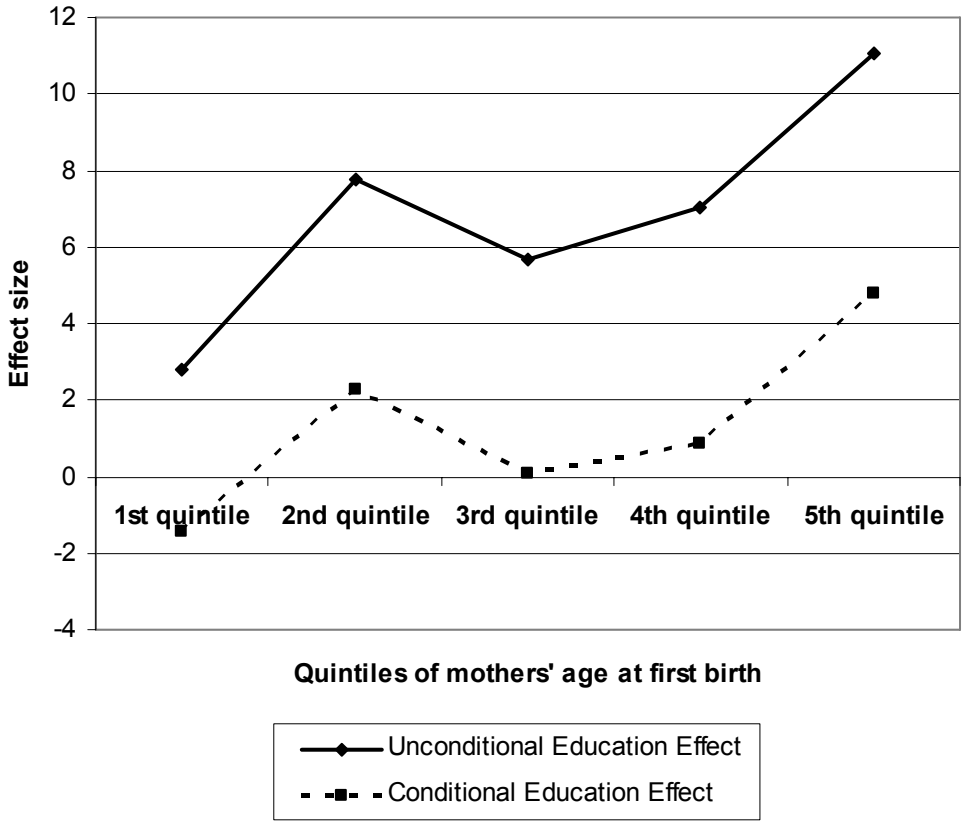
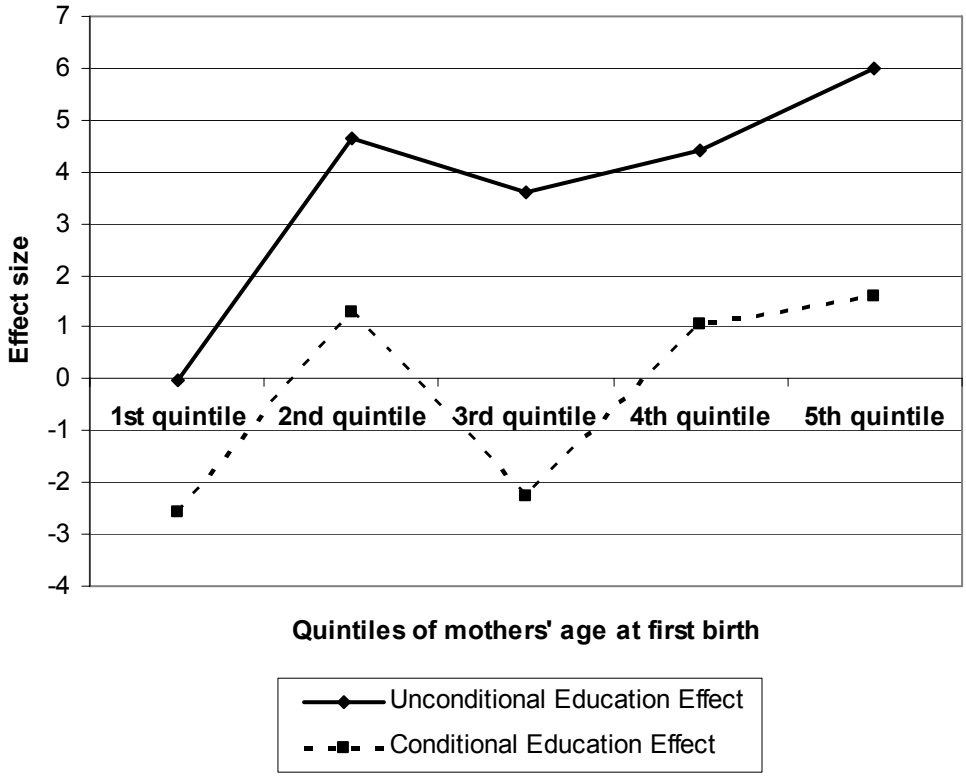


Table 12: HOME: Emotional Supportiveness: education effect sizes by mothers' age at birth of first child

	Unconditional education effect (Col 1)	Conditional education effect (Col 6)
Achievement:		
1st quint of mothers' age * stayed on post-16	-.04	-2.59
	(3.95)	(3.87)
2nd quint of mothers' age * stayed on post-16	4.70	3.88
	(5.00)	(5.27)
3rd quint of mothers' age * stayed on post-16	3.66	.32
	(4.75)	(4.41)
4th quint of mothers' age * stayed on post-16	4.47	3.64
	(4.37)	(4.19)
5th quint of mothers' age * stayed on post-16	6.03	4.17
	(4.31)	(4.22)
N	1879	1879
R-squared	0.02	0.24

*** p<.01; ** p<.05; * p<.10
Standard errors in brackets.

Figure 8: HOME: Emotional Supportiveness: education effect sizes by mothers' age at birth of first child



2.4 Discussion

Part 2 of this report examines the effects of mothers' education on parenting as assessed by the HOME-SF, again producing complexities with respect to gender moderation and selection bias. For parenting in terms of the provision of a cognitively stimulating environment, the initially strong raw correlation shows considerable attenuation once we control for features of the mother's background, her prior achievement, development and aspirations. Again, the effect of mothers' decision to stay on in post-compulsory education persists even with the inclusion of nearly 200 controls. However, were we to include more covariates, it is entirely feasible that we could further reduce the estimated size of this effect. This reduction is substantive given that, in the economic returns to education, failing to include achievement and measures of social background introduces a 48% upward bias on the estimated size of the education effect (Blundell, Dearden and Sianesi, 2003).

The effects of education on mothers' provision of a cognitively stimulating home environment are also moderated by the age at which the mother has her first child. However, here the education effect operates in the opposite direction, such that participating in post-compulsory education has more influence on the older mothers in our sample than the younger ones. Thus, if the sample had not omitted older mothers the estimated effect may have been larger than was the case and we conclude that there is an effect of post-16 participation on the provision of a cognitively stimulating home environment. Alternatively, it could be that the education effect here is stronger

for younger children than for older children. Unfortunately, due to constraints in the data we do not have information on the youngest children, those under 3 years old, and are unable to test this hypothesis further.

There is no effect of staying on in post-compulsory education on emotional warmth and supportiveness.

These findings match a priori theoretical assumptions that the direct effects of maternal education may be particularly important for the provision of a cognitively stimulating environment. As noted in our introduction, parental education may matter for parenting in that it provides parents with the cognitive resources, values and skills that enable them to better support and facilitate their child's learning and developmental environment. That we do not find direct effects of mothers' education on aspects of emotional supportiveness does not necessarily mean that education bears no relation to such elements of parenting. Rather the relationship between education and parenting here may be indirect and instead mediated through aspects of the family such as mothers' mental health and well-being, partner relations and parental beliefs and aspirations. More complex modelling of these data might reveal a better understanding of possible mediation effects.

An alternative explanation could be that these elements of parenting are themselves endogenously determined. While greater education may provide parents with the personal resources to provide an intellectually engaging and cognitively rich proximal environment, it may not carry such gains for the provision of warm, sensitive and consistent parenting as assessed by the emotional warmth sub-scale of the HOME inventory. These skills may be gained through other routes than education. For example, across these findings the inclusion of controls for family proximal process, i.e. the parenting and proximal environment the G2 woman experienced growing up, knock out much of the initial correlation with maternal education, most notably for measures of her emotional supportiveness. The findings presented here may then also reflect an inter-generational transmission of parenting as well as education, again a consistent finding in the developmental literature (Belsky et al., 2005; Patterson, 1998; Scaramella and Conger, 2003; Serbin and Karp, 2003).

Allowing for moderation by gender, the bias in mothers' education again appears to be larger for a mother's daughters than for her sons. The estimated effect of the mother's staying on decision on her parenting, in terms of cognitive stimulation, remains significant in relation to sons. Together with the results in Part 1 of this report, the significant effect of maternal education on cognitive stimulation for sons' PPVT scores is of particular interest. These findings could indicate that in these data one potential pathway for the effect of mothers' education on their son's development is through the provision of a cognitively stimulating environment. However, we cannot infer this from these findings as the analysis does not provide a test of that hypothesis. The effect on cognitive stimulation is not strong enough to provide sufficient expected variation in children's attainment to test this hypothesis. Such an interpretation of these results requires additional exploration using methods that allow modelling of the data and the pathways therein.

In summary, Part 2 of this report also presents complexities of gender moderation and selection bias. Again, there is considerable bias from failing to account for

background characteristics; however, there appears to be a small effect of mothers' decision to stay on in full-time education after age 16 on their parenting as assessed on the cognitive stimulation sub-scale of the HOME inventory, but only for sons. We now turn to our general conclusions and discuss both sets of results and their implications for future research and policy.

3. Conclusions

Children of parents with longer participation in education do better in standardised tests of school attainment and show greater positive social and behavioural development than those of parents with less education. As noted above, much of the developmental literature tends to a causal interpretation of the relationship between parents' education, the development and ability of their children and some of the mechanisms put forward to explain this association. The results of the current two studies, however, suggest that such assumptions should be drawn with considerable caution.

Through the use of comprehensive control sets we have been able to reduce nearly all of the raw correlation between mothers' post-16 education with our various outcomes of children's development and parenting. And while we do find evidence of robust effects of mothers' education, the effect is small and, given the selection issues discussed throughout this report, we are careful not to overstate claims that this is evidence of a causal relationship.

The results presented here suggest that much of the apparent relationship between mother's post-16 education and children's cognitive ability and her parenting is driven by the selection effects. We find that it is largely other factors, such as aspirations, which determine a mother's parenting and her child's attainment as well as her decision to stay on in education; women with higher levels of school attainment and motivation and more supportive contextual backgrounds are more likely to stay on in school post-16 and also more likely to i) have children who attain more highly on achievement tests, and, ii) exhibit more cognitively stimulating behaviours with their children.

Issues of selection bias here are twofold. Firstly, education and decisions to stay on in post-compulsory education are likely to be endogenously determined, i.e. educational decisions taken by individuals are likely to be made on the basis of unobserved beliefs, attitudes and aspirations, features of personality and wider social contexts that may equally predict the subsequent developmental outcomes of their children. Secondly, the over-representation of young mothers in the current sample limits our ability to ascertain the direction of any bias.

While the sensitivity analyses conducted go some way to assessing the direction of this bias, the findings reported here are affected by both of these selection issues. They suggest that if we had more mothers in our sample who had children later in adulthood the education effect would be even lower than that estimated here; although it may be that as their children matured some of the effect would return as the effect may only be identified in older children. Thus, it may be that this is not a moderation effect by age at first birth but is actually in terms of the age of the child. These analyses highlight the importance of the sample selection bias and the difficulties this poses for inference.

Nevertheless, this should not distract us from the key point that the unconditional difference between outcomes for mothers who stayed on and those who did not does not persist after the inclusion of measures that condition for the attainments, motivation and context of the mother-to-be before her staying on decision was made.

As such the raw effect of post-compulsory educational participation of the mother and the outcomes for children and in terms of parenting is strongly biased upwards.

We are also cognisant of the possibility that our estimation strategy may in fact over-control for background characteristics. If we assume that the decision to stay on in post-compulsory education is made on the basis of many factors and is reached over time, so too is the decision to not stay on. Those individuals who at 14 or 15 already plan to leave school at the end of compulsory education may have lower age 16 tests scores and teacher rated abilities not because they are less able but because it matters less to them to do well. Thus the age 16 attainment measures may pick up aspects of the effect of the decision to stay on as well as of prior attainment.

Moreover, it is important to emphasise that the attainment of the mothers at age 16 is at least in part influenced by education and so might comprise part of an education effect in an alternative formulation of the research question. We find that the estimated effect of post-16 participation is reduced strongly when ability at 16 is included in the model but education should not be reduced to the issue of post-16 participation. We are only testing one element of the effects of education and the true meaning and potential range of impacts of education is broader than the narrow definition assessed here. However, it is a strength of our dataset that we are able to so robustly test the estimated parameters of maternal education effects and we encourage others with comparable datasets to use similar analytic strategies in order to better unpack issues of endogeneity and selection.

Taking both parts of the report together, we find that although education effects are strongly influenced by an upwards selection bias, there is evidence of an effect on cognitive stimulation in the home and of some effect on actual child achievement in terms of the PPVT score. However, the latter effect may be due to sample selection bias and is not large. Taken together it may be thought to suggest that a stimulating cognitive home environment has relatively little effect on attainment, but we cannot infer this from these findings as the analysis does not provide a test of that hypothesis. The effect on cognitive stimulation is not strong enough to provide sufficient expected variation in children's attainment to test this hypothesis, particularly if the impacts of this feature of education on income and other important channels to attainment in the next generation were also weak. However, we note that this joint impact is present for sons, a gender difference that we find puzzling. These issues require additional exploration using methods for structural modelling of the pathways between these measures.

This research adds to a developing body of work by the Centre for Research the Wider Benefits of Learning exploring issues of parenting and parenting behaviours. A recent Research Report by the Centre (Feinstein and Sabates, 2006) also examined the effects of mothers' educational participation on parenting style, using different generational information from the same dataset, and found that there was no causal effect of mothers' post-compulsory educational participation on her subsequent parenting assessed by the educational attitudes and behaviours held for her child. This study examined the relationship between a similarly narrow definition of maternal education (the age at which they left full-time education) and parenting in the same NCDS data but focussed on the parenting experienced by cohort members during their own childhood – i.e. using definitions laid out in section 1.1.1: the parenting of G2 by

G1. Their initial OLS analysis seemed to suggest an association between the duration of mother's full time education and her educational attitudes and behaviours, but the use of a more robust instrumental variable (IV) methodology showed that this link was, as we conclude here, due to underlying selection effects.

Thus, while there are important differences between the two reports in terms of the generation and the methodology used, both suggest that the effects of spending additional time in education post-16 may be less direct and causal than other research suggests and that much of the association reported between educational participation and its various associations arises from underlying differences between those who stayed on in education and those who did not.

We may conclude that education *effects* on the attainment of the next generation are slight but it is nonetheless the case that the children of more educated parents do score more highly on these achievement tests. So what is it that promotes this? We have explored this issue in a previous Research Report of the Centre (Feinstein et al. 2004). In that literature review report we find that parenting style is one mechanism which may facilitate the inter-generational transmission of educational success but there are others: for instance, childcare and school settings, neighbourhoods and peers. Further, parenting itself is more complex than our model in this, or the previous, study has been able to represent, not only comprising a complex array of skills and beliefs that shape children's development through diverse pathways, but changing over time as parents learn through experience and as they also adapt their parenting to the behaviour and response of their children. Equally, children are active participants in their own family rather than passive recipients of parenting and as such shape their proximal environment and the parenting within it.

Further, the proxy we have used here for education – a measure of post-compulsory participation – was relatively narrow. Simply extending the time mothers-to-be spent in education appears to have little effect on the subsequent attainment of their children. Therefore any larger effects which we may expect parents' education to have on their children are more likely to reside in the quality and nature of that education. We conclude that education can achieve a range of different goals but what it achieves will depend on the pedagogy, objectives, ethos, forms of assessment and curricula of learning. Education does not provide a universal panacea of positive unintended consequences. If we set the education system the objective of improving parenting style and of generating inter-generational advantage then that system would look rather different to the system through which these women passed.

It is also worth emphasising the implications of these research findings that the selection processes into education may be as important as the effects of education itself in explaining the inter-generational patterns of educational achievement. Motivated and more able women are more likely to choose to stay on in education post-16 and also to have children who themselves do better in school. This creates social inequity and inefficiency if the children of mothers with less education are less able to achieve their true potential than are the children of mothers with more education. We have not tested this hypothesis in the current study but there is ample evidence from elsewhere that this is the case for the UK. Supporting children in learning through early and continued investment in quality education and developmental opportunities is key to addressing these policy priorities.

Modelling pathways by child gender as well as including the possible mediating role of parents' cognitions is an important next step in our investigation of the inter-generational transmission of educational success in these multi-generation longitudinal datasets.

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Appendix 1: Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
G3 child gender	1879	0.49	0.50	0.00	1.00
Outcome variables					
Overall cognition score	1583	0.00	0.93	-3.58	3.70
PIAT Reading Comprehension	1583	100.09	15.30	36	187
PIAT Maths	1583	100.07	15.27	44.84	150.38
PIAT Reading Recognition	1583	99.91	14.95	47	174
PPVT-R score	1747	100.28	14.66	1	155
Global self worth	1021	184.82	34.61	60	266.31
Scholastic competence	1021	159.59	38.55	43.70	271.02
HOME: cognitive stimulation	1879	100.79	15.91	24.00	140.64
HOME: emotional supportiveness	1879	100.06	16.24	16.42	140.96
HOME: total	1879	100.62	16.04	15.00	141.61
Education variable					
Staying on decision at 16	1116	0.18	0.38	0.00	1.00
G1 Family distal factors					
Mother stayed on at age 16	1879	0.20	0.41	-0.98	1.29
Father stayed on at age 16	1879	0.20	0.41	-0.89	1.67
Family size	1879	1.39	0.78	-0.68	4.35
Mother less than 20 at CM's birth	1879	0.04	0.24	-0.84	1.00
Father less than 20 at CM's birth	1879	0.01	0.08	-0.20	1.00
Age 7: No indoor lavatory	1879	0.13	0.36	-0.91	1.18
Age 7: Persons per room	1879	1.59	0.96	-0.87	6.00
Age 11: Had free school meals	1879	0.11	0.31	-0.67	1.04
Age 7: Experienced financial hardship	1879	0.08	0.27	-0.46	1.00
Age 11: Experienced financial hardship	1879	0.12	0.33	-0.76	1.22
Age 16: Experienced financial hardship	1879	0.10	0.30	-0.80	1.08
Father: SES1	1879	0.03	0.19	-0.60	1.00
Father: SES2	1879	0.15	0.35	-0.80	1.36
Father: SES3NM	1879	0.07	0.29	-0.97	1.00
Father: SES3M	1879	0.46	0.51	-1.05	1.81
Father: SES4	1879	0.23	0.41	-0.88	1.48
Father: SES5	1879	0.06	0.24	-0.64	1.00
Age 11: Neighbourhood amenities: Has park	1879	0.88	0.33	-0.13	1.95
Age 11: Neighbourhood amenities: Has playground	1879	0.58	0.50	-1.01	2.13
Age 11: Neighbourhood amenities: Has swimming pool	1879	0.79	0.41	-0.50	2.16
Age 11: Neighbourhood amenities: Has indoor play centre	1879	0.87	0.33	-0.23	1.91
Age 11: Neighbourhood amenities: Has cinema	1879	0.75	0.44	-0.53	2.12
Age 11: Neighbourhood amenities: Has library	1879	0.95	0.22	0.00	1.57
Age 7: No father	1879	0.03	0.16	0.00	1.00
Age 7: English not first language	1879	0.01	0.09	0.00	1.00
Ever experienced single parenthood	1879	0.11	0.31	0.00	1.00
Age 7: Family has 1 social difficulty	1879	0.11	0.32	0.00	1.00
Age 7: Family has 2 social difficulties	1879	0.04	0.19	0.00	1.00
Age 7: Family has 3 social difficulties	1879	0.05	0.22	0.00	1.00
G1 Family proximal factors					
Age 7: Teacher rated: Low parents' interest in education	1879	0.17	0.37	-0.86	1.34
Age 7: Teacher rated: Medium parents' interest in education	1879	0.46	0.50	-1.23	1.96
Age 7: Teacher rated: High parents' interest in education	1879	0.35	0.48	-1.01	1.77
Age 7: Teacher rated: Very high parents' interest in education	1879	0.02	0.15	-0.44	1.00
Age 11: Teacher rated: Low parents' interest in education	1879	0.18	0.37	-0.73	1.31
Age 11: Teacher rated: Medium parents' interest in education	1879	0.41	0.50	-1.08	1.88
Age 11: Teacher rated: High parents' interest in education	1879	0.38	0.49	-1.19	1.89
Age 11: Teacher rated: Very high parents' interest in education	1879	0.03	0.17	-0.45	1.00
Age 16: Teacher rated: Low parents' interest in education	1879	0.30	0.44	-0.93	1.88
Age 16: Teacher rated: Medium parents' interest in education	1879	0.35	0.48	-1.14	1.91
Age 16: Teacher rated: High parents' interest in education	1879	0.34	0.48	-1.17	1.58
Age 16: Teacher rated: Very high parents' interest in education	1879	0.01	0.12	-0.34	1.00

Variable	Obs	Mean	Std. Dev.	Min	Max
G1 Family proximal factors (continued…)					
Age 7: Mother reads newspaper	1879	0.71	0.45	-0.56	1.89
Age 7: Father reads newspaper	1879	0.80	0.39	-0.55	1.81
Age 7: Mother reads book	1879	0.53	0.50	-1.11	1.80
Age 7: Father reads book	1879	0.67	0.47	-0.83	1.96
Age 7: Mother reads to child	1879	0.84	0.37	-0.30	1.85
Age 7: Father reads to child	1879	0.69	0.47	-1.00	2.04
Age 7: Goes on outings with mother	1879	0.94	0.24	0.00	1.64
Age 7: Goes on outings with father	1879	0.87	0.32	-0.13	1.72
Age 16: How anxious are parents that child does well in school	1879	0.25	0.45	-1.27	1.53
Age 11: Neighbourhood amenities: Uses park	1879	0.79	0.40	-0.46	1.96
Age 11: Neighbourhood amenities: Uses playground	1879	0.44	0.50	-1.09	1.82
Age 11: Neighbourhood amenities: Uses swimming pool	1879	0.74	0.44	-0.61	2.01
Age 11: Neighbourhood amenities: Uses indoor play centre	1879	0.50	0.51	-1.00	1.97
Age 11: Neighbourhood amenities: Uses cinema	1879	0.53	0.50	-0.91	1.94
Age 11: Neighbourhood amenities: Uses library	1879	0.71	0.45	-0.73	1.88
Age 7: Parent want child to stay on after min SLA: No	1879	0.26	0.44	0.00	1.00
Age 7: Parent want child to stay on after min SLA: Yes	1879	0.70	0.46	0.00	1.00
Age 11: Parent want child to stay on after min SLA: No	1879	0.06	0.23	0.00	1.00
Age 11: Parent want child to stay on after min SLA: Yes	1879	0.63	0.48	0.00	1.00
G2 Child factors					
Not toilet trained by age 3	1879	0.04	0.18	-0.44	1.00
Not toilet trained by age 4	1879	0.01	0.09	-0.23	1.00
Not toilet trained by age 5	1879	0.09	0.30	-0.74	1.01
Talks at 2	1879	0.96	0.21	0.00	1.56
Walks at 18 months	1879	0.97	0.15	0.00	1.38
Rated happy at 7	1879	0.94	0.23	0.00	1.65
Bullied at 7	1879	0.06	0.22	-0.53	1.00
Backward at 7	1879	0.12	0.31	-0.69	1.10
Difficult at 7	1879	0.09	0.28	-0.69	1.01
Bristol Social Adjustment Guide aged 7 total	1879	7.76	8.50	-13.26	63.00
Age 7: Maths	1879	-0.04	0.99	-3.08	2.52
Age 7: Reading	1879	-0.03	1.00	-3.61	2.31
Age 7: Teacher ability rating	1879	0.04	1.00	-2.65	3.33
Age 7: Draw-a-man score	1879	-0.02	1.00	-3.19	3.08
Bristol Social Adjustment Guide aged 11 total	1879	7.40	8.30	-12.20	50.00
Age 11: Maths	1879	-0.05	0.98	-2.83	2.36
Age 11: Reading	1879	-0.06	0.98	-3.24	2.66
Age 11: Overall teacher ability rating	1879	0.05	0.93	-2.66	2.85
Age11: Copying designs	1879	-0.03	1.00	-5.88	2.77
Age 11: Reads books (not school/hwk)	1879	1.26	0.72	-1.43	2.44
Age 11: Reads newspapers, mags and comics	1879	1.31	0.70	-1.22	2.78
Age 11: Listens to music (not "pop") outside school	1879	0.49	0.81	-2.54	2.38
Age 11: Goes to clubs outside school	1879	0.59	0.92	-2.78	2.28
Age 11: Goes to school clubs	1879	0.25	0.72	-2.47	2.00
Age 11: Collects stamps	1879	0.46	0.84	-2.77	2.30
Age 11: Makes models outside school	1879	0.15	0.61	-2.15	2.00
Age 11: Looks after animals	1879	1.20	0.88	-1.92	2.75
Age 11: Plans on leaving school: get job	1879	0.18	0.38	0	1
Age 11: Plans on leaving school: full-time study	1879	0.25	0.43	0	1
Age 11: Streamed in high ability group	1879	0.13	0.35	-0.99	1.10
Age 11: Streamed in low ability group	1879	0.09	0.28	-0.72	1.00
Age 11: No. of activities outside school	1879	10.99	4.74	0	18

Variable	Obs	Mean	Std. Dev.	Min	Max
G2 Child factors (continued…)					
Age 16: Maths	1879	-0.06	0.98	-2.73	2.95
Age 16: Reading	1879	-0.05	1.00	-3.71	2.30
Age 16: Teacher ability rating: mathematics	1879	1.74	1.14	-1.25	4.47
Age 16: Teacher ability rating: english	1879	2.21	1.12	-0.98	5.03
Age 16: Teacher ability rating: modern languages	1879	1.36	1.35	-2.86	4.80
Age 16: Teacher ability rating: science	1879	1.61	1.21	-2.22	5.21
Age 16: Teacher ability rating: practical sub	1879	2.02	1.12	-1.40	5.37
Age 16: Teacher ability rating: social studies	1879	1.87	1.18	-1.40	4.75
Aged 16: Rutter externalising problems	1879	1.24	0.33	0.46	3.00
Aged 16: Rutter internalising problems aged 16	1879	1.26	0.34	0.27	3.00
Age 16: cautious - impulsive	1879	2.87	0.94	0.28	5.94
Age 16: moody - even-tempered	1879	3.35	1.28	-0.39	6.78
Age 16: timid - aggressive	1879	2.97	0.81	0.43	5.99
Age 16: flexible - rigid	1879	2.84	0.79	0.59	5.24
Age 16: sociable - withdrawn	1879	2.33	1.02	-0.64	5.31
Age 16: lazy - hardworkng	1879	3.16	1.22	-0.81	6.34
Age 16 medical: general motor handicap	1879	0.01	0.08	0	1
Age 16 medical: general physical abnormality	1879	0.01	0.08	0	1
Age 16 medical: mental retardation	1879	0.02	0.13	0	1
Age 16 medical: emotional,behavioural proble	1879	0.02	0.14	0	1
Age 16 medical: abnormality head and neck	1879	0.01	0.09	0	1
Age 16 medical: abnormality of upper limbs	1879	0.01	0.08	0	1
Age 16 medical: abnormality of lower limbs	1879	0.02	0.15	0	1
Age 16 medical: abnormality of spine-summary	1879	0.01	0.08	0	1
Age 16 medical: abnormality of respiratory s	1879	0.02	0.14	0	1
Age 16 medical: abnormality of alimentary sy	1879	0.01	0.07	0	1
Age 16 medical: abnormality of urogenital sy	1879	0.01	0.12	0	1
Age 16 medical: abnormality of heart	1879	0.01	0.11	0	1
Age 16 medical: haematological abnormality	1879	0.00	0.02	0	1
Age 16 medical: abnormality of skin	1879	0.12	0.33	0	1
Age 16 medical: epilepsy	1879	0.00	0.06	0	1
Age 16 medical: cns condition,other than epi	1879	0.00	0.05	0	1
Age 16 medical: abnormal eye condition	1879	0.10	0.30	0	1
Age 16 medical: hearing defect	1879	0.03	0.17	0	1
Age 16 medical: speech defect	1879	0.01	0.09	0	1
Age 16 medical: any other abnormal condition	1879	0.02	0.14	0	1
Age 16: Child attitudes to school: School is a waste of time	1879	3.97	1.10	1	5
Age 16: Child attitudes to school: I am quiet in class and gt on with my work	1879	2.75	0.97	1	5
Age 16: Child attitudes to school: I think homework is a bore	1879	2.69	1.23	1	5
Age 16: Child attitudes to school: I find it difficult to keep my ind on work	1879	3.19	1.22	1	5
Age 16: Child attitudes to school: I never take my work seriously	1879	3.81	1.14	1	5
Age 16: Child attitudes to school: I don't like school	1879	3.34	1.36	1	5
Age 16: Child attitudes to school: I think there is no point in planning for the future	1879	3.70	1.38	1	5
Age 16: Child attitudes to school: I am always willing to help the teacher	1879	2.54	1.02	1	5
Age 16: Ability self perception: Maths	1879	2.82	0.57	2	4
Age 16: Ability self perception: English	1879	3.11	0.49	2	4
Age 16: Ability self perception: Science	1879	2.63	0.58	2	4
Age 16: Ability self perception: Art	1879	2.72	0.64	2	4
Age 16: Ability self perception: Music	1879	2.55	0.60	2	4
Age 16: Ability self perception: Practical subjects	1879	2.94	0.56	2	4
Age 16: Ability self perception: Sports and games	1879	2.95	0.56	2	4

Variable	Obs	Mean	Std. Dev.	Min	Max
G2 School factors					
% males aged 15 studying for GCE 'o' level only	1879	20.05	29.63	-73.10	118.81
% females aged 15 studying for GCE 'o' level only	1879	22.44	32.16	-68.65	133.71
% males aged 15 studying for CSE only	1879	31.34	27.77	-47.28	115.77
% females aged 15 studying for CSE only	1879	30.87	27.88	-53.24	106.45
% males aged 15 studying for both GCE 'o' level & CSE	1879	23.51	23.80	-47.56	108.85
% females aged 15 studying for for both GCE 'o' level & CSE	1879	25.66	25.01	-46.07	108.76
Number of males in last yr obtained at least 2 A-Level (or equiv) passes	1879	12.41	18.56	-49.20	109.96
Number of females in last yr obtained at least 2 A-Level (or equiv) passes	1879	12.10	18.54	-39.48	110.00
Number of males in last yr gone on to f/t fe	1879	8.11	13.15	-33.63	78.26
Number of females in last yr gone on to f/t fe	1879	5.87	10.14	-24.15	82.00
In last yr % males stayed on past min SLA	1879	56.83	27.19	-22.57	136.42
In last yr % females stayed on past min SLA	1879	57.78	27.70	-18.26	130.20
% pupils in school under 16 with fathers in non-manual occupations	1879	3.90	2.25	-2.09	11.49
% pupils in class with SES 1/2 fathers	1879	20.83	22.56	-44.10	115.18
% pupils in class with unskilled/manual fathers	1879	21.23	21.20	-48.33	100.20
No. children whose paretns have seen teacher to discuss child in last yr	1879	0.50	0.33	-0.50	3.00
% of 11 yr olsds consider able to pass 5 or more GCE 'o' level subjects	1879	25.30	16.39	-15.86	99.25
Age 7: indepent school	1879	0.03	0.17	-0.37	1.00
Age 11: indepent school	1879	0.04	0.19	-0.42	1.01
Age 16: Private school	1879	0.04	0.20	-0.58	1.00
G2 Area factors					
Region: North West	1879	0.12	0.32	0	1
Region: North West	1879	0.08	0.26	0	1
Region: Yorks	1879	0.08	0.27	0	1
Region: NMid	1879	0.07	0.26	0	1
Region: East	1879	0.08	0.27	0	1
Region: London & South East	1879	0.16	0.37	0	1
Region: South	1879	0.06	0.24	0	1
Region: South West	1879	0.06	0.24	0	1
Region: Midlands	1879	0.08	0.27	0	1
Region: Wales	1879	0.05	0.23	0	1
Region: Scotland	1879	0.11	0.31	0	1
Region: New	1879	0.04	0.21	0	1

Appendix 2: Combining estimates and standard errors

The multiple imputation procedure creates *m* imputed datasets. The number of datasets is dependent upon the overall percentage of missingness in the data. Each of the *m* datasets is analysed using a complete-data method. The results, which may vary, are then combined using simple arithmetic to obtain overall estimates and standard errors that reflect missing-data uncertainty as well as finite sample variation. The simplest method for combining the results of *m* analysed datasets is Rubin's (1987) method for a scalar (one dimensional) parameter. In this method, let *Q* represent a population quantity (e.g. a regression coefficient) to be estimated. Let A* and √U denote the estimate of A and the standard error that would be used if no data were missing. The method assumes that the sample is large enough so that √U(A*- A) has approximately a standard normal distribution, so that A* ± 1.96 √U has approximately 95% coverage. Rubin's (1987) overall estimate is simply the average of the *m* estimates:

$$\bar{A} = m^{-1} \sum_{j=1}^{m} A^{*(j)}$$

The uncertainty in $\bar{A}$ has two parts: the average within-imputation variance,

$$\bar{U} = m^{-1} \sum_{j=1}^{m} U^{(j)}$$

and the between-imputations variance,

$$B = (m - 1)^{-1} \sum_{j=1}^{m} [A^{*(j)} - \bar{A}]^2$$

The total variance is a modified sum of the two components,

$$T = \bar{U} + (1 + m^{-1}) B$$

and the square root of T is the overall standard error.

WIDER BENEFITS OF LEARNING RESEARCH REPORT NO.19

Are there effects of mothers' post-16 education on the next generation? Effects on children's development and mothers' parenting

There is an extensive body of research which shows that the children of parents with longer participation in education do better in standard tests of school attainment than those whose parents have had less education. One of the mechanisms put forward for explaining the inter-generational transmission of educational success is parenting.

This report adds to a growing body of research from the Centre for Research on the Wider Benefits of Learning on the inter-generational transmission of educational success and issues of parenting skills, behaviours and attitudes. The report seeks to establish whether the strong correlation between mothers' participation in education and both her child's development and her parenting results from a primarily causal relationship, or from selection effects.

Using longitudinal data spanning three generations, we find that while mothers' participation in post-compulsory education has some small positive causal effects, much of the apparent relationship between a mother's post-16 educational participation and measures of her children's cognitive ability and her parenting skills is driven by the selection bias – it is largely other factors, such as her aspirations, motivation and prior achievement, which determine her child's attainment and affect her decision to stay on in education.

Much of the developmental literature tends towards a causal interpretation of the relationship between parents' education and the development and ability of their children. However, the results of this report suggest that such assumptions should be made with considerable caution.

Our findings suggest that simply extending the length of time that women spend in education may do little to directly affect the educational attainment of their children. Rather, it is the ability and aspirations of women which inform their participation in post-16 education, their parenting ability and the attainment of their children. It may be through inter-generational continuities in factors such as these that inequalities in educational success are transmitted through the generations. This suggests that supporting children in learning through early and continued investment in quality education and developmental opportunities is more important in addressing social immobility than simply extending the average length of participation, important though that may be.

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