The Effect of Parents' Employment on Children's Educational Attainment

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Abstract

This paper presents the conditions under which a causal interpretation can be given to the association between childhood parental employment and subsequent education of children. In a model in which parental preferences are separable in own consumption and children's well-being, estimation is complicated by endowment heterogeneity and by the fact that parents may compensate or reinforce children's endowments relevant to educational attainment. A sibling difference estimation strategy is generally not sufficient to provide a consistent estimate of the parameter of interest. Identification rests on two stronger assumptions about the timing of parents' knowledge of their children's endowments and about the technology used to produce children's human capital. We find a negative and significant effect on the child's educational attainment of the extent of mother's full-time employment when the child was aged 0-5. The effects of mother's part-time employment and father's employment are smaller and less well determined but again negative. In the context of our conditional demand function framework, these results suggest that a higher full family income increases the educational attainment of children, and given full family income, a higher mother's or father's wage reduces their children's educational attainment.

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Non-technical summary

In the last two decades there has been an extensive body of empirical work concerned with the links between parental investment in children and children's outcomes, particularly educational attainment. Most of these studies are implicitly embedded in the household production model introduced by Becker (1965) (1976; 1979; 1986), and Behrman et al. (1982), but only a few of them attempt to disentangle the household's tastes from its technology in "producing" young people's human capital.

This paper presents a theoretical framework that provides the conditions under which we can give a causal interpretation to the association between childhood parental employment and subsequent education of children as young adults. In an environment in which parental preferences are separable in their own consumption and children's well-being, estimation is complicated by endowment heterogeneity and by the fact that parents may compensate or reinforce children's endowments relevant to educational attainment. While a sibling difference estimation strategy may be useful to eliminate endowment heterogeneity that is common across siblings, it is generally not sufficient to provide a consistent estimate of the parameter of interest. That rests on two stronger assumptions. First, that the idiosyncratic endowments of children are not revealed to parents at birth (it takes time before parents fully know their children's endowments). Second, the parents' time and good elasticities in the children's human capital production function do not vary across ages of the child nor across siblings.

The empirical analysis uses data from various samples of young people drawn from the British Household Panel Survey. There is a negative and significant effect on the child's educational attainment as a young adult of the mother's full-time employment when the child was aged 0-5. The effect of mother's part-time employment is also negative but smaller and less well determined. Similarly, the effect of father's employment is small, not always precisely estimated but again negative. The negative effects of mother's part-time work and, particularly, of mother's full-time work, persist when we include parents' employment patterns over the entire childhood period. In the context of our conditional demand function framework, these results suggest that a higher full family income increases the educational attainment of children, and given full family income, a higher mother's or father's wage reduces their children's educational attainment.

1. Introduction

In the last two decades there has been an extensive body of empirical work concerned with the links between parental investment in children and children's outcomes, particularly educational attainment.[1] Most of this work is implicitly embedded in the household production model introduced by Becker (1965) and developed by Michael (1973), Leibowitz (1974), Becker (1981), Becker and Tomes (1976; 1979; 1986), and Behrman et al. (1982). Although this model emphasizes the distinction between production technology and preferences, there are only a few studies that attempt to disentangle the household's tastes from its technology in "producing" young people's human capital.[2]

In the literature on educational outcomes, Hanushek (1992) formulates a value-added model to estimate achievement growth using data on schools, families, and students observed over a four-year period.[3] Most of the other studies in this literature have estimated education equations that contain one or more education inputs as well as prices and income variables on the right hand side. Since these so called "hybrid equations" (Rosenzweig and Schultz 1983) do not generally embody any restriction derived from economic theory, they cannot provide relevant information on the household's preferences or education technology and their specifications are likely to be arbitrary. Moreover, many of these studies have ignored the possible endogeneity of education inputs by assuming that young people do not differ in terms of their

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[1] For a detailed overview of existing studies, see Haveman and Wolfe (1995) and Mulligan (1997).
[2] Examples of such studies in the child health literature are Rosenzweig and Schultz (1983), and Grossman and Joyce (1990), which employ instrumental variables techniques, and Rosenzweig (1986), Rosenzweig and Wolpin (1988; 1995), Strauss (1990), and Currie and Cole (1993), which employ data on siblings, half-siblings and cousins to examine how maternal choices and characteristics affect child health outcomes.
[3] Blau et al. (1996) also apply a value-added model to analyse the relationship between infants' health and the labour supply of their mothers.

"endowments" relevant to educational attainment. Therefore, it is not surprising that both the wide variety of specifications and the near total neglect of potential endogeneity problems make "generalizations regarding the absolute and relative effects of potential determinants on attainment virtually impossible" (Haveman and Wolfe 1995, p. 1873).

Several studies have attempted to determine whether parents' (particularly mothers') employment affects children's educational attainment. In reviewing some of the most influential American studies that have examined the effects of early maternal employment on children's early cognitive development, Harvey (1999) underlines that "the results of these studies have been surprisingly mixed considering they used the same data set" (p. 445), that is, the National Longitudinal Survey of Youth. But all of them, including Harvey's own study, estimate hybrid equations and thus confound the technological properties of the education production function and the characteristics of the household's preferences. A similar point can be raised for most of the currently available analyses that use British data, which are concerned either with early learning or with later educational achievements (see Kiernan 1997; Gregg and Machin 1999; Joshi and Verropoulou 2000).

In this paper, we estimate the relationship between parental employment patterns during childhood and children's educational attainment during young adulthood using a "sibling difference" estimator. Although the use of kinship data has become increasingly common in the economic analysis of intergenerational links (Rosenzweig and Wolpin 1995), there is no study attempting to estimate the effect of parental behaviour during childhood on children's later education using a sibling estimator within a framework embedded in economic theory. Other studies have employed kinship data to estimate the relationship between maternal employment and

children's education (e.g., Duncan et al. 1997; Duncan et al. 1998). But these studies do not estimate the relationship of interest within an economic-theory approach. Rather, by including both measures of mothers' labour supply and parental income, they estimate hybrid equations, which fail to have a meaningful economic interpretation. Yet, a meaningful interpretation is important for evaluation of policies concerned with family leave and work-family balance, and of policies intended to reduce dependency on state benefits and improve family finances by encouraging mothers to take up paid work.[4]

In Section 2 we develop a conceptual framework that allows us to assess the effect of parental behaviour on children's education in the presence of heterogeneity in "endowments". This framework leads to the formulation of conditional demand functions that define the conditions under which we can give a causal interpretation to the association between a parent's employment and future outcomes of her children arising from human capital investment in them. The data are described in Section 3, while Section 4 illustrates the econometric model employed to account for such heterogeneity. Section 5 discusses estimates of the effect of parental employment during childhood and their children's educational attainment as young adults and presents supplementary empirical information relevant to the assumptions needed for identification. Section 6 concludes.

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[4] For recent policy initiatives in Britain, see Department for Education and Employment (2000).

2. Framework

2.1 A Static Model of Parents' Human Capital Investment in their Children

It is clear that, in general, the time a mother spends in employment is chosen jointly with human capital investment in her children and parents' own consumption. It would, therefore, be hard to interpret the coefficient of mother's employment time in an equation for her child's eventual educational attainment. Furthermore, there would be no valid instruments for mother's employment, because all exogenous variables, such as her wage and other family income, are also determinants of the child's educational attainment.

There is, however, intuitive appeal in assuming that parents have preferences characterized by a utility function which has earning capacities of children separable from parents' consumption; that is, in the case of a two-child family, parental utility is given by $U=U(x,W(e_a,e_b))$, where x is parental consumption; e_i (i=a,b) is the future earning capacity of each child i, and W(.) is the sub-utility function representing parental welfare from children's earnings. The constraints include two human capital production functions, $e_a=f(t_a,z_a,\varepsilon_a)$ and $e_b=f(t_b,z_b,\varepsilon_b)$, where t_i is the mother's time input into human capital production for the i-th child, z_i is the child-specific input of purchased goods and services and ε_i is the "earnings endowment" of the i-th child.[5] The resource constraint is $y + wT = x + w(t_a+t_b) + p(z_a+z_b) = x + R$, where total mother's time available is T, w is the wage of the mother, p is the price of "child investment goods", y is father's earnings and other non-earned income, and $R=w(t_a+t_b) + p(z_a+z_b)$ denotes the resources devoted to human capital investment in children.

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[5] Relaxation of the assumption that only mothers provide time inputs to human capital investment in children does not alter the main message from the model.

Separable utility implies that e_a and e_b can be expressed as functions of R, ε_a and ε_b, with w, p and y entering these "conditional demand functions" for e_a and e_b only through their effect on R (Pollak 1971).[6] Unfortunately for econometric purposes, R is not generally independent of ε_a and ε_b. It could, however, be instrumented using estimates of w and y.[7]

There is, however, a special case in which R and $t_a + t_b$ are independent of ε_a and ε_b. Assume that the production functions take the form $e_i = \varepsilon_i t_i^{\alpha 1} z_i^{\alpha 2}$ ($\alpha_1 + \alpha_2 \leq 1$), and following Behrman et al. (1982), let $W(e_a, e_b) = [e_a^c + e_b^c]^{1/c}$, with $c \leq 1$ (i.e. a CES form). The parameter c indicates the degree of aversion to inequality between children's earnings, with lower c indicating more inequality aversion. It determines whether parents' human capital investments *reinforce* earnings endowments (c>0) or *compensate* for differences in children's endowments (c<0). If the parents utility function $U(x, W(e_a, e_b))$ is Cobb-Douglas with parameters β and $1-\beta$ respectively, then, letting $\alpha = \alpha_1 + \alpha_2$,

(1) $ln(t_a + t_b) = ln[(1-\beta)\alpha_1] - ln[\beta + (1-\beta)\alpha] + ln[(wT+y)/w]$

(2) $ln(e_a) = \alpha ln(t_a + t_b) + \alpha_2 ln(w/p) + \alpha_2 ln(\alpha_2/\alpha_1) + ln(\varepsilon_a) - \alpha ln[1 + (\varepsilon_b/\varepsilon_a)^{c/(1-c\alpha)}]$

with a similar equation for $ln(e_b)$.[8]

In this case, if α_1 and α_2 do not vary across families, we could treat $t_a + t_b$ as exogenous in the equations for e_i. It would be a 'sufficient statistic' for measuring the effect of (wT+y)/w on e_i for constant w/p, and this effect would be given by the

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[6] This is analogous to expressing demand functions within a period as a function of total expenditure in that period in the context of life cycle optimisation and a separable inter-temporal utility function (Blundell and Walker 1986). If the father also provides time inputs to human capital investment, then $R = w_m(T-h_m) + w_f(T-h_f) + p(z_a + z_b)$, where w_f and h_f (w_m and h_m) are the father's (mother's) wage and hours employed.

[7] In the data used in our empirical analysis, however, parental wages and income during young people's childhood are not available.

[8] Derivation of these expressions use the fact that, in this model, optimisation implies that $w(t_a + t_b) = \alpha_1 R/\alpha$.

production function parameter $\alpha = \alpha_1 + \alpha_2$.[9] Note that we need to control for variation in w/p across families. If the production technology also varied across families, then $t_a + t_b$ would no longer be exogenous. It would be correlated with the stochastic element of equation (2), because the latter would include $\alpha_2 ln(\alpha_2/\alpha_1)$.

One way to control for heterogeneity in w/p, α_1 and α_2 is to take differences between siblings in families. This static model is not, however, very helpful in structuring such an analysis because $t_a + t_b$ does not differ between siblings. The static model could be interpreted as one in which non-identical twins are born, or siblings are born close together. The potential for the use of sibling differences in estimating the effect of mother's employment on child outcomes comes from the differences in birthdays for two siblings, but this requires that we consider the dynamics explicitly.

2.2 A Dynamic Model of Parents' Human Capital Investment in their Children

In this model, each family is assumed to have two children, each of whom lives for two consecutive periods in the parental home (until the end of childhood) and then moves out. We are therefore concerned with household decisions over three periods. The first child arrives in the first period, and the second in the second period. Parents again choose time and goods inputs to human capital investment in their children and their own consumption. During the second period, both children live with their parents and receive human capital investments from them, while in the first and third period only one child receives such investments. For simplicity, we again assume that only mothers provide time inputs to human capital investment in children. We also assume that there is no borrowing or lending across the periods.

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[9] Note that, for given "full income" (wT+y), the elasticity of e_i with respect to w is $-\alpha_1$, and the elasticity of e_i with respect to p is $-\alpha_2$.

Parents have preferences characterized by a utility function which has earning capacities of children separable from parents' consumption; that is, parental utility is given in each period j by $U=U(x_j,W(e_a,e_b))$, where x_j is parental consumption in period j (j=1,2,3). The constraints include two human capital production functions, $e_a=f(t_{1a},t_{2a},z_{1a},z_{2a},\varepsilon_a)$ and $e_b=f(t_{2b},t_{3b},z_{2b},z_{3b},\varepsilon_b)$, where child a is the first child, born in the first period, and child b is born in the second period, t_{ji} is the mother's time input into human capital production for the i-th child in period j, z_{ji} is the corresponding goods input and ε_i is the earnings endowment of the i-th child. There is also a parental resource constraint for each period j: $y_j+w_jT= x_j+ w_j(t_{ja}+t_{jb}) + p_j(z_{ja}+z_{jb})= x_j+R_j$, where T denotes total mother's time available in period j, w_j is the wage of the mother, p_j is price of child investment goods, y_j is father's earnings and other income, $R_j=w_j(t_{ja}+t_{jb})+p_j(z_{ja}+z_{jb})$ denotes resources devoted to human capital investment in children (in period j in each instance), and $t_{1b}\equiv0\equiv t_{3a}$ because of the timing of children. The dynamic nature of the problem comes through human capital investment. We shall show that, even in the special case used in the static model, R_j is not independent of the children's earnings endowments ε_a and ε_b. In what follows, we assume Cobb-Douglas production functions, $e_a=\varepsilon_a t_{1a}^{\alpha t1}z_{1a}^{\alpha z1}t_{2a}^{\alpha t2}z_{2a}^{\alpha z2}$ and $e_b= \varepsilon_b t_{2b}^{\alpha t1}z_{2b}^{\alpha z1}t_{3b}^{\alpha t2}z_{3b}^{\alpha z2}$ $(\alpha_{t1}+\alpha_{t2}+\alpha_{z1}+\alpha_{z2}\leq1)$, and $W(e_a,e_b) = [e_a^c+e_b^c]^{1/c}$, with $c\leq1$. Notice that the production technology is characterised by identical production elasticities for the two siblings.

This time allocation problem is solved in a backward manner (i.e. starting with the third period). Solving the third period problem (when all human capital investment in the first child has finished), we find that

(3) $\partial R_3/\partial\varepsilon_b = [c\beta(1-\beta)(\alpha_{t2}+\alpha_{z2})e_b^c e_a^c][\partial ln(e_b/e_a)/\partial ln(\varepsilon_b)](y_3+w_3T)/\varepsilon_b D^2$

where $D=[e_a{}^c+e_b{}^c]\beta+(1-\beta)(\alpha_{t2}+\alpha_{z2})e_b{}^c$, $\partial R_3/\partial\varepsilon_a$ is similar, but of the opposite sign. As long as parents respond to their children's individual earnings endowments (i.e. $c\neq0$), $R_3= w_3 t_{3b}+p_3 z_{3b}$ depends on ε_a and ε_b, and so neither R_3 nor t_3 are exogenous in equations for e_a and e_b.[10] If parents act to compensate for differences in endowments, a higher endowment for child b (child a) reduces (increases) R_3 and t_3, because we expect that $\partial ln(e_b/e_a)/\partial ln(\varepsilon_b)>0$.[11] The opposite is the case if parents reinforce endowment differences in their human capital investment decisions. Similar analysis indicates that neither R_1 nor R_2 are exogenous. This conclusion would be the same even if children did not overlap in the time periods of human capital investment.

Sibling difference estimates of the "effect" of mother's employment time on child outcomes often compare the amount of the mother's time devoted to human capital investment when the first child is "young" relative to that when the second child is "young", $t_{1a}-(t_{2a}+t_{2b})$; similarly, the difference in amounts when each child is in the second part of his/her childhood is $(t_{2a}+t_{2b})-(t_{3b})$. We have shown that these differences are not likely to be exogenous when parents respond to children's endowments.

One possible justification for their exogeneity is that parents do not know these endowments, which is probably more likely when the child is very young, e.g. pre-school age (see Rosenzweig and Wolpin 1995, for an analogous process of information revelation). So let us suppose that ε_a and ε_b are not known until the second part of the child's childhood, periods 2 and 3 respectively for child a and b. Then the first period time allocation t_{1a} is independent of ε_a and ε_b. But

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[10] Note that $t_{3b}=[\alpha_{t2}/(\alpha_{t2}+\alpha_{z2})](R_3/w_3)$. In the case of a Cobb-Douglas specification for $W(\cdot)$, $c\to0$ and R_3 is exogenous.

[11] We expect $\partial ln(e_b/e_a)/\partial ln(\varepsilon_b)>0$, because $\alpha_{t1}+\alpha_{t2}+\alpha_{z1}+\alpha_{z2}\leq1$ and $c\leq1$. Note that in the static model above, $\partial ln(e_b/e_a)/\partial ln(\varepsilon_b/\varepsilon_a)=1/(1-\alpha c)>0$.

(4) $\partial R_2/\partial\varepsilon_a = \beta c(1-\beta)e_b{}^c e_a{}^c[(\alpha_{t1}+\alpha_{z1})-(\alpha_{t2}+\alpha_{z2})][\partial ln(e_b/e_a)/\partial ln(\varepsilon_a)](y_2+w_2T)/\varepsilon_a D^2$

Thus, the effect of the first child's endowment (ε_a) on resources devoted to second period human capital investment in children depends not only on whether parents compensate or reinforce endowments, but also on the difference between the sums of the human capital production elasticities in the two periods of childhood, $(\alpha_{t1}+\alpha_{z1})-(\alpha_{t2}+\alpha_{z2})$. If there are the same returns to scale within each period (say, 0.5), this difference is zero and $\partial R_2/\partial\varepsilon_a=0$. This assumption is consistent with mother's time inputs having a higher elasticity when the child is young while goods inputs have a higher elasticity later in childhood.[12] Because information on ε_b is not yet revealed, $\partial R_2/\partial\varepsilon_b=0$. Thus, R_2 is exogenous under the assumption that returns to scale are the same within each period.

In most data however, R_2 is not observed. At best, we observe total mother's time inputs to human capital investment in period 2, $t_{2a}+t_{2b}$. But it cannot be expressed simply in terms of R_2. In particular,

(5) $(\alpha_{t1}+\alpha_{z1})t_{2b}/\alpha_{t1} + (\alpha_{t2}+\alpha_{z2})t_{2a}/\alpha_{t2} = R_2/w_2.$

If, however, we make the stronger assumption that the respective production elasticities in the two stages of a child's life are proportional to each other (i.e., $\alpha_{k2}=\lambda\alpha_{k1}$,   k=t,z,   with $0\leq\lambda\leq1$,   where $(\alpha_{t1}+\alpha_{z1})\leq1/(1+\lambda)$),   then $t_{2a}+t_{2b}=\alpha_{t1}R_2/(\alpha_{t1}+\alpha_{z1})w_2$, and we can express e_a and e_b as functions of $t_{2a}+t_{2b}$. Then

(6) $\partial(t_{2a}+t_{2b})/\partial\varepsilon_a=(1-\lambda)\alpha_{t1}\beta c(1-\beta)e_b{}^c e_a{}^c[\partial ln(e_b/e_a)/\partial ln(\varepsilon_a)](y_2+w_2T)/\varepsilon_a D^2/(\alpha_{t1}+\alpha_{z1})w_2$

Thus, equal production elasticities ($\lambda=1$) in the two stages of a child's life are required to justify $t_{1a}-(t_{2a}+t_{2b})$ as an exogenous explanatory variable, even when

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[12] If $\alpha_{t1}+\alpha_{z1}>\alpha_{t2}+\alpha_{z2}$, a higher endowment for the first child would decrease (increase) the resources devoted to children's human capital investment in period 2 (R_2) if parents reinforce (compensate for) endowment differences, because we expect that $\partial ln(e_b/e_a)/\partial ln(\varepsilon_a)<0$. At the same time, t_{2a}/t_{2b} would

information about a child's endowments is not revealed until he/she is older. The reason is that parents can make compensating or reinforcing investments when endowments are revealed. Under these information revelation and production technology assumptions, the difference in amounts of the mother's time devoted to human capital investment when each child is in the second part of his/her childhood, $t_{2a}+t_{2b}-t_{3b}$, is not independent of endowments as long as parents respond to endowments when they are revealed.[13]

3. Data

The preceding framework implies that estimation of the impact of parental employment patterns during childhood on the educational attainments of young adults requires data that provide longitudinal information on parents' fertility, marriage, and work. The data must also allow us to identify siblings whose information is needed in the estimation of the conditional demand functions in the presence of heterogeneity in parental preferences and technology. The data used in this analysis come from the first seven waves (1991-1997) of the British Household Panel Survey (BHPS), which has collected information on a nationally representative random sample of private households in Britain since 1991 and annually thereafter.[14] We match young adults to (at least one of) their parents in at least one of the panel years. Once parents are identified, the BHPS provides a complete work history (collected in the 1993 wave), that makes it possible to construct the patterns of parental employment during the entire childhood of each young adult in the survey. For each young adult, we measure the length of time that his/her parents spent in paid work during three developmental

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increase (decrease) as a consequence of higher ε_a if parents reinforce (compensate for) endowments differences.

[13] When ε_b is not revealed until the last period, $\partial R_3/\partial\varepsilon_b = [c\beta(1-\beta)(\alpha_{t2}+\alpha_{z2})e_b{}^c e_a{}^c](y_3+w_3T)/\varepsilon_b D^2$.

stages, ages 0-5, 6-10 and 11-15, and for mothers we distinguish between time spent in part-time work and time spent in full-time work.[15] The data also provide a complete fertility and marital history (collected in the 1992 wave) so that it is possible to identify siblings and half-siblings and determine the patterns of childhood family structure.[16] The parent-child matching also permits measurement of other family background characteristics that would be unavailable otherwise (such as age of parents' at the young person's birth, parental education, and number of brothers and sisters).

The analysis is performed on four samples, two of which only allow for cross-sectional estimates (i.e. across family comparisons). These estimates offer a useful benchmark for comparison with the existing literature. Our first sample (labeled as Main Sample or MS) consists of 1,026 individuals who: (i) are aged 18 or more and were born between 1970 and 1981; (ii) do not have serious disabilities;[17] (iii) lived with their biological, adoptive or step parent(s) for at least one year during the first seven waves of the panel study; and (iv) have complete information on mother's employment patterns during childhood and other variables relating to her. We impose this last condition so that, by construction, we have full information on the key

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[14] Detailed information on the BHPS can be obtained at http://www.iser.ac.uk/bhps/doc/index.html. A further description of the data used here can be found in Ermisch and Francesconi (2000).

[15] Ermisch and Francesconi (2000) further distinguish the first twelve months of the child's life within the first developmental stage. The parental employment (and family structure) effects of this first year on education are small and never significant. Since the results for the 0-5 stage are similar to the results for the 1-5 stage while the estimates for the other two developmental stages are unchanged, we present our results with only three developmental stages.

[16] The measure of family structure used in this paper is a dummy variable taking the value of one if the young adult spent time in a single-parent family during his/her childhood. This measure is broken down by the timing of the start of a spell in a single-parent family, distinguishing between the three child development stages defined above. Both childhood family structure and childhood parental employment do not suffer from the "window problem" discussed by Wolfe et al. (1996).

variables for our analysis. Condition (i) is imposed because it is rare to obtain A-levels (our measure of educational attainment) before age 18, and also because it restricts the sample to a group of individuals with a comparable educational system.[18] Condition (ii) rules out cases for which mother's employment patterns are arguably determined by children's endowments. Condition (iii) is needed to match data on family background from the parents' records to their child. It creates, however, the potential for sample selection bias if unobservable attributes affecting educational attainment also affect the chances of residence with parents. This is the reason why we present further evidence based on a Restricted Sample (RS), in which individuals from MS must be aged 16-17 when they live with their parent(s).[19] Because 95 percent of the panel members live with their parents when aged 16-17, RS is likely to be a random sample. This sample consists of 647 individuals. Finally, the two samples used for estimates of the effect of parents' employment patterns on children's achievements based on sibling differences (i.e. within family comparisons) are obtained from the siblings present in the Main Sample (SMS) and from the siblings present in the Restricted Sample (SRS). In SMS there are 274 households with 2 or more siblings (or half-siblings) for a total of 599 individuals and a maximum of 381 sibling comparisons. In SRS we have 155 households with 2 or more siblings, totaling 326 individuals and 187 sibling comparisons.

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[17] Serious disabilities are defined as being registered as a disabled person (either with Social Security or with a green card) and having any of the following health problems: sight problems, hearing problems, asthma, diabetes, epilepsy, and emotional disturbances. See Blau and Grossberg (1992) for a similar sample selection. As a result of such a selection we lose 10 individuals in our sample. We have performed the entire analysis also including those 10 disabled individuals and found remarkably similar results to those reported here.

[18] Those who completed their education in 1988 (born 1971-1972) were the first to study for the General Certificate of Secondary Education (GCSE) qualification; earlier cohorts would have studied for "O(Ordinary)-level" qualifications. For non-British readers, "A(Advanced)-level" corresponds to education beyond high school, but short of a university degree; GCSE and O-level qualifications roughly correspond to a high school diploma.

Table 1 shows the means of all variables used in the analysis by estimating sample. To provide a meaningful comparison across samples the figures on the SMS and SRS are computed on all individuals rather than on sibling differences. Educational attainment of the child is defined as achieving an "A(Advanced)-level" qualification or higher qualification.[20] For each young person, we take the highest educational level as that in the latest year in which we observe him/her in the panel. Table 1 indicates that the percentage of individuals who have achieved a highest qualification of at least A level is almost 62 percent in the main sample and 64 percent in SMS (63 and 67 percent in the younger RS and SRS). By construction, we have complete information about their mothers' childhood employment and the other background variables related to her for all young adults in our samples. But one in six people do not have a "father-figure" present during the panel period. When present, the father-figure is the natural father for the cases in which the family has remained intact, but he would be the stepfather in other cases. For short, we shall refer to the father-figures as "fathers". An additional one in six people do not have any information about their father's working patterns during childhood. This is either because the father was not present in the third wave of the BHPS, when the retrospective job history information was collected, or because we could not construct a complete work history over the young adult's childhood.[21] As expected, fathers

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[19] The age restriction on this sample implies that individuals were born between 1974 and 1981. The age range is then 16-24, while the age range in MS is 16-27.

[20] In addition to those who obtained a university degree, our measure of educational attainment includes also those with higher "vocational" qualifications, such as teaching and nursing qualifications, City and Guilds certificate, Higher Certificate/Diploma and University Diploma, many of whom probably did not obtain an A-level. Indeed, 19 percent of the young adults in MS (16 percent of those in RS) have these qualifications (that is, 30 percent of those who have achieved a highest qualification of at least A level). In 40 percent of the sibling pairs, one has a qualification of at least A-level and the other does not.

[21] Rather than dropping individuals with missing father or missing father's work history information from the analysis, we chose to maximise our sample size by retaining all individuals and indicating missing father or missing father's work information with two dummy variables. All variables with missing values have been replaced with zeros.

spent a substantial fraction of time in the labour market. The average figures reported in square brackets of Table 1 are computed for children with fathers present and job history information available. These indicate that fathers worked on average 90 percent of the time during their children's childhood, or approximately 175 months over 192. This means about 1 month of non-employment in each of the 16 years of dependency of their child.

Mothers were, on average, in paid employment almost 96 months during childhood, that is, 50 percent of the first sixteen years of life of their children. Maternal employment and child's age are clearly positively related. Between the child's birth and the sixth birthday, mothers worked on average about 18 months in MS and RS and 16 months in SMS and SRS. During primary school years, their time in paid employment increased to about 30 months; and, finally, during their child's adolescence, they worked for 45 months. This picture does not significantly change if we confine our attention to mothers who were employed sometime at each development stage (the figures are reported in square brackets of Table 1). More than 60 percent of their time in paid employment was in part-time work, but the employment gradient with child's age is as steep in part-time work as it is in full-time work.

Nearly 48 percent of young adults in each sample are women. The average age of the young adults in MS and SMS is just above 21, and slightly less than 20 in RS and SRS. The average year of birth is 1975 for people in the main sample and 1976 for those in the restricted sample.[22] About one-fourth of the people in MS and RS

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[22] Ermisch and Francesconi (2000) document that the absolute age differences between siblings in SMS and SRS are on average of 3.08 and 2.72 years, respectively. Approximately 75 percent and 82 percent of the age differences are less than 4 years in SMS and SRS respectively, while only 15 percent and 7 percent of the age differences are above 5 years. Interestingly, we observe 7 and 5 twin births in SMS

experienced life in a single-parent family; that is, either their mother's partnership dissolved before they reached age 16, or they were born outside a live-in partnership. Of the children who spent some time in a single parent family, 45 percent did so below the age of 6. In SMS and SRS the proportion of young adults who experienced life in a single parent family is lower, and approximately 20 percent. But again, of those who spent time in a single parent family, almost 45 percent did so by age 6. More than one-quarter of the mothers and one-third of the fathers of these young adults had no academic qualification, while 9-10 percent of mothers and fathers held a university degree. On average, mothers gave birth at age 26, when fathers were approximately 2 years older. Approximately 7 percent of the young people were an only child, while 40 percent were firstborn. They had an average of 1-2 brothers and sisters.

4. Econometric model

Consider the model presented in Section 2.2 when information about the child's endowment is not immediately revealed to the parents (i.e., it becomes known only during the second part of the child's childhood). If $\alpha_{k1}=\alpha_{k2}$ ($k=t,z$) the following equation is an approximation to the difference between the conditional demand functions for each sibling's earning capacity (e.g., the difference in educational attainment):

(7) $e_a-e_b = \delta_0 + \delta_1[(t_{2a}+t_{2b})-t_{1a}] + \delta_2(\mathbf{X}_a-\mathbf{X}_b) + \varepsilon_a-\varepsilon_b,$

where the mother's time input into human capital production in each period has been replaced by its complement, mother's employment time, and dynamic responses in the

third period have been "substituted out". Thus, δ_1 reflects preference parameters, expectations about future incomes, prices and wages and realizations of these, as well as household production technology. It measures the full impact of $(t_{2a}+t_{2b})-t_{1a}$ on e_a-e_b. The vector **X** denotes a set of individual characteristics, which, in our estimation, are: the young adult's gender, age, experience of life in a single-parent family at each developmental stage, age of the mother and father at the child's birth, whether or not he/she is the firstborn, whether or not there is a missing father figure, and whether there is no information on the father's employment patterns.

The variables t_{1a} and $t_{2a}+t_{2b}$ in specification (7) serve as sufficient statistics for the effects of w_1, w_2, p_1, p_2, y_1 and y_2 on human capital investment in each child when he/she is "young"; their effects work through $(t_{2a}+t_{2b})-t_{1a}$. While equation (7) approximates a complex reduced form expression, if $\alpha_{k1}=\alpha_{k2}$ (k=t,z) we can interpret δ_1 as reflecting the effect of the amount of mother's time allocated to her children's human capital investment when they were of pre-school age on their subsequent educational attainments, leading us to expect δ_1 to be negative. In other words, this is analogous to the special case of the static model in equation (2) above, in which the coefficient of $ln(t_a+t_b)$ is α, but now δ_1 partly reflects preferences, expectations and realizations of incomes, prices and wages in the dynamic model. The negative δ_1 means, for example, that, for a constant mother's wage and price of child investment goods, higher father's or other income in the first period (y_1) relative to that in the second period (y_2) increases the educational attainment of the first child relative to that of the second child.[23]

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[23] A negative δ_1 also implies that the children from families with higher full income throughout their childhood will have more invested in their human capital and have higher educational attainments and lifetime earnings. As we have not estimated the parameters that allow us to gauge the impacts of the

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Application of ordinary least squares (OLS) to (7) provides a consistent estimate of δ_1 when $\alpha_{k1}=\alpha_{k2}$ (k=t,z), or, equivalently, when $\lambda=1$ in (6), because the difference between the amounts of the mother's time devoted to human capital investment when each child is "young" can be taken as exogenous in equation (7) in this case. If, however, $\lambda\neq1$, an OLS estimate would be a biased estimate of δ_1, and the direction of the bias depends on λ and c. Suppose $\lambda<1$. Then, from equation (6), an OLS estimate of δ_1 would overstate the size of δ_1 if parents reinforce endowment differences and understate it if they compensate for differences in endowments. This is because, when $\lambda<1$, parents respond to a higher ε_a by increasing employment time in period 2 (i.e. reducing $t_{2a}+t_{2b}$) if they act to reinforce endowments; thus, mothers with high $t_{2a}+t_{2b}$ tend to have first children with low ε_a. Conversely, when parents act to compensate for endowment differences, mothers with high $t_{2a}+t_{2b}$ tend to have first children with high ε_a.[24]

In a more complex model, in which the allocation of more of the mother's time to paid employment when the child is a pre-schooler increases her wage in the future, the full effects of the mother's time allocation when the child is a pre-schooler are ambiguous. In such a model, the direct effect on human capital investment of spending more time in paid employment when the child is a pre-schooler, which lowers educational attainments, may be offset by the effect of higher full family income later in childhood if goods inputs are sufficiently more productive in human capital investment than mother's time inputs when a child is older.

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mother's wage, price of child investment goods and full family income on the mother's time allocation, we are not able to assess the quantitative impact of them on children's educational attainments.

[24] As equation (5) shows, if the respective production elasticities in the two stages of a child's life are not proportional, there is not a clear mapping between R_2 and $t_{2a}+t_{2b}$, making interpretation of the regression coefficient δ_1 more difficult.

The static model of Section 2.1 makes it clear that cross-sectional estimates of the relationship between parental employment during childhood and children's later educational achievements are likely to be biased. This is because the resources devoted to human capital investment in children, R, are not generally independent of their endowments, ε_a and ε_b (and even if they are, there is likely to be heterogeneity in w/p and production technology). Most of our knowledge of the association between parents' employment and children's educational attainments is, however, based on evidence obtained from cross-sectional estimates. We shall, therefore, present evidence on such estimates as well.

In the empirical analysis, we estimate logit regressions on both the cross-sectional samples (MS and RS) and the sibling samples (SMS and SRS). In the sibling samples, we sort siblings so that the sibling with higher education is listed first. Correspondingly, the dependent variable takes the value of unity if one of the siblings has an A-level or above and the other does not, and zero otherwise.[25] All figures are marginal effects and should be interpreted as deviations from the corresponding baseline probabilities.

5. Results

5.1 Preferred estimates

Our dynamic model suggests that a causal interpretation of the relationship between parental employment during childhood and educational attainment of children as young adults relies on rather strong assumptions, even if sibling difference estimates are used. The assumption that parents do not know (or have limited information

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[25] Because of the non-random sorting of siblings, a constant term is included in the differenced education equation (Ashenfelter and Rouse 1998).

about) their children's idiosyncratic endowments is more likely to be true when the child is very young (e.g., in pre-school years). Thus, our preferred estimates are those that only use parents' employment patterns (and family structure) in the first of the three developmental stages, (i.e. when the child is aged 0-5) as the parental employment variables. Information on the subsequent developmental stages is dropped from the estimation.

The parameter estimates associated with the parental employment variables are reported in Table 2.[26] There is strong evidence from the sibling difference estimates of an adverse effect of mother's full-time employment on her children's probability of achieving A level or more. The effect is measured with precision, and its point estimate ranges between a 7 and 9 percentage point lower probability, depending on the estimating sample. A negative effect is also detected by the cross-sectional estimates but it is weaker and not statistically significant. There is also evidence of a negative effect on education of the mother's part-time employment during the child's first five years of life. But this effect is smaller in magnitude, ranging from a 3 to 6 percentage point lower probability of achieving A-level or more, and it is less precisely estimated. Interestingly, the effect of father's employment is also negative and around 4 percentage points in the case of SMS. The positive cross-sectional relationship between child's education and father's time in paid work is likely to pick up the positive correlation between children's educational attainment and father's endowment, which, in turn, is positively correlated with his employment patterns. Our conditional demand framework provides a straightforward economic interpretation of these results. A higher full family income when the child was aged 0-5 increases

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[26] The Appendix Table A1 contains the estimates of the parameters for all other variables used in the analysis. A discussion of these estimates can be found in Ermisch and Francesconi (2000).

his/her educational attainments, because this increases parents' time allocated to human capital investment in children. Given full family income, a higher mother's or father's wage in the first five years of life of their child reduces the child's educational achievements, because more time is allocated to the labour market.

How credible is the assumption that parents do not know (or have limited information on) their children's idiosyncratic endowments? Following the suggestion by Rosenzweig and Wolpin (2000), we provide supplemental empirical information needed to support this identifying assumption. Before doing so, we show that parents' labour market behaviour is correlated with children's endowments when the parents are aware of them. In 1991, the BHPS asked mothers whether any of her children has serious health problems.[27] For all the 1,382 mothers with available information we distinguish three labour market states: out of the labour force, part-time employment (working fewer than 30 hours per week) and full-time employment (working 30 or more hours per week). We group children with limiting health conditions by age, according to the three developmental stages used above: 0-5, 6-10, 11-15. Table 3 reports the multinomial logit estimates of mother's labour force participation, with the omitted category being out of the labour force. The estimates are reported for two specifications: the first includes the dummy variables indicating the presence of children with health problems by age only, while the second includes also a standard set of regressors such as mother's education, part-time and full-time experience, number of children by age and partner's earnings. The estimates obtained from both specifications clearly reveal that the presence of children aged 10 or less who have limiting health conditions is associated with a lower likelihood of mother's full-time

employment. The presence of children with poor health status, however, does not affect the probability of part-time employment (according the estimates of specification (2)) nor does it affect the probability of full-time employment provided that the child is an adolescent.

Turning to our assumption about knowledge of children's endowments, we first present evidence that parents do make mistakes in assessing their infant's and children's endowments or they are not fully aware of them. We then argue that parental inaccuracies (and unawareness) tend to decline as children get older. Parents' ability to assess their own children's endowments is partly related to the feedback received from children themselves. Parents seem to be most accurate when their children's performance falls at an extreme, either very high or very low, because of the clarity of the feedback that they receive (Heriot and Schmickel 1967). But parents of children that fall in between such extremes are likely to be more inaccurate. Frankenburg et al. (1976) screen a sample of 1,141 infants and children and find that 30 children have major neuromotor abnormalities, mental deficiency or a combination of both, 106 have minor abnormalities, and 1,005 are normal. Those with minor problems are possibly the "in-between" children, because their abnormalities are clinically questionable and, in many circumstances, temporary. Parents are also asked to complete a diagnostic examination for their own children. A comparison of the examination performed by the parents with that performed by the physicians shows that, among children with major deficiencies, four (or 13 percent) are missed, 46

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[27] The exact question is: "Does your child (do any of your children) under 16 have any health conditions that limit his/her normal childhood activities?" Almost 15 percent of mothers' valid answers (244 out of 1640) is yes.

percent of those with minor problems are undetected, and 27 percent of those who are normal are reported to have problems by their parents.[28]

In the child psychology literature, Hunt (1966) formulates a theory by which parents who do not know their children's abilities are more likely to confront them with an environment that poses either boring under-matches or distressing overmatches. Because parents who know their children's abilities are less likely to do so, the correlation between the parental inaccuracy and children's level of development is expected to be negative. The validation of this theory, therefore, lies entirely on the *fact* that some parents have a limited knowledge of their infants' abilities and interests. In testing this theory, Hunt and Paraskevopoulos (1980) find that mothers largely overestimate the cognitive and intellectual abilities of their own children. In general, overestimation appears to be common also in parents' competency to judge children's performance in post-infancy years, while there is evidence of a tendency toward underestimation in the case of infancy items (see Miller 1988 for a survey).

One of the most compelling arguments to support our information revelation assumption is perhaps given by the complexity of many disorders such as autism, that parents (and physicians) find hard to observe. Approximately one-half of autistic children develop normally until somewhere between 18 to 36 months of age, then autistic symptoms (e.g., self-stimulatory behaviour, self-injury, sleeping and eating problems, attention deficits, and hyper-/hypo-activity) begin to emerge (Edelson 1999). Similarly, children with Landau-Kleffner Syndrome exhibit autistic behaviours quite late: they appear, in fact, to be normal until sometime between ages 3 and 7.

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[28] Knobloch et al. (1979) report overall higher levels of parental accuracy in a sample of 526 infants screened at 28 weeks of age. But, again, parental underscreening of children with minor abnormalities

Parents, however, accumulate information about their children as they grow older. This process is likely to reduce parental inaccuracies about their children's endowments. Entwisle and Hayduk (1981) do find that parents have increasingly realistic academic expectations (lower inaccuracy) as children progress through school, presumably because of the frequency and clarity of the cumulative feedback that the parents receive concerning their children's ability. There is evidence of this phenomenon also in the case of physically handicapped children (Anton and Dindia 1984). These findings therefore support the assumption that parents know their children's endowments later in their childhood (see below).

5.2 The effect of parental employment over the entire childhood

Most of the results presented in Table 2 emerge also when parental employment patterns over the other two developmental stages are included in estimation. As discussed in the previous subsection, this inclusion, however, makes the assumption that parents have a limited knowledge of their children's endowments less credible. Table 4 contains the parameter estimates associated with parental employment. On the basis of the sibling comparisons in the main sample (SMS), the effect is about a 3-percentage point lower probability of achieving at least A level from an additional year of mother's part-time employment when her child was aged 0-5. There is an 8 percentage point lower probability from an additional year of mother's full-time employment at these pre-school ages. The corresponding estimates obtained from SRS are a 6 percentage point and an 11 percentage point lower probability. From the sibling comparisons, the adverse effect of father's employment in pre-school years is around 3-4 percentage points, but it is not well determined. Similarly, the cross-

is highest and around 10 percent. While underscreening of children with major deficiencies is only 3 percent and over-reporting of normal children is 6 percent.

sectional estimates of the mother's (part-time and full-time) employment in the first developmental stage are small and never statistically significant, while the cross-sectional estimates of the father's employment are positive and significant. These results may arise because the cross-sectional estimates fail to control adequately for children's endowment heterogeneity and family background. Interestingly, the SMS estimates suggest that one year more full-time employment when the child was aged 6-10 increases the probability of achieving A-level or higher by 8 percentage points. This large and significant effect is not, however, replicated by the SRS estimate (which is still positive but statistically insignificant). Thus, there may be an offset to the negative impact of full-time employment when the child was a pre-schooler for women who continued to work full-time when the child was aged 6-10.[29]

6. Conclusions

This paper has presented a theoretical framework that provides the conditions under which we can give a causal interpretation to the association between childhood parental employment and subsequent education of children as young adults. In an environment in which parental preferences are separable in own consumption and children's well-being, estimation is complicated by endowment heterogeneity and by the fact that parents may compensate or reinforce children's endowments relevant to educational attainment. While a sibling difference estimate strategy may be useful to eliminate endowment heterogeneity that is common across siblings, it is generally not sufficient to provide a consistent estimate of the parameter of interest. That rests on two stronger assumptions. First, the idiosyncratic endowments of children are not

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[29] There is, indeed, a large amount of persistence in full-time employment: the correlation coefficient between months in full-time employment when the child was aged 0-5 and when he/she was aged 6-10

revealed to parents at birth (it takes time before parents fully know their children's endowments). Second, the parents' time and good elasticities of the children's human capital production function do not vary across ages of the child nor across siblings.

The empirical analysis uses data from various samples of young people drawn from the British Household Panel Survey. There is a negative and significant effect on the child's educational attainment as a young adult of the mother's full-time employment when the child was aged 0-5. The effect of mother's part-time employment is also negative but smaller and less well determined. Similarly, the effect of father's employment is small, not always precisely estimated but again negative. The negative effects of mother's part-time work and, particularly, of mother's full-time work, persist when we include parents' employment patterns over the entire childhood period. In the context of our conditional demand function framework, these results suggest that a higher full family income increases the educational attainment of children, and given full family income, a higher mother's or father's wage reduces their children's educational attainment.

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is 0.62.

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Table 1: Means of variables used in analysis

Variable	Estimating sample			
	MS	RS	SMS	SRS
Dependent variable				
A level or more	0.617	0.629	0.641	0.665
Parental work variables				
Mother's work:[a]				
child aged 0-5 (years)	1.607	1.569	1.405	1.255
	[2.617]	[2.531]	[2.528]	[2.261]
child aged 6-10 (years)	2.581	2.554	2.430	2.416
	[3.134]	[3.060]	[2.996]	[2.917]
child aged 11-15 (years)	3.548	3.593	3.569	3.798
	[3.788]	[3.799]	[3.732]	[3.857]
Mother's part-time work:[a]				
child aged 0-5 (years)	0.952	0.973	0.987	0.921
	[2.331]	[2.359]	[2.355]	[2.327]
child aged 6-10 (years)	1.625	1.598	1.678	1.706
	[3.009]	[2.930]	[2.933]	[2.867]
child aged 11-15 (years)	2.093	2.123	2.231	2.471
	[3.808]	[3.816]	[3.776]	[3.891]
Mother's full-time work:[a]				
child aged 0-5 (years)	0.655	0.596	0.419	0.334
	[2.584]	[2.280]	[2.365]	[2.115]
child aged 6-10 (years)	0.957	0.956	0.751	0.710
	[3.146]	[3.076]	[2.831]	[2.754]
child aged 11-15 (years)	1.455	1.470	1.339	1.327
	[3.563]	[3.602]	[3.349]	[3.547]
Father's work:[a]				
child aged 0-5 (years)	3.630	3.612	3.770	3.643
	[5.413]	[5.398]	[5.462]	[5.549]
child aged 6-10 (years)	3.064	3.052	3.162	3.034
	[4.569]	[4.561]	[4.594]	[4.617]
child aged 11-15 (years)	3.095	3.078	3.175	3.048
	[4.615]	[4.599]	[4.612]	[4.644]
Other variables				
Age	22.285	20.821	22.259	20.902
Female	0.470	0.477	0.467	0.472
Year of birth – 1900	74.729	76.454		
Ever in single-parent family:				
child aged 1-5	0.107	0.111	0.073	0.080
child aged 6-10	0.078	0.085	0.068	0.061
child aged 11-15	0.049	0.045	0.050	0.052
Age of mother at birth ≤21	0.102	0.094	0.097	0.098
Age of mother at birth ≥35	0.037	0.019	0.015	0.015
Age of mother at birth	26.341	26.400	26.070	26.220

Age of father at birth ≤21	0.048	0.051	0.045	0.049
Age of father at birth ≥37	0.056	0.051	0.042	0.034
Age of father at birth[b]	28.698	28.637	28.477	28.301
Number of brothers	0.859	0.869		
Number of sisters	0.718	0.708		
Firstborn	0.450	0.419	0.421	0.411
Only child	0.070	0.062		
Mother's education:				
No qualification (base)	0.	0.		
Less than O level	0.117	0.114		
O level	0.222	0.224		
A level	0.072	0.076		
Higher vocational quals.	0.203	0.221		
Higher qualification	0.081	0.088		
Father's education:				
No qualification (base)[c]	0.	0.		
Less than O level	0.069	0.059		
O level	0.160	0.159		
A level	0.095	0.107		
Higher vocational quals.	0.230	0.233		
Higher qualification	0.085	0.094		
Father is missing (1=yes)	0.166	0.162	0.150	0.156
Information on father's work is missing (1=yes)	0.329	0.331	0.311	0.344
N	1,026	647	599	326

Note: Figures in SMS and SRS are computed on levels (rather than sibling pairs). N is the number of sample-specific observations.

[a] Computed on all cases. Values computed only on cases with working mother or nonmissing father are in square brackets.

[b] Computed only on cases with nonmissing father. The base category (age of father at birth is between 22 and 36) contains also cases with missing father information.

[c] Includes cases with missing father.

Table 2: Effects on the probability of achieving A level or more of the time parents worked when the child was aged 0-5 (Absolute ratios of coefficient to standard error are shown in parentheses)

Child aged 0-5	Cross-sectional estimates		Sibling difference estimates	
	MS	RS	SMS	SRS
Baseline	0.617	0.629	0.641	0.662
Mother's part-time employment	-0.003	-0.004	-0.031	-0.059
	(0.299)	(0.309)	(1.872)	(1.732)
Mother's full-time employment	-0.014	-0.024	-0.074	-0.086
	(0.893)	(1.060)	(2.888)	(2.409)
Father's employment	0.033	0.047	-0.042	-0.033
	(2.175)	(2.611)	(2.055)	(1.512)
Log likelihood	-608	-365	-235	-109
N	1,026	647	381	187

Note: MS = main sample; RS = restricted sample; SMS = siblings from main sample; SRS = siblings from restricted sample. Figures are marginal effects obtained from logit regressions. Estimated standard errors account for arbitrary forms of correlation within siblings or half-siblings. *N* is number of individuals in MS and RS, and number of siblings differences in SMS and SRS. Other variables included in the regressions performed with MS and RS are: gender, cohort, seven age dummies, dummies for firstborn and only child, ever lived in a single parent family in the first developmental stage, number of brothers and sisters, age of mother at child's birth (two dummy variables), age of father at birth (two dummy variables), mother's education (five dummy variables), father's education (five dummy variables), dummy variables for missing father and missing father's work history information, and a constant. Other variables included in the regressions performed with SMS and SRS are the sibling differences in: age, gender, firstborn, ever lived in a single parent family in the first developmental stage, mother's age at birth was 21 or less, mother's age at birth was 35 or more, father's age at birth was 21 or less, father's age at birth was 37 or more, missing father and missing father's history. A constant term is also included because of non-random sorting of siblings.

Table 3: Multinomial logit estimates of children having any limiting health problem on the mother's labour force status, by specification (*N*=1,382)

	Specification (1)		Specification (2)	
	Part-time employment	Full-time employment	Part-time employment	Full-time employment
Child who has health problems is aged:				
0-5	-0.412	-1.731	-0.168	-1.683
	(1.510)	(4.166)	(0.532)	(3.756)
6-10	-0.140	-1.167	-0.061	-0.845
	(0.526)	(3.319)	(0.197)	(2.176)
11-15	0.634	0.066	0.314	0.069
	(2.085)	(0.201)	(0.867)	(0.177)
Log likelihood	-1,483		-1,222	

Note: Source: BHPS, 1991. *N* is the number of mothers. Absolute values of asymptotic *t*-ratios are in parentheses. Specification (1) does not include any other regressor. Specification (2) includes variables for the mother's age group, race, marital status, position in the partner's earnings distribution, housing tenure, education, region of residence, quartic polynomials in full-time and part-time experience, her mother's and father's occupation when she was aged 14, dummy variables for missing information on her mother's and father's occupation, a dummy variable for having lived with both parents up to age 16, a dummy variable for missing information on childhood family structure, number of children by age group, dummy variable for having more than one child with health problems, local unemployment rate (geographic units are 306 travel-to-work areas), and a constant.

Table 4: Effects of childhood maternal time in part-time and full-time employment and paternal time in employment on the probability of achieving A level or more by child developmental stage (Absolute ratios of coefficient to standard error are shown in parentheses)

Time of maternal employment by child developmental stage	Cross-sectional estimates		Sibling difference estimates	
	MS	RS	SMS	SRS
Mothers' part-time employment:				
Child aged 0-5	0.001	-0.005	-0.033	-0.064
(+ 1 year)	(0.097)	(0.342)	(2.128)	(1.828)
Child aged 6-10	-0.004	0.003	0.020	-0.007
(+ 1 year)	(0.547)	(0.352)	(0.844)	(0.173)
Child aged 11-15	0.012	0.012	-0.027	-0.041
(+ 1 year)	(1.865)	(1.519)	(0.708)	(0.627)
Mother's full-time employment:				
Child aged 0-5	-0.008	-0.034	-0.075	-0.105
(+ 1 year)	(0.405)	(1.199)	(2.731)	(2.404)
Child aged 6-10	-0.018	0.009	0.081	0.045
(+ 1 year)	(1.114)	(0.438)	(2.596)	(0.802)
Child aged 11-15	0.029	0.024	0.002	-0.036
(+ 1 year)	(2.983)	(2.013)	(0.063)	(0.799)
Father's employment				
Child aged 0-5	0.029	0.034	-0.039	-0.031
(+ 1 year)	(1.905)	(2.352)	(1.887)	(1.188)
Child aged 6-10	0.016	-0.001	0.005	0.012
(+ 1 year)	(1.025)	(0.045)	(0.177)	(0.793)
Child aged 11-15	-0.009	0.018	-0.020	0.018
(+ 1 year)	(0.542)	(0.947)	(0.573)	(0.795)
N	1,026	647	381	187

Note: Family structure enters by developmental stage. For all the other variables used in the estimation see note of Table 2.

Table A1: Effects of other variables on the probability of achieving A level or more (Absolute ratios of coefficient to standard error are shown in parentheses)

Variable	Cross-sectional estimates		Sibling difference estimates	
	MS	RS	SMS	SRS
Female	0.013	0.020	0.015	0.021
	(0.448)	(0.553)	(0.388)	(0.750)
Year of birth – 1900	0.026	0.038		
	(2.709)	(1.559)		
Age			0.005	0.009
			(0.844)	(0.681)
Age 19	0.198	0.195		
	(3.379)	(3.149)		
Age 20	0.295	0.288		
	(4.779)	(3.890)		
Age 21	0.336	0.352		
	(5.250)	(3.992)		
Age 22	0.376	0.411		
	(5.269)	(3.759)		
Age 23 or more	0.397	0.428		
	(5.139)	(3.326)		
Ever in single-parent family:				
Child aged 0-5	-0.130	-0.099	-0.154	-0.213
	(2.669)	(2.703)	(2.203)	(3.902)
Age of mother at birth ≤21	-0.078	-0.043	-0.065	-0.081
	(1.533)	(0.652)	(0.847)	(1.893)
Age of mother at birth ≥35	0.011	0.182	0.077	0.063
	(0.132)	(1.198)	(1.116)	(0.496)
Age of father at birth ≤21	0.092	0.186	-0.043	0.135
	(1.252)	(1.951)	(1.136)	(1.107)
Age of father at birth ≥37	0.130	0.018	0.022	0.064
	(1.822)	(0.214)	(0.190)	(0.321)
Number of brothers	-0.021	-0.021		
	(1.022)	(0.828)		
Number of sisters	-0.025	-0.035		
	(1.144)	(1.264)		
Firstborn	-0.005	0.001	0.036	0.052
	(0.026)	(0.011)	(0.769)	(1.328)
Only child	0.040	0.009		
	(0.586)	(0.101)		
Mother's education:				
Less than O level	0.050	0.065		
	(1.072)	(1.117)		
O level	0.078	0.107		
	(1.976)	(2.193)		
A level	0.137	0.144		
	(2.215)	(1.936)		

Higher vocational quals.	0.183	0.238		
	(4.269)	(4.430)		
Higher qualification	0.208	0.256		
	(2.863)	(2.952)		
Father's education:				
Less than O level	0.055	0.049		
	(0.910)	(0.604)		
O level	0.041	0.051		
	(0.891)	(0.892)		
A level	0.097	0.126		
	(1.694)	(1.839)		
Higher vocational quals.	0.147	0.132		
	(3.284)	(2.400)		
Higher qualification	0.251	0.233		
	(3.245)	(2.552)		
Father is missing (1=yes)	0.056	0.081	-0.040	-0.062
	(0.940)	(1.105)	(1.272)	(0.752)
Information on father's work	0.427	0.496	-0.401	-0.348
is missing (1=yes)	(1.862)	(2.208)	(0.445)	(0.840)
Log likelihood	-608	-365	-235	-109
N	1,026	647	381	187

Note: See Table 2 for other estimates.