PARENTS' CURRENT INCOME, LONG-TERM CHARACTERISTICS AND CHILDREN'S EDUCATION: EVIDENCE FROM THE 1970 BRITISH COHORT STUDY

Massimiliano Bratti

No 658

WARWICK ECONOMIC RESEARCH PAPERS

DEPARTMENT OF ECONOMICS

THE UNIVERSITY OF WARWICK

Parents' Current Income, Long-Term Characteristics and Children's Education: Evidence from the 1970 British Cohort Study*

Massimiliano Bratti†

Abstract

This paper investigates the effect of parents' current income and long-term family characteristics on individuals' highest educational qualification obtained by age 26 using UK data from the 1970 British Cohort Study. The issues of the possible *sample selection bias* produced by the not completely random omission of current family income and that of its potential endogeneity are addressed, using a *hot-deck* multiple imputation procedure and including an indicator of child ability, respectively. I find evidence that current family income has a statistically significant positive impact on children's education, although it is one of negligible magnitude. Long-term family characteristics are far more important.

JEL classification: I20 J24

Key words: children, education, family income, ordered probit, *hot-deck* imputation

*I wish to thank my PhD supervisors Mark Stewart and Jeremy Smith for their support. The paper has benefited from presentations at the University of Warwick, the *ZEW Summer Workshop 2002 on Human Capital* (Mannheim, special thanks to my discussant Charlotte Lauer), the *European Society for Population Economics* 2002 Conference (Bilbao) and the *European Economic Association* 2002 Conference (Venice). The BCS70 data were kindly provided by and used with the permission of the UK Data Archive (UKDA, University of Essex). Funding from ESRC is gratefully acknowledged. The usual disclaimer applies.

†Department of Economics, University of Warwick, CV4 7AL Coventry, UK. Email: massimiliano.bratti@warwick.ac.uk

1 Introduction

Acquiring education is often considered to be the main way in which deprived individuals can improve their economic and social status. In fact, education has economic returns in terms of both higher labour incomes[1] and better employment prospects. However, analyses of the demand for education usually show that an individual's early family background is a powerful predictor of his/her future educational outcomes, and this casts serious doubts on the role of education as an instrument able to promote intergenerational mobility and reduce social inequality.

Several studies report that long-term family factors, such as parents' education and social class, are of paramount importance for children's education. This partly reduces the policy relevance of analyses of the demand for education, since policy makers are hardly able to affect most of the long-term characteristics of a family.

However, there are certain short-term characteristics of a household, such as its current level of income, which policy makers can indeed affect. Understanding the role of current family income on children's educational achievement is therefore a central issue in the study of the demand for education.

This paper uses data from the British Cohort Study 1970 (BCS70) to assess the role of long-term and short-term family characteristics in determining children's educational attainment. Unlike other data sets the BCS70 includes indicators of a child's ability which enable the researcher to reduce the problem of so called *ability bias*, i.e. the spurious correlation between family characteristics and a child's education which arises when ability is genetically transmitted. An important feature of this data set is the high number of observations with missing parental income. In the present paper, therefore, I check the sensitivity of the results to the particular way in which the observations with missing family income are treated. The ordered probit analysis of the highest educational qualification obtained by age 26 shows that some results are sensitive to the way of handling observations with missing values. However, estimating the model only on non-missing observations, including a missing-value dummy for family income, or using

[1] For a recent survey of the literature on the return to education see for instance Card (2001). For some evidence relating to the UK see Blundell *et al.* (2000) and Dearden *et al.* (2002).

a *hot-deck* multiple imputation procedure, all generate the same finding as to the effect of current income: though statistically significant, the positive effect of current family income on children's highest educational qualification is of negligible magnitude. Instead, the effect of long-term family characteristics, such as parental education and social class, is far more important. Moreover, I find some differences across genders: the mother's education, for instance, appears to have a particularly important effect on daughters' education but not on sons'.

The paper is organised as follows. The next section introduces the problems arising in empirical studies of the effect of family income on children's education. Section 3 briefly reviews the main findings in the empirical literature. Section 4 describes the principal features of my empirical analysis relative to the UK. Section 5 details the analysis of individuals' highest educational qualification obtained, and section 6 concludes.

2 Assessing the effect of family income empirically

Three main reasons why household income may exert a positive effect on children's educational attainment have been put forward in the literature:

1. education is a consumption good;
2. capital markets are imperfect;
3. the presence of uncertainty.[2]

In fact, using models in which the child is the decision maker, some scholars have shown that exogenous family transfers affect the demand for education in the presence of a consumption motive for education (Kodde and Ritzen 1984), capital market imperfections for young people (Kodde and Ritzen 1994) or uncertainty relating to their return to education (Levhari and Weiss 1974, Kodde 1986). Although these models do not endogenise family transfers (individual non-labour income), in general resources transferred to children may be considered a form of parents' consumption (or investment), which depends in a life-cycle setting on the level of household

[2]For a more detailed description of the various cases see the longer version of this working paper, Bratti (2002).

permanent income. The literature on consumption[3] has shown that *excess sensitivity* of consumption to current income may be generated by the presence of capital market imperfections (for parents in this case), or by the presence of uncertainty over (parents') future incomes, which causes these incomes to be more heavily discounted. This provides empirical giustification for the inclusion of both long-term family characteristics affecting household permanent income and current family income in demand-for-education regressions. In this setting, one would expect household permanent income to be significant only if at least one of the three cases listed above applies to children and the *excess sensitivity* of children's education to current family incomes in the presence of credit restrictions for adults or uncertainty over parents' future income. If we consider the family as the decision maker (see for instance Becker and Lewis 1973, Becker and Tomes 1976, Cigno 1993) the sole case in which we do not expect household permanent income to be significant is that of perfect capital markets in the *old-age security hypothesis* (Cigno 1993). In both the cases of imperfect capital markets and of the presence of uncertainty for parents' income, then, we expect also current household income to be important, regardless of children's education is consumption or investment.

However, empirical assessment of the effect of current family income on children's education poses some problems.

First, it is useful to distinguish between the effects of permanent and transitory family income, since it is the latter which can be more easily affected by policy makers. By including long-term parents' attributes, like education and social class, in demand-for-education regressions it is possible to single out the effect of current income free from cross-correlations, which can be considered the effect of transitory income. This implies that the effect of long-term household characteristics comprises both pecuniary effects, operating through permanent income, and non-pecuniary effects such as the 'quality of parenting'.

Second, it may be that certain characteristics contribute both to household income and to children's schooling. An example is parental ambition, or other parents' personality traits. If these traits are unobservable to the econometrician (and not controlled for), the effect of family income may simply pick up the effect of other factors (*simultaneity bias*). When the

[3]See for example Muellbauer and Lattimore (1995).

unobserved parental attribute is innate ability, the problem is given the specific name of *ability bias*. The general 'solution' to these problems is the use of instrumental variables (IV) techniques which require the analyst to find variables uncorrelated with the unobserved parental traits but correlated with parents' current income. In both cases, Shea (2000) and Mayer (1997), for instance, have suggested measures of families' occupation and financial capital as possible sources of valid instruments.

I include current family income along with a set of long-term characteristics relating to the family background, such as parents' education and social class, in my empirical analysis since these are expected to be closely correlated with and act as a proxy for permanent household income. My purpose in including them is to separate out the effects of long-term family characteristics and transitory family income. The problem of *ability bias* should be greatly attenuated by the inclusion of a measure of individual ability at age 10 and by the use of an IV procedure (for parents' income, see Appendix A). The *simultaneity bias* should instead be mitigated by the inclusion of a proxy for 'parenting quality' (see Mayer 1997), i.e. the interest of the parents in a child's education assessed by the teacher when the child was 10 years old, which Feinstein and Symons (1999) found is the most important 'parenting' variable.

3 Previous empirical literature: the role of household income

Study of the demand for education using micro-data has a long tradition in the UK. Here I focus only on some recent investigations into the role of household income.[4]

Rice (1987) estimates a probit model of the decision to go on to post-compulsory education in the UK using data from the 1976 *Family Expenditure Survey*. She finds that current household income (when the child is 16 years old) is not significant in explaining the decision to continue in post-compulsory education for males, whereas its effect is statistically significant and positive for females. For the latter, the introduction of educational maintenance allowances (EMA) is predicted to raise the probability of par-

[4]For a comprehensive survey of the literature on children's attainments see Haveman and Wolfe (1995).

ticipating in education significantly. To be noted is that Rice is unable to control either for child ability or for parents' education, and that her estimates of the effect of current family income probably suffer from so-called *ability bias* (see Griliches 1977) and partially capture also the effect of long-term family characteristics.

Micklewright (1989) uses data from the *National Child Development Study* (NCDS) to analyse the probability of staying on at school after the minimum leaving age (16). He finds that once a child's ability and type of school have been controlled for, parental education and social class remain significant, while current family income is not important for a child's probability of staying at school.[5]

Ermisch and Francesconi (2000a) estimate an education equation (the highest educational qualification obtained) using data from the *British Household Panel Study* (BHPS) 1991-95 and an ordered probit model. They find a strong current family income[6] effect for women, but not for men. The same authors, Ermisch and Francesconi (2001), using data from the BHPS 1991-97 and an ordered logit model, find that children from families in the bottom income quartile (when the child is 16 years old) have significantly lower educational attainments (levels of education).[7] In both studies, Ermisch and Francesconi control for long-term family characteristics (such as parental education and social class) but do not include controls for a child's ability in the education equation.

Harmon and Walker's (2000) study of early school leaving uses *Family Resource Survey* data over 1994-97, finding that parental income effects are small, and moreover not statistically robust, whereas parental education has a very significant bearing on a child's probability of staying on at school at age 16.[8]

Feinstein (2000) uses data from the *1970 British Cohort Study* (BCS70) and finds that both parental social class and, especially, parental education have strong effects on a child's minimum educational qualification, whilst the effect of current income is significant but negligible (all family background

[5]Although the author states that this result may be due to the fact that the income variable is affected by a considerable measurement error, the use of the variable related to bad household financial conditions produces identical results.

[6]Family income is measured when the child is 16 years old.

[7]In this second paper they do not perform separate analyses by gender.

[8]They use an IV procedure to estimate the effect of exogenous variations in family income.

variables are measured when the child is aged 10).

Chevalier and Lanot (2002) use data from both the NCDS and the BCS70 in order to investigate the role of family background and financial characteristics on children's educational achievement (i.e. the age at which they left full-time education). They use a categorical income variable in their ordered probit model, finding that current 'family income remains over and above its effect on ability a significant determinant of schooling' (p.9). Chevalier and Lanot then propose an alternative estimation procedure which greatly reduces the importance of current family income.[9]

McCulloch and Joshi (2002) estimate the impact of current family income on the Peabody Picture Vocabulary Test[10] (PPVT) using NCDS data. They employ multilevel analysis and multiple imputation techniques to address the issue of missing income information and find that 'it would take very large increases in income to produce a great effect on children's proficiency at the vocabulary test' (p. 297).

The empirical evidence on the role of current family income is 'mixed' not only for the UK but for other countries as well.

Cameron and Heckman (1998) use US data from the *Occupational Change in Generations* (OCG) and the *National Longitudinal Survey of Youth* (NLSY) to estimate an ordered discrete choice model. They find that long-term family characteristics are far more important than current family income (when the child is 16 years old) in determining children's educational outcomes, and that when measures of a child's ability are included, household income is not statistically significant.

Blau (1999) analyses data from the NLSY and finds that family background characteristics play a more important role than family income in determining the early cognitive development of children, and that only policies addressed to permanent income have a non negligible effect.

Cameron and Heckman (2001) use US data from the NLSY to estimate a schooling transition model with individuals' unobserved heterogeneity, finding that family income (measured as a two-year average between age 14 and age 18) plays a significant role in high school completion while it has a small effect on college attendance.

Plug and Vijverberg (2001), using US data from the *Wisconsin Longitu-*

[9]Family income is measured when the child is 14 years old in the NCDS and when the child is 10 in the BCS70.

[10]The PPVT is a measure of verbal intelligence and scholastic aptitude.

dinal Survey, find that family income affects a child's schooling attainment mainly through its permanent component, whereas its short-run component exerts a positive, but quantitatively small, effect on a child's educational attainment.

Shea (2000) examines US data from the *Panel Study of Income Dynamics* (PSID) finding that unpredictable exogenous changes in parental income have a negligible impact on children's human capital. However, parental income does matter at the lowest levels of income, which suggests that credit constraints may be binding for low-income households.

Lefebvre and Merrigan (1998) using Canadian data from the *National Longitudinal Survey of Children and Youth* (NLSCY), find that the amount of money a family earns does not affect a child's cognitive development, although receiving welfare has a strong negative effect on the PPVT score for children aged 4 and 5.

Maurin (2002) uses French data from the *Enquête Permanente sur les Conditions de Vie*, IV techniques and a semiparametric approach to find that low income strongly affects early school transitions.

Bratti (2001) studies the probability of going on to post-compulsory education in Italy, using data drawn from the Bank of Italy's *Survey of Household Income and Wealth* (SHIW). He finds a statistically significant positive impact exerted by current family income (when the child is 14), especially as regards males in Central and Southern Italy, even after controlling for long-term family characteristics but not for a child's ability.

The intention of this paper is to add new evidence to the existing research by:

1. using the BSC70, a relatively unexploited and rich data-set able to show new evidence on a more recent British cohort, compared to studies using the British NCDS (containing data on the 1958 British cohort). In fact, economic theory suggests that the impact of current household income on children's education may vary across time because income uncertainty, preferences and capital market imperfections change over time. For this reason, study of a new British cohort is valuable *per se*. Moreover, the availability of indicators of a child's innate ability attenuates the problem of *ability bias* (i.e. the potentially spurious correlation posited between parental variables and a child's attainment on the basis of inherited ability), compared to

studies which must to rely exclusively on instrumental variables techniques[11] in order to identify the effect of exogenous variations in current family income;

2. addressing the issue of the potential non-random omission of current household income with respect to individual observed characteristics, which may introduce a *sample selection bias* in the analysis, by means of a *hot-deck* multiple imputation procedure and using different ways of handling missing income observations to compare the results;

3. investigating the specific role of long-term and short-term family variables for a child's highest educational qualification, using an ordered probit analysis.

My approach in this paper differs from that of Chevalier and Lanot (2002), who also use BCS70 data, mainly because I analyse the highest educational qualification obtained and not the age at which individuals left school; I consider a continuous measure of income rather than dummies for income groups.[12] The main differences with respect to Feinstein (2000), who also investigates BCS70 data, are the following: Feinstein uses missing value dummies for missing household income while I compare different ways of handling missing observations; he uses an average weekly income measure;[13] he estimates three separate probit regressions for the minimum educational qualification obtained (i.e. O-levels, A-levels and university degree), while I use an ordered probit model which seems to rationalise the underlying economic theory better (see Cameron and Heckman 1998 and section 4.2 of this paper).

4 The empirical analysis

The following subsections describe the data, the econometric model and the explanatory variables used in the empirical analysis to estimate education

[11] And encounter the usual problem of finding valid identifying instruments. Studies using the BHPS, for example, do not control for children's ability.

[12] Chevalier and Lanot (2002) do not say how observations with missing family income were treated. However, judging from the size of their sample, it seems that they were dropped from the analysis.

[13] The procedure used to obtain this variable is not specified in the paper, but since income is reported in categorical form in the BCS70, each individual was probably attributed the midpoint of his/her income group.

regressions.

4.1 Data description

In this paper I use data drawn from the BCS70. The BCS70 began in 1970 when data were collected on the births and families of 17,198 babies born in England, Wales, Scotland and Northern Ireland from the 5^{th} to the 11^{th} of April. There are currently five complete follow-up surveys available: 5-year, 10-year, 16-year, 26-year and 30-year. As to the highest educational qualification achieved I focus on the 26-year follow-up, since the 30-year one has only recently become available and the quality of the data is still being examined. In order to carry out my analysis I need the family income and the highest educational outcome of individuals included in the BCS70. For this reason I use a matched sample of individuals who replied to both the 16-year and the 26-year follow-up surveys.[14] Like other authors, I use current parents' income and other family background variables when the individual is aged 16 (i.e. at the minimum school leaving age).

The matched sample includes 7,141 individuals. I drop 293 individuals for whom education information is not available. The distribution of the highest educational qualifications obtained at age 26 by the remaining 6,848 individuals is: 3.5% less than O-levels, 22.61% O-levels, 36.08% vocational qualifications, 10.98% A-levels or equivalent qualifications, 26.83% undergraduate (UG) or postgraduate (PG) degrees.

4.2 The econometric model

In the empirical literature, a popular way to model educational choices is to use an ordered discrete choice model (hereafter ODCM). Most of the studies on individual educational outcomes surveyed in section 3 used an ordered probit or an ordered logit model.

Cameron and Heckman (1998) offer a rare example of how a ODCM can be interpreted in an optimising framework. Here I use a slightly modified

[14] In order to take account of panel attrition, I initially estimated some probit models including a high number of explanatory variables in order to compute the probability of response and to weight the observations. In all cases the proportion of the variance in the response rate explained by the models was very low, with almost no variable significant and very imprecise estimates. I interpreted these findings as an indication of the randomness of response, with respect to individual observed characteristics, and I accordingly used the unweighted observations.

version of their model. Let us assume that the direct costs of schooling level j, which can be years of schooling or educational qualifications, given the individual's characteristics $X = x$ are $c(j|x)$, which are assumed to be weakly convex and increasing in j. The X are the same across all schooling transitions. Let us also assume that $c(0|x) = 0$ and that the discounted lifetime return to schooling is $R(j|\epsilon)$, concave and increasing in j, with $R(0|\epsilon) > 0$, where ϵ is a person specific shifter of the return to education (in the literature on the returns to education it is typically the unobservable individual's ability). The optimal level of schooling is determined by the individual[15] by solving the problem:

$$\underset{j}{Max}[R(j|\epsilon) - c(j|x)] \tag{1}$$

for $j = 0, ..., \overline{s}$, where $\overline{s}$ is the highest educational qualification achievable.

Let us assume that ϵ is stochastic, $\epsilon \perp X$ and that:

$$R(j|\epsilon) = R(j)\epsilon \tag{2}$$

where $E(\epsilon) = 1$, $\epsilon \geq 0$, while

$$c(j|x) = c(j)\psi(x) \tag{3}$$

where $\psi(x) \geq 0$.

If s is the optimal educational level then:

$$\frac{[c(s) - c(s-1)]\psi(x)}{R(s) - R(s-1)} \leq \epsilon \leq \frac{[c(s+1) - c(s)]\psi(x)}{R(s+1) - R(s)}. \tag{4}$$

ϵ is therefore bounded by the ratios of the marginal return to the marginal cost of the different educational qualifications. If ϵ is continuously distributed and defining:

$$exp[l(j)] = \frac{R(j) - R(j-1)}{c(j) - c(j-1)} \tag{5}$$

[15] Alternatively, a problem of the same form is obtained by assuming, for instance, that parents are altruistic and decide the optimal schooling level of their child by maximising his/her consumption.

then:

$$Pr(j = s|X = x) = Pr[exp[l(s)]\psi(x) \leq \epsilon \leq exp[l(s+1)]\psi(x)]. \quad (6)$$

If we further assume that $\psi(x) = exp(-x\beta)$, the ODCM takes the more familiar form:

$$Pr(j = s|X = x) = Pr[l(s) - x\beta \leq \mu \leq l(s+1) - x\beta] \quad (7)$$

where $\mu = ln(\epsilon)$. The parameters to be estimated are β and the cut-points $l(j)'s$. In this framework individual and parental attributes increase or decrease the cost of education and therefore affect the probability of obtaining the different educational qualifications. On this assumption I follow Cameron and Heckman (1998), who in turn draw on Becker (1975), only for illustrative purposes. The specification can be adjusted so that it can also allow for the return to education to depend on individual and family characteristics, see for instance Lauer (2002). However, this has no empirical relevance, since only the effect of the covariates on the ratio of the marginal return to the marginal cost of the educational qualifications, and not on the single components (return and cost), can be identified.

Hence, Cameron and Heckman (1998) offer a simple economic rationalisation for the ODCM and an economic interpretation for the cut-points.

4.3 Explanatory variables

In this section I list the explanatory variables included in the econometric model, since they may affect the cost and the return to education. In order to ensure comparability of results, for the specification of the education equation I follow the previous literature. When not stated otherwise, all variables are measured when the child was aged 16. The explanatory variables included are:[16]

[16] In all regressions they are entered separately. I prefer not to include interaction terms because, in my opinion, this would hanger the interpretation of the estimated effects (for instance, it would be difficult to interpret the interaction between current income and parental education or social class, since the last two variables are also proxies for permanent household income). Moreover, using a *hot-deck* procedure, any interaction term involving household income generates a new variable with missing values needing imputation.

- *British ability scales (BAS).*[17] This is an indicator of 'child quality'.[18] The BAS score is computed according to performance on a questionnaire which assesses both verbal and mathematical ability.[19] The BAS score is computed at age 10, so as to reflect mostly innate ability and early parental inputs. I include a dummy for individuals with a missing BAS score. The inclusion of an ability score enables the researcher to reduce the problem of so-called *ability bias*. In fact, in the case that the ability of a child is not observed, the positive relationship between family income and a child's education may be only spurious and driven by the correlation between a child's ability and his/her parents' ability, which affects their income.

- *Parents' education* and *social class.* I include both mother's and father's education and social class. These are long-term family factors. The impact of parents' education and social class on children's educational outcomes may operate through several channels: it may affect the taste for education (non-pecuniary effects), the 'quality of parenting',[20] or it may be a proxy for permanent income affecting the consumption and investment demand for education. Moreover, it helps to partial out the effect of current family income from its permanent component. I consider the following social classes: professional occupations (I), managerial and technical occupations (II), skilled occupations - non manual (IIINM), skilled occupations - manual (IIIM), partly skilled (IV), unskilled (V), student and missing social class (and a dummy if the parent is dead).

- *Age of the parents.* This may affect, for example, future economic constraints, such as future family incomes (see Gambetta 1987). A dummy variable for omitted age is also included.

- *Parents' interest in children's education.* I include dummies for the

[17] See Elliot et al. (1979).

[18] According to Becker (1975), for instance, children at maturity decide on the total amount of investment in education on the basis of their parents' earlier choice of investment in 'child quality'.

[19] Unlike Chevalier and Lanot (2002), I do not consider maths and reading scores separately since they are strongly correlated, which may cause multicollinearity problems (compare with Feinstein 2000).

[20] See for instance Datcher-Loury (1988), who finds that greater time devoted to child care by highly educated mothers raises children's years of schooling.

level of mother's and father's interest in their child's education as assessed by the teacher when the child was 10 years old. There are five possible levels: interested, moderately interested, scarcely interested, not interested, cannot say. Feinstein and Symons (1999), for instance, find in their study of secondary school attainment that the quality of 'parenting' is more important than parental education, and that the most important parental input is interest in children's education.

- *Smoker.* This is a dummy for the individual who is a habitual smoker. It may be a proxy for the individual discount rate.[21]

- *Disability* and *ethnicity.* These are included in order to assess the degree of social exclusion, i.e. the impact of belonging to a minority on educational attainment.

- *Siblings.* I include the number of younger, same age, older but aged under 21, older and aged over 21, siblings in the family in order to take the composition of the family into account. In fact, siblings of different ages may compete for the allocation of monetary resources within a family or for parents' child care time.[22]

- *Family structure* I include dummies for the structure of the family: both natural parents present, natural father only, natural mother only, natural father and relatives, natural mother and relatives, other situation and missing family structure.

- *Residence.* I include dummies for residence in England, Wales or Scotland.[23] There may be regional differences in educational attainment due, for instance, to different traditions in setting value on education or to school quality effects.

- *Neighbourhood characteristics.* I consider the characteristics of the neighbourhood: affluent, rural, poor, other. The characteristics of the neighbourhood, over and above family income, may also be associated

[21] Harmon *et al.* (2000), for instance, observe that: '...smoking when young is a sign of having a high discount rate - since young smokers reveal that they are willing to incur the risk of long term damage for short term enjoyment' (p.24).

[22] Stafford (1987), for instance, finds that the presence of closely age-spaced siblings within a family negatively affects children's school performance.

[23] Although the BSC70 also includes individuals resident in Northern Ireland, the (matched) sample used in this paper does not.

with children's educational attainment (see for instance Brooks-Gunn *et al.* 1993).

- *Home ownership.* I include controls for home owned outright by parents, home owned with mortgage, home rented and missing house information. This can be considered as a proxy for the wealth and the permanent income of a family.

- *Family income.* This is current weekly parents' income. The BCS70 reports parents' income in categorical form. After controlling for long-run family characteristics which are proxies for permanent income and contextual factors (such as the parents' interest in children's education) this variable captures the financial effect of transitory family income. Since family income is of primary interest in my analysis, I shall devote more space to its description in the following section.

Means and standard deviations of the variables are reported in table 1.

Blau (1999) claims that many of the explanatory variables included in previous studies (and some of those that I have included, such as parents' education) should be excluded from a reduced form model of the demand for education because they are potentially endogenous. However, Blau himself does not take a 'purist' reduced form approach.[24] As I said, I followed a specification widely used in the literature. It may be argued that even if some variables are endogenous, such as parents' education and family structure, they are predetermined and (albeit to different extents) the related decisions are not easily reversible and cannot be changed in the short-run.[25] This is particularly true if we want to assess the impact on children's education of transitory variations in household income,[26] which are not likely to

[24] In fact, although in his study of children's development Blau estimates two models, one including household income and the other including mother's wage and nonwage income (since labour supply may be endogenous), he does not take account of the fact that the mother's wage depends on variables, like her education, which he considers endogenous and excludes from the analysis.

[25] Unlike in the case of the demand for non-durable goods, the demand for some consumption and investment goods, such as parents' education or children (see Becker and Lewis 1973), is durable and irreversible. For instance, if children are an 'inferior good', even if the parents' income increases at a certain point in the life-cycle, they cannot reduce their realised fertility (some choices are not reversible!).

[26] Since most policy interventions concern the period in which the decision to go on to post-compulsory education must be made.

affect long-term family decisions. In this respect, conditional demand rather than unconditional demand functions might be of particular interest for policy interventions. Another way to justify the inclusion of potential choice variables in the right hand side (RHS, hereafter) of education regressions is that the main source of endogeneity is the omission of innate ability, and that once it has been observed and controlled for, or proxied, the problem disappears.

Hence, my model can be seen either as a reduced form model, if all the explanatory variables included are exogenous, or as a conditional demand model if some of the variables included in the RHS of the education equation are choice variables.

4.3.1 Family income

As said, the BCS70 reports parents' income in categorical form. It may be convenient to use a continuous measure of household income for at least two reasons, one statistical and the other practical. Firstly, the use of a continuous income variable rather than income groups increases the precision of the estimate of the effect of current income. Secondly, the BCS70 groups weekly household income into classes of 50 pounds sterling. This means that if income groups are used, differences in educational attainment can only be assessed between individuals falling into different groups. However, policy makers are likely to be interested in finer policy interventions.[27]

In order to obtain a continuous income variable, I follow Stewart (1983), using interval regression techniques to predict parents' income. The procedure is also briefly explained in Appendix A. In the interval regression for parental income I include several explanatory variables, among which the one-digit Standard Industrial classification 1980 (SIC 80) and the Standard Occupational Classification 1980 (SOC 80) of parents' jobs. The results are reported in table 2.

[27]For individuals with household income at the lower bound of each group a 50 pounds increase in income would be necessary to change group. 50 pounds at the 1986 value are 85 pounds at the 1999 value. The Educational Maintenance Allowance (EMA) pilot scheme started in September 1999 in the UK provided 16-19 years old students with a financial allowance of 30 pounds or 40 pounds per week (for annual family income less than 13,000 pounds), depending on the piloting area, if they remained in full-time education after year 11 (see Chevalier and Lanot 2002). It is evident that a transfer of 50 pounds per week at the 1986 value would largely exceed the amount of the pilot scheme.

Family income is available only for 4,365 individuals (63.74% of the observations). Since the high number of missing values may be an issue, in order to assess the robustness of the results to different ways of treating observations with missing values I carried out several analyses:

1. I simply discarded the observations with missing household income;
2. I included a dummy for the observations with missing household income;
3. I imputed family income using a multiple *hot-deck* procedure,[28] with 10 imputations.[29]

While the first two methods are frequently used in empirical work,[30] the third is relatively new and represents an attempt to give more satisfactory treatment to the problem of missing information. A major assumption with the *hot-deck* procedure is that the missing data are missing at random (MAR), the probability that a line is missing varying only with respect to the variables specified in the imputation model (also called the case of *ignorable non-response*). A *hot-deck* procedure finds for each respondent with missing values a matching respondent with non missing data, where matching means 'close' with respect to the variables specified in the imputation model, and replaces all the values of the non respondent with those of the matching respondent.[31] By repeating the procedure several times it is possible to obtain many complete data sets from which to obtain valid inferences with standard complete-data tools. Graphs showing the distribution of income for the non-missing and the imputed observations are given in figure 1. It turns out that the imputed incomes are mainly drawn from the

[28] I used the *hotdeck* command in Stata (see Mander and Clayton 2001). Lines with missing values were replaced with lines sampled from the non-missing observations. The approximate Bayesian bootstrap method of Rubin and Schenker (1986) was used.

[29] Rubin (1987) shows that the efficiency of an estimate based on M imputations is approximately $(1 + \gamma/M)^{-1}$, where γ is the rate of missing information, in my sample about 0.36. Therefore, using 10 imputations the efficiency in my case is 0.97. The efficiency gained by using more than 10 imputations is usually very low, unless the rate of missing is very high.

[30] See for instance Ermisch and Francesconi (2000), who drop observations with missing values, and Blau and Grossberg (1992), who include missing value dummies.

[31] This also implies that if the observed characteristics are strongly correlated with the individual unobserved characteristics, the problem of selection on unobservables should be negligible.

lower tail of the income distribution. This reflects the fact that low-income families may be more reluctant to provide income information.[32] Therefore, using the sample with non-missing income might introduce a serious *sample selection* bias in the analysis due to the fact that income is not missing completely at random (MCAR). I used 10 imputations, and the estimates (coefficients and standard errors) were corrected for the uncertainty arising from the sampling variability under the imputation model (see Appendix B). In order to examine the performance of the imputation procedure, a random sample (36%) without replacement was drawn from the sample with non-missing family income and reset to missing income. I then used the multiple *hot-deck* procedure with 10 imputations on the 'artificial' sample. The difference in absolute value between the 'true' and the 'imputed' income was less than 5 pounds for about 82% of the imputed observations.

I specified the rationale for including parents' income in educational regressions in section 2. The reader will have noticed that I excluded from the theoretical survey all models in which parents' child care time directly affects children's educational outcomes. In those models, parental work has a twofold effect: a direct negative effect, since it displaces parents' time from child care, and an indirect positive effect operating through the increased monetary resources invested in 'child quality'. However, the empirical evidence suggests that childrearing is particularly intensive at early ages, when the child's cognitive development is still incomplete. Blau and Grossberg (1992), for instance, maintain that the effect of mother's employment depends on the timing of labour supply. They find that the negative first-year effect of mother's employment is mainly a direct effect due to the reduction of child care time on the part of working mothers, while the net positive effect in later years is mainly due to the increase in household income. Ermisch and Francesconi (2000b) find that mothers' full-time employment has a negative effect on a child's educational attainment only at ages 0-5. There is consequently some evidence that, having controlled for 'child quality' through the BAS score, which is the result of a child's innate ability and parental time and monetary inputs at early ages, the effect of parental work when the child is aged 16 acts through household income only.

[32] Income surveys sometimes observe higher non-response also at high income levels. In our case the fact that the lower limit of the last income group is not very high, 500 pounds per week (jointly for both parents), may in part explain this finding.

5 Determinants of the level of education: results of the ordered probit analysis

In this section I describe the results obtained from the estimation of an ordered probit model of the highest educational qualification obtained. Although the economic interpretation of an ODCM rests upon some restrictive assumptions (see section 4.2), it remains nonetheless the econometric specification most widely used to model educational outcomes. The ordered probit model can be derived from equation (7) by assuming lognormality of ϵ.[33]

The discrete nature of the educational outcome is analysed using an ordered probit with 5 outcomes: less than O-levels, O-levels, vocational qualifications, A-levels or equivalent, undergraduate (UG) or postgraduate (PG) degrees. I sometimes refer to this last category as Higher Education (HE).[34] The results of the estimation are shown in table 3 for males and table 4 for females. The reference individual had the following characteristics at age 16: *white ethnicity, no disabilities, non-smoking, living in England in a house owned outright by his/her parents, in a relatively affluent area, in a family with both natural parents, both parents with university education, from social class I and interested in their children's education.*

Since the previous literature (see section 3) seems to suggest a different effect of parents' income on male and female children's education, I performed separate analyses by gender.

While most of the results were robust to the particular treatment of the missing information, some were sensitive to the specific strategy adopted to handle observations with missing parents' income.[35] Looking at males (table 3), for instance, and comparing the first two columns, perhaps the most striking feature is that including a missing-value dummy for omitted

[33] In this case the probability in equation (7) becomes: $Pr(j = s|X = x) = \Phi((l(s + 1) - x\beta)/\sigma) - \Phi((l(s) - x\beta)/\sigma)$, where $\Phi(\cdot)$ is the standard normal distribution function and σ is the standard deviation of μ.

[34] The order used is the natural order in which the different educational certificates are obtained in the educational system. I placed vocational education before A-levels applying the criterion of the degree of generality and abstractness of the human capital acquired. In this sense vocational education may furnish specific human capital compared to A-levels, which impart a more abstract and general form of knowledge usually required to enter university.

[35] These observations will be sometimes called 'missing observations' throughout the paper.

current household income greatly reduces the size of the income coefficient. Moreover, statistically significant effects of mother's education, especially at the lowest levels of schooling, and age emerge. A possible explanation for this may be the positive correlation between mother's education and age and household income. In that case, in the analysis using missing-value dummies, a low mother's education may be picking up the effect of a low family income. Hence, simply discarding the observations with missing values and including a missing-value dummy may produce very different qualitative and quantitative implications for the analysis.

In what follows I shall focus on the results of the analysis using the *hot-deck* imputation, since, as said, it is a more accurate way to treat the observations with missing information. The multiple *hot-deck* imputation method is a compromise between the need to use a larger data set, exploiting all the information available and increasing the precision of the estimates, and that of isolating the effect of the variable with missing values, avoiding treatment of the observations with missing values as a homogeneous category.[36]

The coefficients of the ordered probit model are difficult to interpret. A positive sign for the coefficient of a variable means that the variable raises the probability of the highest outcome and reduces that of the lowest. However, if we are interested in the effect on the intermediate outcomes, predicted probabilities or marginal effects must be computed. Hence, tables 5 and 6 report the marginal effects for males and females, respectively, computed at the sample average values for all variables. In the following sections I comment only on the results relating to parental income and long-term family characteristics.

5.1 Males

The predicted probabilities of the five educational outcomes for the 'average' male individual (i.e. the individual with sample mean characteristics) are: 0.6% less than O-levels, 11.8% O-levels or equivalent, 38% for vocational education, 14.6% A-levels or equivalent, 35% for HE.

Living in rented accomodation reduces[37] the probability of HE by 12.2

[36] As happens when a missing-value dummy is included.

[37] In the comment, I interpret the effects in a 'causal' way, even if there might be endogeneity problems for some variables, as stated in section 4.3.

percentage points.[38] This can be interpreted as a wealth effect of the household's financial resources on the child's education. Living in a rural area reduces the probability of HE by 14.1 percentage points.

There is a positive effect of early academic ability on educational attainment. A one standard deviation (SD=14.7) increase in the BAS score raises the probability of HE by 15.6 percentage points.

As is often found, father's education is a powerful predictor of children's educational outcomes: children whose fathers have less than O-levels have a 18.7 percentage points lower probability of HE compared to children whose fathers have a university education (UG or PG degrees), and children whose fathers possess O-level qualifications have a 13.5 percentage points lower probability. The mother's education has no effect on her son's education.

Also noticeable is the positive effect of the father's social class. Children with fathers from social classes IIIM, IV and V, for instance, are about 23 percentage points less likely to receive HE than children from social class I. Since I controlled for factors which affect, or are proxies for, the 'quality of parenting', such as parents' education and their interest in children's educational outcomes, this is likely to be a pecuniary effect, i.e. the effect of permanent family income. The same effect is not found for mother's social class.

Children with fathers only moderately interested in their education when they were 10 years old are about 7 percentage points less likely to complete HE than children with fathers interested in their education.

Finally, parents' income has a positive effect on children's education. Increasing weekly household income by 24 pounds sterling, the 1986 equivalent of 40 pounds at the 1999 value, which is the maximum amount of the 1999 EMA pilot scheme (see footnote 26), raises the probability of HE by 0.7 percentage points while reducing the probabilities of the lower outcomes. The same effect computed from the models estimated only on non missing observations and including missing-value dummies are 0.8 and 0.4 percentage points, respectively. It is worth noting that this would be the effect of an increase in non-school contingent family income. This is different from the effect of an increase in school contingent family income, such as

[38]The differences are with respect to the 'average' male individual possessing the reference characteristic of the specific group of variables considered. In this case, for instance, the difference is with respect to the 'average' male individual living in accomodation owned by his parents.

that produced by school vouchers or an EMA. Hence, though statistically significant, the size of the effect of household transitory income does not seem to be important, and this conclusion is not sensitive to the particular treatment of observations with missing family income.

5.2 Females

The predicted probabilities of the five educational outcomes for the 'average' female individual are: 0.7% less than O-levels, 14.7% O-levels, 42.1% vocational qualifications, 15.7% A-levels or equivalent, 26.8% for HE.

Living in rented housing is associated with a 9.1 percentage points lower probability of HE.

A one SD increase in the BAS score raises the probability of HE by 17.2 percentage points. Hence, the effect of ability is greater for females than for males.

In the case of females, too, there is a positive gradient for father's education: children with fathers possessing less than O-levels education, for instance, have a 9.4 percentage points penalty in the probability to complete HE, a weaker effect than that found for males. However, an interesting finding is that for females there is also a positive effect of mother's education, which is greater than that of father's education. Children with mothers who have less than O-levels are 30.3 percentage points less likely to obtain a HE education, and those with mothers with A-levels are 19.1 percentage points less likely. Similar results have been found by Blundell *et al.* (1997) who observe that father's and mother's years of education affect the probability of A-level attainment of both males and females, with a dominant effect of mother's education on the educational attainment of females. In the same study, mother's years of education are not significant for the HE attainment of males but are significant for females. Glick and Sahn (2000) find similar evidence for Guinea, where mother's education has a significant impact only on daughters' schooling. They interpret this result as evidence of differences in maternal and paternal preferences for the schooling of daughters relative to sons. These findings suggest the presence of a 'gender role model' effect, or that mothers and fathers may allocate their resources differently to daughters' and sons' education and that pooling parents' incomes might be inappropriate.[39] Unfortunately, the BCS70 does not have separate informa-

[39] Although the fact that the effect of mother's social class, which is a proxy for mother's

tion on mother's and father's incomes.

There is also a positive effect of father's social class. An individual whose father is from social class IV, for example, is 16 percentage points less likely to obtain a HE, while no effect of mother's social class is found over and above that of mother's education.

Children whose fathers were only moderately interested or not interested at all in their education when they were aged 10 are 5.8 and 16.8 percentage points less likely to obtain a HE, respectively, while children whose mothers were only scarcely interested in their education are 15.3 percentage points less likely to get a HE. Therefore, we also observe a 'gender role' effect, similar to that noted for mother's education, for mother's interest in children's education, which affects only daughters' educational attainment.

As to the effect of income, an increase of 24 pounds sterling in weekly family income raises the probability of HE by 0.9 percentage points. Hence, the effect of household income is greater on the educational achievement of daughters than it is on that of sons, which confirms early findings by Rice (1987) and Ermisch and Francesconi (2000a).[40] The same effect computed from the models estimated considering only non missing observations or including missing value dummies is 1%. Since families are likely to be equally credit constrained irrespective of the gender of their children, the differential impact of income for males and females may be due to a stronger consumption motive for the education of daughters, or to the greater uncertainty of their return to education. However, these tentative explanations would require further research.

6 Concluding remarks

This paper has investigated the role of household income on children's educational outcomes. It has addressed the issue of missing information for parents' income using a *hot-deck* multiple imputation procedure, and that of the *ability bias* by including an indicator of innate ability (British Ability Scales) and using IV techniques. The analysis of the highest educational qualification obtained shows that, though statistically significant and positive, the impact of current family income does not seem to be important

permanent income, is not significant does not support the latter hypothesis.

[40] Although the former study does not control for both child ability and parents' education while the latter does not control for child ability.

in determining children's educational attainment. By contrast, long-term family characteristics, such as parents' social class and education, are of paramount importance. Thus, my results argue in favour of the relatively scarce effectiveness of policies based on temporary (non-schooling contingent) monetary transfers to poor families (see for example Cameron and Heckman 1998, 2001) when the child's cognitive development can be considered as already completed (at age 16). My analysis shows, however, that a child's early cognitive development, measured by the British Ability Scales, is an important predictor of his/her future educational outcomes and it may be partially determined by early parental inputs, aspect which should be subject to further research.

Other interesting findings of the analysis are that, while father's education affects the educational attainment of both sons and daughters, with a stronger effect on the former, mother's education affects only the educational attainment of the latter. These gender differences may be interpreted as the effect on children of the 'gender role model' that they have inherited from their parents, or as the outcome of gender differences in parental preferences with regard to children's education. However, this finding, too, requires more research.

7 Appendix A: From grouped to continuous family income

In the BCS70, family income (i.e. the income of the parents) is observed in a certain interval on a continuous scale. We want to transform the grouped variable into a continuous one. The procedure has been investigated by Stewart (1983). I summarise here only the main features of the problem and the proposed solution. The latent structure of the model under consideration is given by:

$$y_i = z_i'\gamma + u_i \tag{8}$$

where y_i is the latent family income of individual i, which falls within a certain interval of the real line $(A_{k-1},\ A_k)$. z_i and γ are vectors of regressors affecting family income and of unknown parameters to be estimated, respectively. u_i's are i.i.d. normally distributed random disturbances with zero mean and variance σ^2 and are assumed to be independent of z_i.

Ad hoc procedures, such as assigning to each individual the midpoint of her income group, do not in general result in consistent estimates of the parameters γ, while consistent estimates can be obtained by assigning to each observation its conditional expectation:

$$E(y_i|A_{k-1} < y_i < A_K, z_i) = z_i'\gamma + \sigma \left[\frac{\phi(Z_{k-1}) - \phi(Z_k)}{\Phi(Z_k) - \Phi(Z_{k-1})} \right] \tag{9}$$

where $Z_k = (A_k - z_i'\gamma)/\sigma$ and $\phi(\cdot)$ and $\Phi(\cdot)$ are the standard normal density and cumulative distribution functions.

Stewart (1983) suggests several ways to estimate the parameters of interest γ and σ.

In my specific case the parameters are estimated using a maximum likelihood estimator.[41]

After estimating γ and σ consistently, it is possible to obtain predicted values for y_i, i.e. a continuous measure of family income.

This measure is used in a second stage for the estimation of the education equations (the ordered probit model of the highest education qualification obtained).

I have included among the regressors z_i the variables commonly used in the estimation of earnings equations, in particular the country of residence, and for both parents: a quadratic of age (as a proxy for work experience), the level of education, the ethnic group and also the one-digit Standard Industrial Classification (SIC 1980) group and the Standard Occupational Classification (SOC 1980) group, which may be considered a finer disaggregation of parental social class. The estimates are reported in table 2. Since the SIC 1980 group is used to predict parents' income but is excluded from the education equation, my method is implicitly equivalent to an IV estimation procedure, where the SIC 1980 group represents the 'identifying instrument'. Analogous exclusion restrictions are applied, for instance, in Maurin (1999) and Shea (2000). Evidence in favour of the validity of this exclusion restriction is provided by some of the literature on interindustry wage differences. First, estimates of the amount of the differences which can be accounted for by unmeasured workers' ability generally leave a substantial part of the differences unexplained (see for instance Katz and Summers

[41] See 'methods and formulas' for the TOBIT command in the Stata Reference Manual (Stata 2001, p. 186-187).

1989). Moreover, the literature has shown that wage premia are higher in industries with higher profits, and that industries that pay higher wages do so in all occupations, findings that are difficult to reconcile with the *unobserved ability hypothesis*.[42] Therefore, in the present study the problem of the *ability bias* is addressed both by including a measure of individual ability (the BAS score) and by using IV techniques.

8 Appendix B: Multiple Imputation

In this section I summarise the main characteristics of multiple imputation procedures. The interested reader can find the details in Rubin (1987).

In order to create imputed values for a variable with missing values it is necessary to accomplish three main tasks:

1. *the modeling task*. At the modeling stage the researcher chooses a specific model for the data. Given the variables to be imputed Y and some covariates X, at this stage the researcher specifies the joint distribution $Pr(X, Y)$. Since we are considering the case of *ignorable non response*, the posterior distribution of Y_{mis} is the conditional distribution of Y_{mis} given the observed values X and Y_{obs}. If we assume that $Pr(X, Y)$ is modeled in i.i.d. form we obtain:

$$Pr(X,Y) = \int Pr(X,Y|\theta)Pr(\theta)d\theta = \int \left[\prod_{i=1}^{N} f_{XY}(X_i, Y_i)\right] Pr(\theta)d\theta. \tag{10}$$

   where f_{XY} can be, for instance, a multivariate normal distribution. In our specific case, the modeling stage consists of specifying the covariates used to match the missing incomes to non-missing incomes.

2. *the estimation task*. Given that θ and Y_{mis} are *a posteriori* independent with distribution depending on θ only through $\theta_{Y|X}$ (for the proof see Rubin 1987, p.163), the aim of the estimation task is to obtain the posterior distribution of $\theta_{Y|X}$ so that a random draw of $\theta_{Y|X}$ can be made. Calculating the posterior distribution of $\theta_{Y|X}$ can be

[42] Which states that some industries pay higher wages to attract workers with higher ability. For a brief review see Romer (1996).

analytically intractable or computationally demanding. For this reason, approximate posterior distributions corrected using special Monte Carlo techniques are sometimes used.

3. *the imputation task*. With an estimation of the posterior distribution of $\theta_{Y|X}$ in hand it is possible to draw a value of θ, say θ^*, and a value of Y_{mis} from its conditional posterior distribution given the random draw for θ, $Pr(Y_{mis}|X, Y_{obs}, \theta = \theta^*)$. Repeating this process M times provides M draws from the joint posterior distribution of (Y_{mis}, θ).

In my specific case the modeling, estimation and imputation tasks were performed using the stata *hotdeck* command (Mander and Clayton 2001), which implements a *hot-deck* multiple imputation procedure. The only degree of freedom that I had was in the specification of the covariates used to perform the matching between missing and non-missing observations. I reported the results for the model using some family attributes which are more likely to be correlated with family income and for which item non-response is relatively low: residence, age, education, ethnicity and social class.[43]

After accomplishing the imputation task we have M complete data-sets, which can be analysed using standard statistical procedures. Hence, for each version of the data set it is possible to obtain an estimate for the parameter of interest β (see section 4.2), say $\hat{\beta}_m$. The estimate for β is the average of the M estimates:

$$\overline{\beta} = \frac{1}{M} \sum_{m=1}^{M} \hat{\beta}_m. \tag{11}$$

Moreover, indicated with $\hat{U}_m$ the estimated covariance matrix for $\hat{\beta}_m$, the average within-imputation covariance matrix is:

$$\overline{U} = \frac{1}{M} \sum_{m=1}^{M} \hat{U}_m \tag{12}$$

while the between-imputation covariance matrix is

$$B = \frac{1}{M-1} \sum_{m=1}^{M} (\hat{\beta}_m - \overline{\beta})(\hat{\beta}_m - \overline{\beta})^T \tag{13}$$

[43] I tried also other imputation models (using for instance also the Standard Industrial and the Standard Occupational Classifications) and the results were not sensitive to the particular model used.

and the estimated total covariance matrix is:

$$T = (1 + r)\overline{U} \tag{14}$$

where $r = (1 + \frac{1}{M})tr(B\overline{U}^{-1})$ is the average relative increase in variance due to nonresponse across the components of β.

References

[1] Becker, G. (1975) *Human Capital*. Chicago: Chicago University Press.

[2] Becker, G. and Lewis, H. (1973) 'On the Interaction Between the Quantity and Quality of Children', *Journal of Political Economy*, 82: S279-288.

[3] Becker, G. and Tomes, N. (1976) 'Child Endowments and the Quantity and Quality of Children', *Journal of Political Economy*, 84: S143-162.

[4] Blau, D. M. (1999) 'The Effect of Income on Child Development', *Review of Economics and Statistics*, 81: 261-276.

[5] Blau, F. D. and Grossberg, A. J. (1992) 'Maternal Labour Supply and Children's Cognitive Development', *Review of Economics and Statistics*, 74: 474-481.

[6] Blundell, R., Dearden, L., Goodman, A. and Reed, H. (1997) *Higher Education, Employment and Earnings in Britain*. London: The Institute for Fiscal Studies (IFS).

[7] Blundell, R., Dearden, L., Goodman, A. and Reed, H. (2000) 'The Returns to Higher Education in Britain: Evidence from a British Cohort', *Economic Journal*, 110: F82-F99.

[8] Bratti, M. (2001) 'Oltre la Scuola dell'Obbligo: Un'Analisi Empirica della Decisione di Proseguire nell'Istruzione Post-Obbligatoria in Italia', *Moneta e Credito*, 214: 175-203.

[9] Bratti, M. (2002) 'Parents' Current Income, Long-Term Characteristics and Children's Education: Evidence from the 1970 British Cohort Study', *Quaderni di Ricerca* n. 174, Dipartimento di Economia, Università degli Studi di Ancona, Ancona.

[10] Brooks-Gunn, J., Duncan, G. J., Klebanov, P. K. and Sealand, N. (1993) 'Do Neighborhoods Affect Child and Adolescent Development?, *American Journal of Sociology*, 99: 353-395.

[11] Cameron, S. and Heckman, J. (1998) 'Life Cycle Schooling and Dynamic Selection Bias: Models and Evidence for Five Cohorts of American Males', *Journal of Political Economy*, 106: 262-333.

[12] Cameron, S. and Heckman, J. (2001) 'The Dynamics of Educational Attainment for Black, Hispanic, and White Males', *Journal of Political Economy*, 109: 455-499.

[13] Card, D. (2001) 'Estimating the Return to Schooling: Progress on Some Persistent Econometrics Problems', *Econometrica*, 69: 1127-1160.

[14] Chevalier, A. and Lanot, G. (2002) 'The Relative effect of Family Characteristics and Financial Situation on Educational Achievement', *Education Economics*, 10: 165-181.

[15] Cigno, A. (1993) 'Intergenerational Transfers Without Altruism', *European Journal of Political Economy*, 7: 505-18.

[16] Datcher-Loury, L. (1988) 'Effects of Mother's Home Time on Children's Schooling', *Review of Economics and Statistics*, 70: 367-373.

[17] Dearden, L., McIntosh, S., Myck, M. and Vignoles, A. (2002) 'The Returns to Academic and Vocational Qualifications in Britain', *Bulletin of Economic Research*, 54: 249-274.

[18] Elliot, C. D., Murray, D. J. and Pearson, L. S. (1979) *British Ability Scales, Manual 4: Tables of Abilities and Norms*. Windsor: NFER.

[19] Ermisch, J. and Francesconi, M. (2000a) 'Educational Choice, Families, and Young People's Earnings', *Journal of Human Resources*, 35: 143-176.

[20] Ermisch, J. and Francesconi, M. (2000b) 'The Effect of Parents' Employment on Children's Educational Attainment', Institute for Economic and Social Research (ISER) Working Papers n. 31, University of Essex.

[21] Ermisch, J. and Francesconi, M. (2001) 'Family Matters: Impacts of Family Background on Educational Attainments', *Economica*, 68: 137-156.

[22] Feinstein, L. (2000) 'The Relative Economic Importance of Academic, Psychological and Behavioural Attributes Developed in Childhood', Center for Economic Performance (CEP) Discussion Papers n. 443, LSE, London.

[23] Feinstein, L. and Symons, J. (1999) 'Attainment in Secondary School', *Oxford Economic Papers*, 51: 300-321.

[24] Gambetta, D. (1987) *Were They Pushed of Did They Jump? Individual Decision Mechanisms in Education*. Cambridge: Cambridge University Press.

[25] Glick, P. and Sahn, D. E. (2000) 'Schooling of Girls and Boys in a West African Country: The Effects of Parental Education, Income, and Household Structure', *Economics of Education Review*, 19: 63-87.

[26] Griliches, Z. (1977) 'Estimating the Returns to Schooling: Some Econometrics Problems', *Econometrica*, 45: 1-22.

[27] Harmon, C. and Walker, I. (2000) 'Child Outcomes and Child Poverty: Provisional Results on Early School Leaving', mimeo, University of Warwick, Coventry.

[28] Harmon, C., Oosterbeek, H. and Walker, I. (2000) 'The Returns to Education: A Review of Evidence, Issues and Deficiencies in the Literature', Center for the Economics of Education (CEE) Discussion Papers n. 5, LSE, London.

[29] Haveman, R. and Wolfe, B. (1995) 'The Determinants of Children's Attainments: A Review of Methods and Findings', *Journal of Economic Literature*, 33: 1829-1878.

[30] Katz, L.F. and Summers, L.H. (1989) 'Industry Rents: Evidence and Implications', *Brooking Papers on Economic Activity*, Microeconomics, 209-275.

[31] Kodde, D. A. (1986) 'Uncertainty and the Demand for Education', *Review of Economics and Statistics*, 68: 460-467.

[32] Kodde, D. A. and Ritzen, J. M. M. (1984) 'Integrating the Consumption and Investment Motives in a Neoclassical Model of Demand for Education', *Kyklos*, 37: 598-608.

[33] Kodde, D. A. and Ritzen, J. M. M. (1994) 'The Demand for Education under Capital Market Imperfections', in E. Cohn and G. Johnes (eds.), *Recent Developments in the Economics of Education*. Adelrshot: Elgar.

[34] Lauer, C. (2002) 'Family Background, Cohort and Education A French-German Comparison', Discussion Paper No. 02-12, Centre for European Economic Research (ZEW), Mannheim.

[35] Lefebvre, P. and Merrigan, P. (1998) 'Family Background, Family Income, Maternal Work and Child Development', Center for Research on Economic Fluctuations and Employment (CREFE) Working Papers No. 78, Université du Québec à Montréal.

[36] Levhari, D. and Weiss, Y. (1974) 'The Effect of Risk on the Investment in Human Capital', *American Economic Review*, 64: 950-963.

[37] Mander, A. P. and Clayton, D. (2001) 'HOTDECK: Stata Module to Impute Values Using the Hotdeck Method, Statistical Software Components from Boston College Department of Economics'. Software downloadable at *http://fmww.bc.edu//repec//bocode//h//hotdeck.ado*

[38] Maurin, E. (2002) 'The Impact of Parental Income on Early Schooling Transitions: A Re-examination Using Data over Three Generations', *Journal of Public Economics*, 85: 301-332.

[39] Mayer, S. (1997) *What Money Can't Buy: Family Income and Children's Life Chances*. Camdridge (MA): Harvard University Press.

[40] McCulloch, A. and Joshi, H.E. (2002) 'Child Development and Family Resources: Evidence from the Second Generation of The 1958 British Birth Cohort', *Journal of Population Economics*, 15: 283-304.

[41] Micklewright, J. (1989) 'Choice at Sixteen', *Economica*, 221: 25-39.

[42] Muellbauer, J. and Lattimore, R. (1995) 'The Consumption Function: A Theoretical and Empirical Overview', in *Handbook of Applied Econometrics, Volume 1. Macroeconometrics*. Oxford: Blackwell.

[43] Plug, E. and Vijverberg, W. (2001) 'Schooling, Family Background and Adoption: Is It Nature or Is It Nurture?', IZA Discussion Paper no. 247, IZA, Bonn. Forthcoming in *Journal of Political Economy*.

[44] Rice, P. G. (1987) 'The Demand for Post-Compulsory Education in the UK and the Effects of Educational Maintenance Allowances', *Economica*, 54: 465-75.

[45] Romer, D. (1996) *Advanced Macroeconomics*. New York: McGraw-Hill.

[46] Rubin, D. B. and Schenker, N. (1986) 'Multiple Imputation for Interval Estimation from Simple Random Samples with Ignorable Nonresponse', *Journal of the American Statistical Association*, 81: 366-374.

[47] Rubin, D. B. (1987) *Multiple Imputation for Nonresponse in Surveys*. New York: John Wiley and Sons.

[48] Shea, J. (2000) 'Does Parents' Money Matter?', *Journal of Public Economics*, 77: 155-84.

[49] Stafford, F. P. (1987) 'Women's Work, Sibling Competition, and Children's School Performance', *American Economic Review*, 77: 972-980.

[50] Stata (2001) *Stata 7, Reference Su-Z*. College Station, Texas: Stata Press.

[51] Stewart, M. B. (1983) 'On Least Squares Estimation when the Dependent Variable Is Grouped', *Review of Economic Studies*, 50: 737-753.

Table 1. Descriptive statistics

Variable	Males			Females		
	N. obs	Mean	S.D.	N. obs	Mean	S.D.
Welsh residence	3034	0.06	0.25	3814	0.06	0.23
Scottish residence	3034	0.09	0.29	3814	0.09	0.29
House: owner with mortgage	3034	0.49	0.50	3814	0.49	0.50
House: rented or other	3034	0.18	0.38	3814	0.19	0.39
House: missing information	3034	0.17	0.37	3814	0.15	0.36
BAS score	2289	79.62	15.29	2932	77.89	14.14
BAS score missing	3034	0.25	0.43	3814	0.23	0.42
Father edu. less than 0-level	3034	0.25	0.44	3814	0.27	0.45
Father edu. O-level	3034	0.10	0.30	3814	0.11	0.31
Father edu. A-level	3034	0.05	0.22	3814	0.06	0.23
Father other education	3034	0.07	0.25	3814	0.07	0.26
Father missing education	3034	0.40	0.49	3814	0.37	0.48
Mother edu. less than 0-level	3034	0.29	0.46	3814	0.34	0.47
Mother edu. O-level	3034	0.13	0.34	3814	0.13	0.33
Mother edu. A-level	3034	0.03	0.17	3814	0.03	0.16
Mother other education	3034	0.10	0.30	3814	0.10	0.31
Mother missing education	3034	0.40	0.49	3814	0.37	0.48
Parents' income (£10)	1933	23.48	12.99	2432	22.61	12.78
Missing parents' income	3034	0.36	0.48	3814	0.36	0.48
Father s.c.: II	3034	0.20	0.40	3814	0.20	0.40
Father s.c.: IIINM	3034	0.07	0.25	3814	0.07	0.26
Father s.c.: IIIM	3034	0.24	0.42	3814	0.26	0.44
Father s.c.: IV	3034	0.05	0.22	3814	0.05	0.23
Father s.c.: V	3034	0.01	0.11	3814	0.02	0.13
Father s.c.: Student	3034	0.01	0.10	3814	0.01	0.11
Father: Dead	3034	0.02	0.14	3814	0.02	0.15
Father s.c.: Missing social class	3034	0.35	0.48	3814	0.31	0.46
Mother s.c.: II	3034	0.12	0.32	3814	0.12	0.33
Mother s.c.: IIINM	3034	0.22	0.42	3814	0.22	0.41
Mother s.c.: IIIM	3034	0.03	0.18	3814	0.04	0.20
Mother s.c.: IV	3034	0.10	0.30	3814	0.11	0.32
Mother s.c.: V	3034	0.04	0.19	3814	0.04	0.20
Mother s.c.: Student	3034	0.14	0.35	3814	0.16	0.37
Mother s.c.: Dead	3034	0.00	0.07	3814	0.00	0.07
Mother s.c.: Missing social class	3034	0.33	0.47	3814	0.30	0.46
Age father	3034	28.14	22.62	3814	28.16	22.51
Age mother	3034	29.30	20.52	3814	29.82	20.25
Age father missing	3034	0.38	0.49	3814	0.38	0.49
Age mother missing	3034	0.32	0.47	3814	0.30	0.46

Table 1. (continue)

Variable	Males			Females		
	N. obs	Mean	S.D.	N. obs	Mean	S.D.
Disability	3034	0.01	0.08	3814	0.01	0.08
Handicap	3034	0.01	0.09	3814	0.00	0.06
Not known	3034	0.19	0.39	3814	0.17	0.38
West Indian	3034	0.00	0.06	3814	0.01	0.08
Indian	3034	0.01	0.09	3814	0.01	0.10
Pakistani-Bangladeshi	3034	0.01	0.07	3814	0.00	0.05
Mixed and other	3034	0.01	0.08	3814	0.01	0.07
Missing ethnicity	3034	0.18	0.39	3814	0.16	0.37
N. younger siblings	3034	0.56	0.81	3814	0.59	0.84
N. same age siblings	3034	0.02	0.14	3814	0.02	0.13
N. older siblings < 21	3034	0.35	0.56	3814	0.34	0.55
N. older siblings >= 21	3034	0.16	0.50	3814	0.17	0.52
No siblings information	3034	0.18	0.38	3814	0.16	0.36
Rural housing estate	3034	0.01	0.12	3814	0.02	0.13
Poor housing estate	3034	0.43	0.50	3814	0.43	0.50
Other housing estate	3034	0.11	0.31	3814	0.11	0.32
Missing housing info.	3034	0.31	0.46	3814	0.29	0.46
Natural father only	3034	0.06	0.23	3814	0.07	0.25
Natural mother only	3034	0.01	0.10	3814	0.01	0.08
Natural father + relative	3034	0.05	0.22	3814	0.06	0.23
Natural mother + relative	3034	0.01	0.09	3814	0.01	0.07
Other situation	3034	0.02	0.16	3814	0.03	0.16
Missing family structure	3034	0.20	0.40	3814	0.18	0.39
Father moderately interested	3034	0.16	0.37	3814	0.15	0.36
Father scarcely interested	3034	0.02	0.15	3814	0.02	0.14
Father not interested	3034	0.02	0.13	3814	0.01	0.12
Cannot say	3034	0.47	0.50	3814	0.50	0.50
Mother moderately interested	3034	0.23	0.42	3814	0.23	0.42
Mother scarcely interested	3034	0.03	0.17	3814	0.03	0.16
Mother not interested	3034	0.01	0.12	3814	0.01	0.11
Can not say	3034	0.28	0.45	3814	0.28	0.45

Notes. For parents' income and the BAS score, means and standard deviations are for the observations with non missing values.

Table 2. Results of the interval regression for parents' income

Variable	Coeff.	Std. Err.	P-value
Residence			
Welsh residence	-24.00	6.82	0.00
Scottish residence	4.08	6.04	0.50
Father's SOC			
Missing	21.52	34.21	0.53
Professional	-29.34	5.46	0.00
Technical	-48.77	5.38	0.00
Administrative	12.47	22.13	0.57
Skilled trades	33.68	24.12	0.16
Personal service	34.06	17.48	0.05
Sales	18.17	16.33	0.27
Process	12.00	15.06	0.43
Elementary	37.41	8.98	0.00
Father's SIC			
missing	-44.57	34.28	0.19
Agriculture	10.81	9.05	0.23
Energy	-48.09	14.01	0.00
Extraction	-1.91	8.74	0.83
Metal goods	-4.44	7.40	0.55
Other manufacturing	-5.04	8.37	0.55
Construction	-11.97	7.38	0.11
Distribution	-18.07	7.92	0.02
Transport	1.80	7.42	0.81
Banking	-0.69	7.53	0.93
Mother's SOC			
Missing	12.21	29.02	0.67
Professional	-18.05	9.61	0.06
Technical	40.78	7.87	0.00
Administrative	22.62	8.83	0.01
Skilled trades	16.52	32.77	0.61
Personal service	19.10	29.26	0.51
Sales	48.47	32.43	0.14
Process	-22.77	32.19	0.48
Elementary	58.77	16.42	0.00
Mother's SIC			
missing	-17.48	28.96	0.55
Agriculture	12.27	22.27	0.58
Energy	12.53	21.79	0.57
Extraction	-0.28	22.19	0.99
Metal goods	29.17	11.74	0.01
Other manufacturing	22.42	9.43	0.02
Construction	14.52	18.34	0.43
Distribution	-14.82	5.20	0.00
Transport	-24.26	15.20	0.11
Banking	-4.40	6.22	0.48

Table 2. (continue)

Variable	Coeff.	Std. Err.	P-value
Age father	16.08	3.98	0.00
Age father squared	-0.18	0.04	0.00
Age mother	20.56	4.50	0.00
Age mother squared	-0.22	0.05	0.00
Age father missing	277.11	93.16	0.00
Age mother missing	509.96	100.47	0.00
Father's Education			
Less than O-level	-94.76	7.48	0.00
O-Level	-68.09	8.27	0.00
A-Level	-52.51	9.29	0.00
Other	-39.36	9.04	0.00
Missing	-93.05	8.74	0.00
Mother's Education			
Less than O-level	-96.20	11.52	0.00
O-Level	-58.49	11.99	0.00
A-Level	-41.27	15.34	0.01
Other	-55.66	11.62	0.00
Missing	-75.20	12.44	0.00
Father's Ethnicity			
West Indian	-31.76	32.67	0.33
Indian	13.93	48.94	0.78
Other	35.67	25.65	0.16
Missing	-25.18	10.32	0.02
Mother's Ethnicity			
West Indian	6.67	34.05	0.85
Indian	-31.12	52.31	0.55
Pakistani-Bangladeshi	-77.30	16.68	0.00
Other	-27.76	21.85	0.20
Missing	-19.31	16.50	0.24
N. obs	4365		
Wald (p-value)	2154.56 (0.00)		
Log-likelihood	-9289.01		

Notes. The reference household has the following characteristics: English residence, father white, with a university education and manager (SOC) in the Other Sectors (SIC), mother white, with a university education and manager in the Other Sectors. Parents' income is combined gross income of child's mother and father (excludes child benefits but includes all other earned and unearned income before deductions of tax, national insurance, etc.). In particular, weekly income is reported in categorical form: less than £50; £50-£99; £100-£149; £150-£199; £200-£249; £250-£299; £300-£349; £350-£399; £400-£449; £450-£499; £500+; Refusal to answer; uncertain. Observations falling into the last two categories are considered missing.

Table 3. Ordered probit estimates of educational attainment: males

Variable	*Non-missing sample*			*Missing value dummy*			*Multiple hotdeck*		
	Coef.	Std. Err.	P-value	Coef.	Std. Err.	P-value	Coef.	Std. Err.	P-value
Welsh residence	0.1869	0.103	0.07	0.0593	0.084	0.48	0.1698	0.101	0.09
Scottish residence	0.3660	0.087	0.00	0.2971	0.069	0.00	0.3521	0.085	0.00
House: owner with mortgage	-0.0615	0.071	0.39	-0.0419	0.061	0.49	-0.0428	0.066	0.52
House: rented or other	-0.3462	0.083	0.00	-0.3476	0.071	0.00	-0.3438	0.077	0.00
House: missing information	-	-	-	-0.8446	0.223	0.00	-	-	-
BAS score	-0.0479	0.012	0.00	-0.0413	0.011	0.00	-0.0514	0.011	0.00
BAS score squared	0.0005	0.000	0.00	0.0004	0.000	0.00	0.0005	0.000	0.00
BAS score missing	-0.8692	0.449	0.05	-0.5408	0.407	0.18	-1.0011	0.409	0.01
Father edu. less than 0-level	-0.4621	0.122	0.00	-0.3903	0.100	0.00	-0.4880	0.117	0.00
Father edu. O-level	-0.2940	0.127	0.02	-0.2289	0.105	0.03	-0.3469	0.123	0.01
Father edu. A-level	-0.1197	0.146	0.41	-0.0955	0.123	0.44	-0.1621	0.140	0.25
Father other education	-0.1963	0.136	0.15	-0.1349	0.113	0.23	-0.2145	0.131	0.10
Father missing education	-0.5013	0.139	0.00	-0.4500	0.115	0.00	-0.4755	0.134	0.00
Mother edu. less than 0-level	-0.2985	0.190	0.12	-0.4647	0.157	0.00	-0.3178	0.189	0.09
Mother edu. O-level	-0.2733	0.196	0.16	-0.3549	0.161	0.03	-0.2319	0.194	0.23
Mother edu. A-level	-0.2027	0.243	0.40	-0.2983	0.201	0.14	-0.2261	0.241	0.35
Mother other education	-0.2150	0.186	0.25	-0.3051	0.152	0.05	-0.2036	0.186	0.28
Mother missing education	-0.3675	0.200	0.07	-0.4631	0.166	0.01	-0.3678	0.199	0.07
Parents' income (£10)	0.0090	0.000	0.00	0.0060	0.000	0.01	0.0073	0.003	0.01
Missing parents' income	-	-	-	0.1005	0.078	0.20	-	-	-
Father s.c.: II	-0.4877	0.159	0.00	-0.4163	0.127	0.00	-0.4431	0.151	0.00
Father s.c.: IIINM	-0.3840	0.181	0.03	-0.4806	0.148	0.00	-0.3865	0.171	0.02
Father s.c.: IIIM	-0.5812	0.168	0.00	-0.5965	0.134	0.00	-0.5994	0.158	0.00
Father s.c.: IV	-0.5732	0.196	0.00	-0.6337	0.156	0.00	-0.5949	0.184	0.00
Father s.c.: V	-0.4682	0.313	0.14	-0.6971	0.248	0.01	-0.5958	0.287	0.04
Father s.c.: Student	-0.4447	0.271	0.10	-0.3830	0.231	0.10	-0.4397	0.265	0.10
Father: Dead	-0.4453	0.246	0.07	-0.5321	0.221	0.02	-0.5010	0.238	0.04
Father s.c.: Missing social class	-0.2740	0.202	0.17	-0.4524	0.159	0.00	-0.3948	0.191	0.04
Mother s.c.: II	0.1994	0.451	0.66	0.1027	0.382	0.79	0.1549	0.465	0.74
Mother s.c.: IIINM	0.1964	0.456	0.67	0.1168	0.386	0.76	0.1240	0.469	0.79
Mother s.c.: IIIM	0.3277	0.469	0.49	0.2617	0.395	0.51	0.2402	0.479	0.62
Mother s.c.: IV	0.0680	0.464	0.88	0.0045	0.390	0.99	0.0440	0.475	0.93
Mother s.c.: V	0.2579	0.473	0.59	0.1584	0.400	0.69	0.2495	0.483	0.61
Mother s.c.: Student	0.2386	0.458	0.60	0.1361	0.386	0.72	0.2043	0.470	0.66
Mother s.c.: Dead	0.9034	0.564	0.11	0.4552	0.473	0.34	0.6222	0.564	0.27
Mother s.c.: Missing social class	-0.1409	0.467	0.76	-0.0218	0.393	0.96	-0.1349	0.478	0.78
Age father	-0.0051	0.062	0.94	-0.0541	0.055	0.33	0.0155	0.062	0.80
Age father squared	0.0001	0.001	0.92	0.0007	0.001	0.25	-0.0001	0.001	0.88
Age mother	0.0813	0.078	0.29	0.1449	0.066	0.03	0.0810	0.076	0.29
Age mother squared	-0.0008	0.001	0.37	-0.0016	0.001	0.03	-0.0008	0.001	0.33
Age father missing	-0.0180	1.481	0.99	-1.0392	1.307	0.43	0.6035	1.465	0.68
Age mother missing	1.8623	1.734	0.28	3.1955	1.483	0.03	1.7613	1.696	0.30
Child smokes	-0.5332	0.070	0.00	-0.4544	0.057	0.00	-0.4885	0.066	0.00
Impairment	-0.0117	0.136	0.93	-0.0791	0.116	0.50	-0.0454	0.126	0.72
Disability	-0.6951	0.285	0.02	-0.4909	0.216	0.02	-0.6231	0.234	0.01
Handicap	-0.2463	0.282	0.38	-0.4351	0.271	0.11	-0.4364	0.272	0.11
Not known	0.4588	0.185	0.01	0.3170	0.139	0.02	0.3286	0.157	0.04
West Indian	0.1387	0.293	0.64	0.4152	0.279	0.14	0.1334	0.303	0.66
Indian	1.2918	0.413	0.00	1.2279	0.355	0.00	1.2165	0.377	0.00
Pakistani-Bangladeshi	0.8511	0.465	0.07	0.5384	0.377	0.15	0.6500	0.443	0.14
Mixed and other	0.1832	0.454	0.69	0.1808	0.330	0.58	0.1742	0.449	0.70
Missing ethnicity	0.1243	0.244	0.61	-0.0148	0.195	0.94	-0.0939	0.259	0.72
N. younger siblings	0.0823	0.032	0.01	0.0803	0.028	0.00	0.0682	0.031	0.03
N. same age siblings	-0.2269	0.165	0.17	-0.1798	0.141	0.20	-0.2209	0.152	0.15
N. older siblings < 21	-0.0758	0.044	0.09	-0.0817	0.039	0.03	-0.0864	0.041	0.04
N. older siblings >= 21	-0.0487	0.049	0.32	-0.0110	0.043	0.80	-0.0151	0.046	0.75
No siblings information	0.5468	0.641	0.39	0.4178	0.260	0.11	0.5839	0.589	0.32

Table 3. (continue)

Variable	*Non-missing sample*			*Missing value dummy*			*Multiple hotdeck*		
	Coef.	Std. Err.	P-value	Coef.	Std. Err.	P-value	Coef.	Std. Err.	P-value
Rural housing estate	-0.3162	0.207	0.13	-0.2874	0.200	0.15	-0.4202	0.205	0.04
Poor housing estate	-0.0597	0.072	0.41	-0.0421	0.062	0.50	-0.0559	0.066	0.40
Other housing estate	-0.1239	0.093	0.18	-0.0938	0.080	0.24	-0.1251	0.086	0.15
Missing housing info.	0.0624	0.090	0.49	0.0915	0.079	0.25	0.0745	0.085	0.38
Natural father only	0.0081	0.130	0.95	0.0099	0.118	0.93	-0.0198	0.125	0.87
Natural mother only	0.1367	0.291	0.64	0.1764	0.244	0.47	0.1549	0.257	0.55
Natural father + relative	-0.0542	0.097	0.58	-0.1145	0.085	0.18	-0.0937	0.090	0.30
Natural mother + relative	0.2661	0.280	0.34	0.0494	0.242	0.84	0.0987	0.266	0.71
Other situation	0.0237	0.149	0.87	-0.1939	0.136	0.15	-0.1206	0.147	0.41
Missing family structure	0.1325	0.143	0.35	0.0388	0.115	0.74	0.1285	0.126	0.31
Father moderately interested	-0.1589	0.094	0.09	-0.1528	0.073	0.04	-0.1824	0.086	0.03
Father scarcely interested	-0.1892	0.197	0.34	-0.1383	0.154	0.37	-0.1891	0.189	0.32
Father not interested	-0.1496	0.215	0.49	-0.0943	0.165	0.57	-0.1213	0.203	0.55
Cannot say	-0.2371	0.080	0.00	-0.1539	0.062	0.01	-0.2390	0.074	0.00
Mother moderately interested	-0.0704	0.080	0.38	-0.1340	0.062	0.03	-0.0406	0.073	0.58
Mother scarcely interested	-0.1582	0.171	0.36	-0.2899	0.132	0.03	-0.2078	0.161	0.20
Mother not interested	-0.2218	0.241	0.36	-0.0952	0.205	0.64	-0.1824	0.237	0.44
Cannot say	0.0346	0.089	0.70	-0.0751	0.069	0.28	0.0046	0.083	0.96
N-obs	1933			3034			3034		
Log-likelihood	-2349.32			-3752.93					
Pseudo R^2	0.14			0.12					
N inputations							10		

Notes. Coefficients on grey background are significant at the 5% level. The reference individual has the following characteristics: white ethnicity, no disability, non smoking, living in England in accomodation owned outright by his parents in an affluent area and with both natural parents, both parents with university educations, from social class I and interested in their children's education. All the characteristics except the BAS score (age 10) and parents' interest in children's education (age 10) are observed at age 16.

Table 4. Ordered probit estimates of educational attainment: females

Variable	*Non-missing sample*			*Missing value dummy*			*Multiple hotdeck*		
	Coef.	Std. Err.	P-value	Coef.	Std. Err.	P-value	Coef.	Std. Err.	P-value
Welsh residence	0.0494	0.110	0.65	0.1073	0.087	0.22	0.0365	0.107	0.73
Scottish residence	0.3479	0.077	0.00	0.2640	0.062	0.00	0.3661	0.075	0.00
House: owner with mortgage	-0.0837	0.062	0.18	-0.0601	0.051	0.24	-0.0794	0.057	0.16
House: rented or other	-0.2654	0.075	0.00	-0.2678	0.063	0.00	-0.2847	0.069	0.00
House: missing information	-	-	-	0.0525	0.260	0.84	-0.0245	0.286	0.93
BAS score	-0.0136	0.010	0.18	-0.0193	0.008	0.02	-0.0153	0.009	0.10
BAS score squared	0.0003	0.000	0.00	0.0003	0.000	0.00	0.0003	0.000	0.00
BAS score missing	0.5906	0.381	0.12	0.3681	0.295	0.21	0.5185	0.349	0.14
Father edu. less than 0-level	-0.2915	0.106	0.01	-0.2704	0.086	0.00	-0.2707	0.100	0.01
Father edu. O-level	-0.2590	0.113	0.02	-0.2601	0.092	0.01	-0.2278	0.106	0.03
Father edu. A-level	-0.0808	0.122	0.51	-0.1551	0.101	0.12	-0.0651	0.117	0.58
Father other education	-0.2462	0.117	0.04	-0.2466	0.095	0.01	-0.2331	0.112	0.04
Father missing education	-0.3944	0.120	0.00	-0.3707	0.096	0.00	-0.3260	0.113	0.00
Mother edu. less than 0-level	-0.7778	0.147	0.00	-0.8057	0.127	0.00	-0.8109	0.143	0.00
Mother edu. O-level	-0.6949	0.152	0.00	-0.7438	0.131	0.00	-0.7427	0.147	0.00
Mother edu. A-level	-0.4743	0.202	0.02	-0.4883	0.169	0.00	-0.4865	0.201	0.02
Mother other education	-0.4821	0.151	0.00	-0.4541	0.130	0.00	-0.4867	0.147	0.00
Mother missing education	-0.8407	0.161	0.00	-0.8466	0.138	0.00	-0.8622	0.156	0.00
Parents' income (£10)	0.0145	0.000	0.00	0.0141	0.000	0.00	0.0115	0.002	0.00
Missing parents' income	-	-	-	0.3208	0.067	0.00	-	-	-
Father s.c.: II	-0.3490	0.133	0.01	-0.4358	0.103	0.00	-0.3288	0.121	0.01
Father s.c.: IIINM	-0.4120	0.154	0.01	-0.4721	0.120	0.00	-0.3609	0.141	0.01
Father s.c.: IIIM	-0.4097	0.143	0.00	-0.5332	0.110	0.00	-0.4070	0.130	0.00
Father s.c.: IV	-0.4584	0.168	0.01	-0.5527	0.129	0.00	-0.4482	0.151	0.00
Father s.c.: V	-0.5984	0.207	0.00	-0.7188	0.177	0.00	-0.6080	0.191	0.00
Father s.c.: Student	-0.6645	0.298	0.03	-0.7854	0.227	0.00	-0.7347	0.245	0.00
Father: Dead	-0.1130	0.202	0.58	-0.1457	0.163	0.37	-0.1178	0.186	0.53
Father s.c.: Missing social class	-0.4465	0.166	0.01	-0.4967	0.128	0.00	-0.4517	0.150	0.00
Mother s.c.: II	0.4010	0.545	0.46	0.4058	0.386	0.29	0.3917	0.545	0.47
Mother s.c.: IIINM	0.3516	0.547	0.52	0.3818	0.389	0.33	0.3164	0.547	0.56
Mother s.c.: IIIM	0.1267	0.553	0.82	0.2378	0.394	0.55	0.0838	0.552	0.88
Mother s.c.: IV	0.2770	0.548	0.61	0.3468	0.390	0.37	0.2714	0.548	0.62
Mother s.c.: V	0.2557	0.556	0.65	0.2536	0.397	0.52	0.2276	0.554	0.68
Mother s.c.: Student	0.2778	0.547	0.61	0.3335	0.388	0.39	0.2567	0.547	0.64
Mother s.c.: Dead	-0.1231	0.724	0.87	-0.0022	0.477	1.00	0.0596	0.651	0.93
Mother s.c.: Missing social class	0.3104	0.549	0.57	0.2970	0.392	0.45	0.2765	0.549	0.61
Age father	-0.0371	0.061	0.54	-0.0013	0.049	0.98	-0.0216	0.059	0.72
Age father squared	0.0005	0.001	0.45	0.0001	0.001	0.83	0.0003	0.001	0.62
Age mother	0.0551	0.067	0.41	0.0162	0.055	0.77	0.0887	0.064	0.16
Age mother squared	-0.0005	0.001	0.48	-0.0001	0.001	0.87	-0.0009	0.001	0.22
Age father missing	-0.5137	1.445	0.72	0.3256	1.166	0.78	-0.1834	1.397	0.90
Age mother missing	1.1840	1.487	0.43	0.2858	1.229	0.82	1.9500	1.422	0.17
Child smokes	-0.5397	0.059	0.00	-0.4865	0.048	0.00	-0.4943	0.052	0.00
Impairment	-0.1356	0.177	0.44	-0.1414	0.157	0.37	-0.0988	0.170	0.56
Disability	-0.3861	0.289	0.18	-0.2348	0.261	0.37	-0.2607	0.272	0.34
Handicap	-0.6180	0.355	0.08	-0.6326	0.357	0.08	-0.6182	0.352	0.08
Not known	-0.4238	0.152	0.01	-0.3810	0.131	0.00	-0.3853	0.137	0.01
West Indian	0.3792	0.246	0.12	0.4542	0.210	0.03	0.4486	0.251	0.07
Indian	0.4552	0.256	0.08	0.5058	0.204	0.01	0.5914	0.249	0.02
Pakistani-Bangladeshi	0.1544	0.516	0.77	0.0939	0.462	0.84	0.1067	0.470	0.82
Mixed and other	-0.0644	0.295	0.83	-0.0469	0.284	0.87	-0.0334	0.294	0.91
Missing ethnicity	0.0364	0.247	0.88	-0.0257	0.207	0.90	-0.0625	0.224	0.78
N. younger siblings	0.0400	0.031	0.19	0.0322	0.026	0.21	0.0413	0.028	0.14
N. same age siblings	0.1817	0.184	0.32	0.1924	0.140	0.17	0.2293	0.163	0.16
N. older siblings < 21	-0.0559	0.041	0.18	-0.0486	0.035	0.17	-0.0635	0.039	0.10
N. older siblings >= 21	-0.0356	0.043	0.41	-0.0743	0.038	0.05	-0.0416	0.040	0.30
No siblings information	-0.1163	0.177	0.51	0.3127	0.287	0.28	0.5738	0.312	0.07

Table 4. (continue)

Variable	*Non-missing sample*			*Missing value dummy*			*Multiple hotdeck*		
	Coef.	Std. Err.	P-value	Coef.	Std. Err.	P-value	Coef.	Std. Err.	P-value
Rural housing estate	-0.0274	0.163	0.87	-0.0263	0.144	0.86	-0.0132	0.157	0.93
Poor housing estate	-0.0177	0.064	0.78	-0.0545	0.055	0.32	-0.0369	0.059	0.53
Other housing estate	-0.0451	0.084	0.59	-0.0996	0.070	0.16	-0.0632	0.076	0.41
Missing housing info.	-0.0967	0.084	0.25	-0.0966	0.069	0.16	-0.1148	0.076	0.13
Natural father only	0.0896	0.115	0.43	0.0235	0.101	0.82	0.0170	0.109	0.88
Natural mother only	0.3434	0.376	0.36	0.3728	0.284	0.19	0.3056	0.327	0.35
Natural father + relative	-0.1880	0.093	0.04	-0.2413	0.080	0.00	-0.1990	0.086	0.02
Natural mother + relative	0.2879	0.198	0.15	0.2624	0.178	0.14	0.2984	0.188	0.11
Other situation	-0.2174	0.148	0.14	-0.1076	0.125	0.39	-0.1351	0.138	0.33
Missing family structure	0.1754	0.140	0.21	0.0961	0.115	0.40	0.1487	0.129	0.25
Father moderately interested	-0.1645	0.085	0.05	-0.1859	0.066	0.01	-0.1735	0.075	0.02
Father scarcely interested	0.3795	0.192	0.05	0.0654	0.167	0.70	0.2686	0.172	0.12
Father not interested	-0.7066	0.295	0.02	-0.5391	0.226	0.02	-0.5823	0.262	0.03
Cannot say	-0.1845	0.069	0.01	-0.2101	0.055	0.00	-0.1724	0.061	0.01
Mother moderately interested	-0.1066	0.071	0.13	-0.0860	0.056	0.13	-0.1171	0.063	0.06
Mother scarcely interested	-0.5689	0.174	0.00	-0.3650	0.138	0.01	-0.5309	0.145	0.00
Mother not interested	-0.2527	0.340	0.46	-0.1048	0.261	0.69	-0.2112	0.286	0.46
Cannot say	-0.1541	0.075	0.04	-0.0747	0.061	0.22	-0.1292	0.067	0.05
N-obs	2432			3814			3814		
Log-likelihood	-2933.95			-4701.36					
Pseudo R^2	0.15			0.13					
N inputations							10		

Notes. Coefficients on grey background are significant at the 5% level. The reference individual has the following characteristics: white ethnicity, no disability, non smoking, living in England in accomodation owned outright by her parents in an affluent area and with both natural parents, both parents with university educations, from social class I and interested in their children's education. All the characteristics except the BAS score (age 10) and parents' interest in children's education (age 10) are observed at age 16.

Table 5. Marginal effects from the mutliple *hot-deck* model: males

Variable	Highest education				
	< O-level	O-level	Vocational	A-level	UG Degree or higher
Welsh residence	-0.003	-0.030	-0.035	0.004	0.064
Scottish residence	-0.005	-0.057	-0.077	0.003	0.135
House: owner with mortgage	0.001	0.007	0.009	-0.001	-0.016
House: rented or other	0.008	0.070	0.058	-0.014	-0.122
BAS score	-0.004	-0.060	-0.092	0.000	0.156
Father edu. less than 0-level	0.007	0.079	0.105	-0.005	-0.187
Father edu. O-level	0.004	0.052	0.080	0.000	-0.135
Father edu. A-level	0.001	0.021	0.039	0.002	-0.064
Father other education	0.002	0.029	0.051	0.002	-0.085
Father missing education	0.006	0.077	0.103	-0.004	-0.182
Parents' income (£10)	0.000	-0.003	-0.003	0.000	0.007
Father s.c.: II	0.005	0.064	0.103	0.002	-0.173
Father s.c.: IIINM	0.004	0.054	0.091	0.003	-0.152
Father s.c.: IIIM	0.008	0.095	0.130	-0.004	-0.229
Father s.c.: IV	0.008	0.094	0.130	-0.004	-0.228
Father s.c.: V	0.008	0.094	0.130	-0.004	-0.228
Father s.c.: Student	0.005	0.063	0.102	0.002	-0.172
Father: Dead	0.006	0.075	0.114	0.000	-0.194
Father s.c.: Missing social class	0.004	0.055	0.093	0.003	-0.155
Child smokes	0.014	0.106	0.071	-0.024	-0.166
Impairment	0.001	0.009	0.008	-0.002	-0.016
Disability	0.027	0.153	0.048	-0.042	-0.186
Handicap	0.015	0.102	0.049	-0.026	-0.140
Not known	-0.005	-0.054	-0.071	0.004	0.126
West Indian	-0.002	-0.023	-0.028	0.003	0.051
Indian	-0.006	-0.109	-0.275	-0.057	0.447
Pakistani-Bangladeshi	-0.006	-0.083	-0.155	-0.012	0.254
Mixed and other	-0.003	-0.030	-0.037	0.003	0.066
Missing ethnicity	0.002	0.018	0.017	-0.003	-0.034
N. younger siblings	-0.001	-0.012	-0.014	0.002	0.026
N. same age siblings	0.005	0.046	0.036	-0.010	-0.078
N. older siblings < 21	0.002	0.017	0.016	-0.003	-0.031
N. older siblings >= 21	0.000	0.003	0.003	0.000	-0.006
No siblings information	-0.005	-0.078	-0.138	-0.008	0.229
Rural housing estate	0.012	0.093	0.058	-0.022	-0.141
Poor housing estate	0.001	0.010	0.011	-0.002	-0.021
Other housing estate	0.003	0.024	0.023	-0.004	-0.046
Missing housing info.	-0.001	-0.013	-0.015	0.002	0.028
Father moderately interested	0.003	0.032	0.038	-0.004	-0.069
Father scarcely interested	0.003	0.033	0.039	-0.004	-0.071
Father not interested	0.002	0.021	0.026	-0.002	-0.046
Cannot say	0.004	0.043	0.048	-0.006	-0.089

Notes. Marginal effects are computed for the 'average individual', i.e. for the individual with sample average values for all variables. They may not sum to 0 because of rounding.

Table 6. Marginal effects from the multiple *hot-deck* model: females

Variable	Highest education				
	< O-level	O-level	Vocational	A-level	UG Degree or higher
Welsh residence	-0.001	-0.008	-0.005	0.002	0.012
Scottish residence	-0.005	-0.069	-0.071	0.015	0.130
House: owner with mortgage	0.001	0.016	0.014	-0.004	-0.027
House: rented or other	0.006	0.064	0.039	-0.019	-0.091
House: missing information	0.000	0.005	0.004	-0.001	-0.008
BAS score	-0.005	-0.080	-0.099	0.013	0.172
Father edu. less than 0-level	0.004	0.053	0.050	-0.013	-0.094
Father edu. O-level	0.003	0.044	0.043	-0.010	-0.080
Father edu. A-level	0.001	0.011	0.014	-0.002	-0.024
Father other education	0.003	0.045	0.044	-0.010	-0.082
Father missing education	0.005	0.066	0.057	-0.017	-0.112
Mother edu. less than 0-level	0.008	0.123	0.181	-0.008	-0.303
Mother edu. O-level	0.006	0.108	0.171	-0.004	-0.281
Mother edu. A-level	0.003	0.059	0.122	0.008	-0.191
Mother other education	0.003	0.059	0.122	0.008	-0.191
Mother missing education	0.009	0.135	0.187	-0.012	-0.319
Parents' income (£10)	-0.001	-0.006	-0.004	0.002	0.009
Father s.c.: II	0.004	0.057	0.070	-0.010	-0.121
Father s.c.: IIINM	0.004	0.064	0.075	-0.012	-0.131
Father s.c.: IIIM	0.005	0.074	0.082	-0.015	-0.147
Father s.c.: IV	0.006	0.083	0.088	-0.017	-0.160
Father s.c.: V	0.011	0.122	0.105	-0.030	-0.207
Father s.c.: Student	0.015	0.156	0.111	-0.042	-0.241
Father: Dead	0.001	0.018	0.028	-0.002	-0.045
Father s.c.: Missing social class	0.006	0.084	0.088	-0.018	-0.161
Child smokes	0.015	0.122	0.047	-0.039	-0.144
Impairment	0.002	0.021	0.016	-0.006	-0.033
Disability	0.006	0.059	0.035	-0.018	-0.083
Handicap	0.022	0.158	0.043	-0.052	-0.171
Not known	0.010	0.092	0.044	-0.029	-0.117
West Indian	-0.005	-0.077	-0.095	0.013	0.165
Indian	-0.006	-0.094	-0.131	0.010	0.221
Pakistani-Bangladeshi	-0.009	-0.031	0.012	0.011	0.018
Mixed and other	0.003	0.010	-0.004	-0.003	-0.005
Missing ethnicity	0.006	0.018	-0.009	-0.006	-0.009
Natural father only	0.000	-0.004	-0.003	0.001	0.006
Natural mother only	-0.004	-0.058	-0.058	0.013	0.108
Natural father + relative	0.005	0.048	0.023	-0.015	-0.060
Natural mother + relative	-0.004	-0.057	-0.057	0.013	0.105
Other situation	0.003	0.032	0.017	-0.010	-0.042
Missing family structure	-0.003	-0.031	-0.025	0.008	0.051
Father moderately interested	0.003	0.037	0.028	-0.010	-0.058
Father scarcely interested	-0.003	-0.045	-0.059	0.007	0.100
Father not interested	0.018	0.144	0.052	-0.046	-0.168
Cannot say	0.003	0.037	0.028	-0.010	-0.058
Mother moderately interested	0.002	0.025	0.019	-0.007	-0.039
Mother scarcely interested	0.017	0.132	0.047	-0.043	-0.153
Mother not interested	0.004	0.047	0.031	-0.014	-0.068
Cannot say	0.002	0.028	0.021	-0.008	-0.043

Notes. Marginal effects are computed for the 'average individual', i.e. for the individual with sample average values for all variables. They may not sum to 0 because of rounding.

Figure 1. Distribution of weekly parents' income (£10) for the 'non-missing income sample' and for the imputed observations (average of the 10 imputations).