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

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ABSTRACT

This paper presents conditions under which a causal interpretation can be given to the association between childhood parental employment and subsequent educational attainment of children. It is a parameter of a conditional demand function. Its 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 identify the effect of parents' employment. Identification rests on 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. 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 a large 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 in several other contexts by 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 and the role of individual "endowments", there are only a few studies that address endowment heterogeneity in attempting to estimate the technology of producing young people's human capital.[2]

Most of the studies of educational outcomes, such as those surveyed by Haveman and Wolfe (1995), have ignored the possible endogeneity of education inputs. They implicitly assume either that young people do not differ in terms of their endowments relevant to educational attainment, or that parents do not respond to these endowments. This is also true for most of the research that uses British data, which is concerned either with early learning or with later educational achievements (see Kiernan 1997; Gregg and Machin 1999; Joshi and Verropoulou 2000).

A few studies have, however, addressed the issues of endowment heterogeneity and consequent endogeneity of inputs in their econometric analyses of the impact of parents' employment on educational achievements, but it is not clear how to interpret the relationships that are estimated. Hanushek's (1992) value-added

[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.

model of improvements in test scores when the child was in primary school is supposed to estimate relationships "in terms of the underlying determinants of time allocations." (p.89, footnote 2). But the relationship estimated in Hanushek's study includes measures of mother's employment at the time of the test and parents' permanent income.[3] As explained below, the inclusion of mother's employment may make sense if the relationship is a conditional demand function, but such a function should exclude income. Alternatively, while income should be included as a regressor if the relationship is a reduced form, mother's employment should then be excluded (Blau 1999). Duncan et al. (1997, 1998) use sibling comparisons to reduce endogeneity bias in estimating a relationship between educational attainments and measures of the mother's employment and parents' income. This is neither a conditional demand function nor a reduced form. Furthermore, the conditions under which sibling differences in mother's employment can be treated as exogenous are not examined. Ruhm's (2000) preferred econometric approach to estimating a relationship between a mother's working hours and test scores when the child was a pre-schooler successfully addresses the endogeneity of mother's working hours if they can be described by a permanent-transitory components model. His preferred specification also includes the mother's hourly wage (and occupation) prior to the birth. This may be appropriate in a conditional demand framework, but it is likely to be endogenous because of correlation between parents' endowments and those of their children.[4]

The equations in all of these studies are similar to what Rosenzweig and Schultz (1983) call "hybrid equations" in the context of estimating household

[3] That is, the estimation method uses between-family variation in mother's employment and permanent income as well as variation over time for each child.
[4] Ruhm (2000) also estimates a siblings-fixed effect model, but it is unclear what variables are included in the relationship.

production functions for health. Such equations do not embody any restriction derived from economic theory, and so they are difficult to interpret. Yet, a clear interpretation is important for the evaluation of policies concerned with family leave and policies intended to reduce dependency on state benefits and improve family finances by encouraging mothers to take up paid work.[5] In model specifications guided by economic theory it is also easier to determine the conditions required to identify the key parameters. It is not surprising that the wide variety of specifications and the 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).

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. In Section 2 we develop a conceptual framework that allows us to assess the effect of parental behaviour on children's educational attainments in the presence of heterogeneity in endowments. This framework leads to the formulation of conditional demand functions and to conditions under which we can give a causal interpretation to the association between parents' employment and their children's educational attainments. The data are described in Section 3, while Section 4 illustrates the econometric issues arising because of endowment heterogeneity. Section 5 discusses estimates of the effect of parental employment during early childhood on children's educational attainment as young

[5] In many countries, there has been a gradual shift toward public policies that favour the employment of mothers of young children. For recent policy initiatives in this direction in Britain, see Home Office (1998) and Department *for* Education and Employment (2000).

adults, and Section 6 presents supplementary empirical information relevant to the assumptions needed for identification. Section 7 concludes.

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 a regression 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 future earning capacities of children separable from parents' "standard of living". That is, in the case of a two-child family and taking father's leisure time to be exogenous, parental utility is given by $U=U(V(x,L),W(e_a,e_b))$, where x is parental consumption; L is the mother's leisure time; V(.) is the sub-utility function representing the parents' living standard; 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.[6] The resource constraint is $y + wT = wL + x + w(t_a+t_b) + p(z_a+z_b) = wL + x + R$, 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 resources devoted to human capital investment in children.

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 affecting e_a and e_b only through their effect on R in these "conditional demand functions" (Pollak 1971).[7] Unfortunately for econometric purposes, R is not generally independent of ε_a and ε_b. While estimates of w and y would appear to be natural instruments for R, these are problematic. As Browning and Meghir (1991) point out, these may be endogenous. In this particular context, w and y are likely to reflect parents' endowments, which are correlated with their children's endowments.[8]

In order to clarify what these conditional demand functions might look like in the context of our analysis, assume that the production functions take the Cobb-Douglas 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

[6] Relaxation of the assumptions that only mothers provide time inputs to human capital investment in children, that father's leisure is exogenous and that there are only two children does not alter the main implications of the model.

[7] 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 $R=w_m(T-h_m-L_m)+w_f(T-h_f-L_f) + p(z_a+z_b)$, where w_f and h_f (w_m and h_m) are the father's (mother's) wage and hours employed. See Browning and Meghir (1991) for a study that estimates conditional household demand functions for goods, conditioning on each person's labour supply.

[8] In any case, in the data used in our empirical analysis parents' wages and income during young people's childhood are not available.

reinforce earnings endowments ($c>0$) or *compensate* for differences in children's endowments ($c<0$). If, for simplicity, we also assume that $V(x,L)=x^{\gamma}L^{1-\gamma}$ and $U=V(x,L)^{\beta}W(e_a,e_b)^{1-\beta}$, then, letting $\alpha=\alpha_1+\alpha_2$ and h be the mother's time in employment

$$(1) \qquad \ln(T-h)=\ln[(1-\beta)\alpha_1+(1-\gamma)\beta]-\ln[\beta+(1-\beta)\alpha]+\ln\frac{wT+y}{w}$$

$$(2) \qquad \ln(e_a)=\alpha\ln(T-h)+\alpha_2\ln\left(\frac{w}{p}\right)+\alpha_2\ln\left(\frac{\alpha_2}{\alpha_1}\right)+\ln(\varepsilon_a)-\alpha\ln\left[1+\left(\frac{\varepsilon_b}{\varepsilon_a}\right)^{\frac{c}{1-c\alpha}}\right]$$

$$+\ \alpha\{\ln[(1-\beta)\alpha_1]-\ln[(1-\beta)\alpha_1+(1-\gamma)\beta]\},$$

with a similar equation for $\ln(e_b)$.[9]

The conditional demand function to be estimated is equation (2). Its stochastic element (*cum* constant term) is comprised of the last four terms on the right hand side of (2). The mother's time not in employment, $T-h$, 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 production function parameter $\alpha=\alpha_1+\alpha_2$.[10] Thus, the relationship between mother's employment and her child's earning capacity is measuring a production function parameter, namely the returns to scale in the human capital production function. Note that we would need to control for variation in w/p across families in estimating this parameter. But variation in preferences (β and γ) and in the production technology (α_1 and α_2) across families makes it likely that $T-h$ is endogenous, because equation (1) shows that these parameters affect $T-h$. Even if these parameters were identical across families, $(wT+y)/w$ and w/p are likely to be

[9] Derivation of these expressions use the fact that, in this model, optimisation implies that $w(t_a+t_b)=\alpha_1 R/\alpha$ and that $(t_a+t_b)/L=(1-\beta)\alpha_1/[(1-\beta)\alpha_1+(1-\gamma)\beta]$.

[10] 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 $-\alpha_2$.

correlated with children's endowments (ε_a and ε_b) because of intergenerational correlation in endowments, thereby making *T-h* and *w/p* endogenous.

One way to control for heterogeneity in *w/p*, β, γ, α_1, α_2 and parental endowments is to take differences between siblings in families. This static model is not, however, very helpful in structuring such an analysis because *T-h* does not differ between siblings. The potential for the use of sibling differences in estimating the effect of the mother's employment on child outcomes comes from the difference in birthdays for two siblings, but this requires that we consider the parents' dynamic decisions 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 whose childhood lasts for two consecutive periods. 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 and leisure. 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. The timing of decisions is illustrated in Figure 1. For simplicity, we again assume that only mothers provide time inputs to human capital investment in children and that father's leisure time is exogenous. We also assume that there is no borrowing or lending across the periods.

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 $U=U(V(x_j,L_j),W(e_a,e_b))$, where x_j and L_j denote parental

consumption and mother's leisure respectively 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},ε_a) and e_b=f(t_{2b},t_{3b},z_{2b},z_{3b},ε_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: $y_j+w_jT=x_j+wL_j+w_j(t_{ja}+t_{jb})+p_j(z_{ja}+z_{jb})=x_j+wL_j+R_j$, where T denotes total mother's time available in each period, 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 $t_{1b}\equiv 0\equiv t_{3a}$ because of the timing of children. The dynamic nature of the problem comes through human capital investment. 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 $e_b=\varepsilon_b t_{2b}^{\alpha_{t1}} z_{2b}^{\alpha_{z1}} t_{3b}^{\alpha_{t2}} z_{3b}^{\alpha_{z2}}$ ($\alpha_{t1}+\alpha_{t2}+\alpha_{z1}+\alpha_{z2}\leq 1$), the same CES sub-utility function for children's well being as before, $W(e_a,e_b)=[e_a^c+e_b^c]^{1/c}$ with $c\leq 1$, and a Cobb-Douglas sub-utility index for parents' well-being, $V(x_j,L_j)=x_j^{\gamma}L_j^{1-\gamma}$.

We shall show that the mother's employment in period j, $h_j=T-(L_j+t_{ja}+t_{jb})$, is not usually independent of the children's earnings endowments ε_a and ε_b. This time allocation problem is solved in a backward manner. Solving the third period problem (when all human capital investment in the first child has finished), we find that

$$(3)\qquad \frac{\partial t_{3b}}{\partial \varepsilon_b}=[c\beta(1-\beta)\alpha_{t2}e_b^c e_a^c]\left[\frac{\partial \ln(e_b/e_a)}{\partial \ln(\varepsilon_b)}\right]\frac{(y_3+w_3T)}{\varepsilon_b D^2 w_3},$$

where $D=[e_a^c+e_b^c]\beta+(1-\beta)(\alpha_{t2}+\alpha_{z2})e_b^c$; $\partial t_{3b}/\partial \varepsilon_a$ is similar, but of the opposite sign. A sufficient condition for $\partial h_3/\partial \varepsilon_b=0$ is that $\partial t_{3b}/\partial \varepsilon_b=0$. In this case, h_3 would be

exogenous in equations for e_a and e_b. Equation (3) indicates that as long as parents respond to their children's individual earnings endowments (i.e. $c\neq 0$), this sufficient condition is not satisfied.[11] But $\partial t_{3b}/\partial \varepsilon_b=0$ is not a necessary condition for $\partial h_3/\partial \varepsilon_b=0$. If it turns out that if $\alpha_{t2}/(\alpha_{t2}+\alpha_{z2})=1-\gamma$, then $\partial h_3/\partial \varepsilon_b=0$, even though $\partial t_{3b}/\partial \varepsilon_b\neq 0$, because of compensatory responses of mother's leisure. Assuming this would, however, impose strong restrictions on the production and preference parameters that would be hard to justify. When $\partial t_{3b}/\partial \varepsilon_b\neq 0$ and parents act to compensate for differences in endowments, a higher endowment for child *b* (child *a*) reduces (increases) t_{3b}, because we expect that $\partial \ln(e_b/e_a)/\partial \ln(\varepsilon_b)>0$.[12] The opposite is the case if parents reinforce endowment differences in their human capital investment decisions. Similar analysis indicates that neither t_{1a} nor $t_{2a}+t_{2b}$ are independent of ε_a and ε_b.

Sibling difference estimates of the "effect" of mother's employment time on child outcomes compare employment when the first child is "young" relative to that when the second child is "young", $h_1-h_2=L_2+(t_{2a}+t_{2b})-L_1-t_{1a}$; similarly, the difference in amounts when each child is in the second part of his/her childhood is $h_2-h_3=L_3+t_{3b}-L_2-(t_{2a}+t_{2b})$. We have shown that these differences are not likely to be exogenous when parents know their children's endowments and respond to them.

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

[11] In the case of a Cobb-Douglas specification for $W(\cdot)$, $c\rightarrow 0$ and h_3 is exogenous.

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

second part of the child's childhood, periods 2 and 3 respectively for child *a* and *b*. Then the mother's first period employment time is clearly independent of ε_a and ε_b. But

$$(4) \qquad \frac{\partial R_2}{\partial \varepsilon_a} = \beta c(1-\beta) e_b^c e_a^c [(\alpha_{t1} + \alpha_{z1}) - (\alpha_{t2} + \alpha_{z2})] \left[\frac{\partial \ln(e_b / e_a)}{\partial \ln(\varepsilon_a)} \right] \frac{(y_2 + w_2 T)}{\varepsilon_a D^2}.$$

A sufficient condition for $\partial h_2/\partial \varepsilon_a=0$ is that $\partial(t_{2a}+t_{2b})/\partial \varepsilon_a=0$. Having $\partial R_2/\partial \varepsilon_a=0$ does not ensure this, because even if $\partial R_2/\partial \varepsilon_a=0$,

$$(5) \qquad sign \frac{\partial (t_{2a} + t_{2b})}{\partial \varepsilon_a} = sign(c) \times sign(\alpha_{t2} - \alpha_{t1}).$$

That is, a shift of resources in favour of one of the children in response to the revelation of the first child's endowment could change $t_{2a}+t_{2b}$ even when $\partial R_2/\partial \varepsilon_a=0$, because of the different production elasticities in the two periods of childhood. For instance, if parents reinforce endowments, $\partial(t_{2a}+t_{2b})/\partial \varepsilon_a$ will be positive as long as $\alpha_{t2}>\alpha_{t1}$. From equations (4) and (5), a sufficient condition for $\partial h_2/\partial \varepsilon_a=0$ is that $\alpha_{k1}=\alpha_{k2}$, $k=t,z$; in this case, $\partial R_2/\partial \varepsilon_a=0$ and $\partial(t_{2a}+t_{2b})/\partial \varepsilon_a=0$.

Thus, equal production elasticities in the two stages of a child's life is a sufficient condition for h_1-h_2 to be independent of the difference between siblings in endowments, ε_a-ε_b. This condition precludes the parents making compensating or reinforcing investments when endowments are revealed. Again, it is not a necessary condition, because even if $(t_{2a}+t_{2b})$ does respond to ε_a when it is revealed, parents' preferences (particularly γ) may be such that the response in the mother's leisure exactly offsets the response in $(t_{2a}+t_{2b})$, producing no response of h_2 to ε_a. Note that even under these restrictive information revelation and production technology assumptions, the difference in mother's employment time when each child is in the

second part of his/her childhood, h_2-h_3, is not independent of endowments as long as parents respond to endowments when they are revealed (see equation (3)).

2.3 Implications of the dynamic model for the empirical analysis

Two implications of the dynamic model should be emphasized. First, the model suggests that empirical analysis of the effects of parents' employment on children's future earning capacity focus on parents' time allocations early in childhood, when it is more plausible that parents do not know their children's endowments. Second, the dynamic model suggests that if the production elasticities change slowly as the child ages and if children are not born too far apart, the condition that $\alpha_{k1}=\alpha_{k2}$ ($k=t,z$) is likely to be approximately satisfied. Thus, in the empirical application below, we focus on the effects of parents' employment when the child was aged 0-5. If knowledge about endowments is small at these ages and birth intervals are not very wide (they are typically 2-3 years in our data), then the sibling differences in parents' employment time when a child was aged 0-5 would be exogenous, even if production elasticities change later in childhood.[13]

3. Data

Because the young adults in our sample are only in their early 20s, we shall measure future earning capacity in terms of educational attainments. Our measure of educational attainment is dichotomous, indicating whether or not a young adult has

[13] Another reason for focussing on parents' employment in these pre-school ages is that later, when the children are in school, there is less conflict between parents' time in paid employment and time with their children. Indeed, children themselves are not available at home for a large part of the day.

achieved an "A(Advanced)-level" qualification or higher qualification.[14] Having at least one A-level qualification is a necessary condition for entry to university, and A-level and higher qualifications significantly raise future earnings.

The preceding framework implies that estimation of the impact of parental employment patterns during childhood on their educational attainments requires data that provide longitudinal information on parents' employment by age of the child, and they must also allow us to identify siblings. 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.[15] 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 their parents spent in paid work when they were aged 0-5, and for mothers we distinguish between time spent in part-time work and time spent in full-time work. 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

[14] 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.

[15] 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 (2001).

[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 first 5 years of life. Neither childhood family structure nor childhood parental employment suffer from the "window problem" discussed by Wolfe et al. (1996).

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 are used for estimates based on between-family comparisons. These 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 1979; (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 variables for our analysis. Condition (i) is imposed because it is rare to obtain A-levels (our measure of higher 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

[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 virtually indentical 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.

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.

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 for individuals rather than for sibling differences. 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 about 65 percent of individuals have achieved a highest qualification of at least A-level or its equivalent.[20]

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.

[19] The age restriction on this sample implies that individuals were born between 1974 and 1979. The age range is then 18-24, while the age range in MS is 18-27.

[20] Individuals with A-level or higher qualifications include 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 qualification of at least A level).

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. As expected, fathers spent a substantial fraction of time in the labour market. The average figures reported in Table 1 are computed for children with fathers present and job history information available. Mothers were, on average, in paid employment about 18 months between the child's birth and their sixth birthday. Among mothers who worked at least one month during these pre-school years, they worked on average about 2.5 years. More than 60 percent of their time in paid employment was in part-time work.

4. Econometric issues

As noted above, we focus on the effects of parents' employment when the child was aged 0-5. Our maintained hypothesis is that knowledge about endowments is limited at these ages, and that production elasticities change slowly with age. Under these conditions, the sibling difference in parents' employment time when their children were aged 0-5 (h_1-h_2) is independent of ε_a-ε_b. The model we estimate is an approximation to the difference between the conditional demand functions for each sibling's future earning capacity (e_a-e_b), which is educational attainment in our application. If we were using a continuous measure of e_a-e_b, the conditional demand equation would be

$$(6) \qquad e_a - e_b = \delta_0 + \delta_1[h_1 - h_2] + \delta_2(\mathbf{X}_a - \mathbf{X}_b) + \varepsilon_a - \varepsilon_b,$$

where dynamic responses in the third period have been "substituted out". The coefficient δ_1 reflects preference parameters, expectations about future incomes, prices and wages and realizations of these, as well as household production technology. Thus, it measures the full impact of h_1-h_2 on e_a-e_b. The vector $\mathbf{X}_i$ denotes a set of individual characteristics that may affect educational attainment and future earning capacity independently of parents' employment. In our empirical analysis, these are: the young adult's gender, age, experience of life in a single-parent family when aged 0-5, age of the mother and father at the child's birth, whether or not he/she is the firstborn. The last variable is meant to control for birth order effects, particularly as there may be concern that the patterns of parents' employment, particularly the mother's, vary with birth order.[21]

Under our maintained hypothesis, application of ordinary least squares (OLS) to (6) would provide a consistent estimate of δ_1. If, however, production elasticities changed relatively rapidly while the child was, say, aged under 10, an OLS estimate would be an inconsistent estimate of δ_1, and the direction of the bias depends on the production elasticities and the utility parameters, c, β and γ. Suppose $\alpha_{t2}<\alpha_{t1}$ and $\alpha_{z2}=\alpha_{z1}$. Then, from equations (4) and (5) and the expectation that $\partial\ln(e_b/e_a)/\partial\ln(\varepsilon_a)<0$, parents respond to a higher ε_a by 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. As long as changes in mother's leisure time do not offset these changes in $t_{2a}+t_{2b}$, employment time in period *2* moves in the opposite direction to $t_{2a}+t_{2b}$. Thus, an OLS estimate of δ_1 would

[21] In fact, there are no significant differences in the mean months of mother's full-time and part-time

overstate the size of δ_1 if parents reinforce endowment differences and understate it if they compensate for differences in endowments, when $\alpha_{t2} < \alpha_{t1}$.

The effects of w_1, w_2, p_1, p_2, y_1 and y_2 on a child's educational attainment work through h_1-h_2 in equation (6), which approximates a complex behavioural relationship. 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-h)* is α, but now δ_1 partly reflects preferences, expectations and realizations of incomes, prices and wages in the dynamic model. A negative δ_1 means 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.[22]

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.

The discussion of the static model of Section 2.1 makes it clear that estimates of the relationship between parental employment during childhood and children's later

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employment when the child was aged 0-5 between first born children and higher order parities.

[22] 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 do not estimate the parameters that allow us to gauge the impacts of the mother's wage, price of child investment goods and full family income on the mother's time allocation,

educational achievements based on between-family comparisons are likely to be biased. This is because of heterogeneity in children's endowments, in *w/p*, in preferences and in production technology. Most of our knowledge of the association between parents' employment and children's educational attainments is, however, based on evidence obtained from such estimates. We shall, therefore, present evidence on them as well.[23]

5. Results

Before considering estimates of the parents' employment-child's education relationship based on multivariate analysis, we present some non-parametric estimates. Consider two groups of sibling pairs. The first is those sibling pairs who report a difference in educational attainments (i.e. one has at least one A-level and the other does not, $|e_a-e_b|=1$), and the second is those who have the same attainment ($e_a-e_b=0$). In the first group, we sort sibling pairs so that the sibling with higher education is listed first, and in the second group they are randomly sorted. We then compare the distributions of differences in their parents' employment when they were aged 0-5 between these two groups of sibling pairs. Kernel density estimates of the distributions of differences in years of mother's full-time employment for these two groups are shown in Figure 2. For both sibling samples, the group in which one sibling had a higher education has a distribution with generally lower (algebraic) differences in mother's full-time employment than the group with the same educational attainment. That is, the mother tended to work full-time less when the

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we are not able to assess the quantitative impact of these variables on children's educational attainments.

[23] Besides the covariates in $\mathbf{X}_i$, these regressions also include mother's and fathers' education, number of brothers, number of sisters, year of birth and whether or not the individual is an only child.

sibling with the higher education was aged 0-5 than she did when the sibling with lower education was aged 0-5. This is what we would expect if more full-time employment by the mother reduced the amount of her time allocated to her children's human capital investment when they were of pre-school age.

The simple tests of differences in means between these two groups of sibling pairs shown in Table 2 suggest such an effect. The mean differences are negative in both groups, but the size of the mean difference in years in full-time employment is twice as large in the group in which one sibling has at least one A-level and the other does not. This difference in differences is statistically significant for mother's full-time employment, but not for her part-time employment, nor for father's employment.

The comparisons in Figure 2 and Table 2 do not, of course, control for other differences between siblings in family background (i.e. the variables in $\mathbf{X}_i$). To do so, we estimate logit regressions, where for the sibling comparisons the dependent variable takes the value of unity if one of the siblings has an A-level or above (sorted first) and the other does not, and zero otherwise, and the explanatory variables are sibling differences.[24] As noted, for some individuals we do not have father's work history information. We follow two alternative approaches: one excludes cases with missing father's information and the other excludes variables related to the father.[25] The marginal effects implied by the parameter estimates associated with an additional

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

[25] Following a common practice, we also retained all individuals, substituted mean or reference values when father's information was missing, and indicating missing father or missing father's work information with two dummy variables. This approach produces biased estimates, although the size of the bias is small if the covariances between mother's and father's employment variables are small, and the difference between the means of the father's employment variable in the missing and non-missing samples is small. Estimates of the effects of mother's full-time and part-time employment lie in between the two estimates shown in Table 3 (panel A), but estimates of the effect of father's employment is twice as large (see Ermisch and Francesconi 2001).

year of each type of parental employment in each approach are reported in Table 3.[26] These effects should be interpreted as deviations from the corresponding baseline probabilities, which are computed at the sample values.

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 statistically significant, and its point estimate ranges between a 7 and 9 percentage point lower probability for each additional year of full-time employment, depending on the estimating sample and the approach to treating father's missing information (panel A). A negative effect is also detected by the between-family estimates, but it is weaker and not statistically significant (panel B). From the sibling difference estimates, 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 the point estimate of this effect is smaller in magnitude, ranging from a 3 to 6 percentage point lower probability of achieving A-level or more for each year of part-time employment, and it is less precisely estimated. Interestingly, the effect of father's employment is also negative and around 2 percentage points per year, but not statistically different from zero. The positive and significant association between child's education and father's time in paid work found in the between-family estimates is likely to pick up the positive correlation between a child'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 the results from the sibling difference estimates. A higher full family

[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 (2001).

income when the child was aged 0-5 increases his or her educational attainments, because this increases parents' time allocated to human capital investment in children. Thus, the effect of poverty on child's education partly works through lower parents' time inputs. 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.

There may be heterogeneity in responses among families in our sample. For example, the impact of full-time employment when children were pre-schoolers may differ between mothers in better-paid jobs and mothers in poorer jobs. Better-paid mothers might have been able to afford better-quality child care or they might have allocated their time differently when not at work. To test this, we divided mothers between those whose highest qualifications were A-level or higher (about 35 per cent of the total) and those with qualifications below A-level. We then examined whether the impact of each type of mother's employment differed significantly between the two groups. These estimates are shown in Table 4. In the sibling comparisons, the negative effect of full-time employment when children were aged 0-5 was smaller for more-educated mothers, significantly so in the restricted sample. Nevertheless, the adverse effects on educational attainments for young people with more highly educated mothers who had worked full-time for longer periods remain substantial. They are even larger for less educated mothers.

We also investigated whether the impacts of parents' employment when children were pre-schoolers differed by the mother's age at first birth and a measure of the prestige of the occupation in which she worked when her children were dependent. The latter is the maximum "Hope-Goldthorpe score" she achieved while her children

were aged under 16.[27] No statistically significant differences in the parents' employment impacts were found, but there was some weak evidence that the effects of mother's full-time employment were smaller for women who worked in more prestigious occupations (the *t*-value of the interaction term is 1.75).

6. Credibility of identifying assumptions

How credible is the assumption that parents do not know (or have limited information about) 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 its first wave (1991), the BHPS asked every mother whether any of her children has serious health problems.[28] For all the 1,382 mothers with available information on other relevant variables (such as education, work experience and partner's income) 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). Multinomial logit estimates reveal that the presence of a child aged 10 or less who has limiting health conditions is associated with a substantially lower likelihood of mother's full-time employment. The presence of a child of any age with poor health does not, however, significantly affect the probability of part-time employment by the mother.[29]

[27] The Hope-Goldthorpe index is highly correlated with earnings observed over the 1990s, with a correlation coefficient of 0.75 for women.

[28] 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.

[29] Additional British evidence is offered by the Survey of Disabled Children Living in Private Households collected in 1985, when the children in our main sample were on average 10 year-olds and

Turning to our assumption about knowledge of children's endowments, we first present evidence that parents have limited knowledge of their infant's and children's endowments and they make mistakes in assessing them. We then argue that parental accuracy in assessing endowments tends to increase as children get older, and therefore sibling-difference estimates of effects of employment when children were in school are likely to be biased. A large body of the developmental psychology literature documents that 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

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the children in our restricted sample were 2 years younger. Using these data, Smyth and Robus (1989) show that, among mothers with a disabled child aged 0-4, 20 percent are in part-time employment as compared to 21 percent of all mothers of children of the same age (information from the general population of mothers is obtained from the 1985 Labour Force Survey). The difference in part-time participation rates between these two groups of mothers is always small, even for other child development stages. But the presence of a disabled child affects mothers' participation patterns in full-time employment. Among mothers with a disabled child aged 0-4, the full-time participation rate is 4 percent whereas the corresponding rate for the general population of mothers is 9 percent. Large differences in full-time participation rates emerge also for other child development stages. For example, in the case of children aged 10-15, only 16 percent of mothers with a disabled child work full-time as compared to 26 percent of mothers from the entire population. Smyth and Robus (1989) find also sizeable differences in father's employment patterns. Considering the entire childhood period, almost 90 percent of fathers from the general population are in employment, but only 75 percent of fathers with disabled children work.

physicians shows that, among children with major deficiencies, four (or 13 percent) are missed, 46 percent of those with minor problems are undetected, and 27 percent of those who are normal are reported to have problems by their parents.[30]

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

[30] 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 is highest at around 10 percent, while underscreening of children with major deficiencies is only 3 percent and over-reporting of normal children is 6 percent.

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.

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) 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 a similar learning phenomenon 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.

7. Conclusions

This paper has presented a theoretical framework that provides conditions under which we can give a causal interpretation to the association between childhood parental employment and subsequent educational attainments of children as young adults. It is a parameter of a conditional demand function. In an environment in which parental preferences are separable in the parents' own living standard 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 eliminate endowment heterogeneity that is common across siblings, it is generally not sufficient to identify the "effect" of parents' employment. That rests on the assumption that the idiosyncratic endowments of children are not revealed to parents at birth (it takes time before parents fully know their children's endowments) and that the parents' time and

good elasticities of the children's human capital production function change slowly with age. Estimation based on comparisons between families must also make this assumption, but additional stronger assumptions are required (e.g. no correlation in endowments across generations or no effect of parents' endowments on their employment or educational attainments).

The empirical analysis uses data from samples of young people drawn from the British Household Panel Survey during 1991-1997. 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. 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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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 employment variables				
Mother's employment, child aged 0-5 (years):	1.607	1.569	1.405	1.255
If worked at least one month:	2.617	2.531	2.528	2.261
Mother's part-time employment, child aged 0-5 (years):	0.952	0.973	0.987	0.921
If worked at least one month:	2.331	2.359	2.355	2.327
Mother's full-time employment, child aged 0-5 (years):	0.655	0.596	0.419	0.334
If worked at least one month:	2.584	2.280	2.365	2.115
Father's employment, child aged 0-5 (years):[a]	5.413	5.398	5.462	5.549
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 0-5	0.107	0.111	0.073	0.080
Age of mother at birth ≤21	0.102	0.094	0.097	0.098
Age of mother at birth 22-34 (base)	0.861	0.887	0.888	0.887
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 22-34 (base)[b]	0.896	0.898	0.913	0.917
Age of father at birth ≥37	0.056	0.051	0.042	0.034
Age of father at birth[c]	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)	0.305	0.277		
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)[d]	0.361	0.348		

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 only on cases with nonmissing father and employment history information available.

[b] Contains also cases with missing father information.

[c] Computed only on cases with nonmissing father.

[d] Includes cases with missing father.

Table 2: Mean differences in years of parental employment by sibling pairs with and without educational differentials, child aged 0-5

Difference in parental employment (h_1-h_2)	Without educational differentials (e_a-e_b=0) [1]	With educational differentials ($\|e_a$-$e_b\|$=1) [2]	Difference [1] – [2]
SMS (*N*=381)			
Mother's employment			
Part-time	-0.285	-0.309	0.024
			(0.172)
Full-time	-0.309	-0.613	0.304
			(2.167)
Father's employment	-0.004	-0.035	0.031
			(0.266)
SRS (*N*=187)			
Mother's employment			
Part-time	-0.327	-0.514	0.187
			(1.439)
Full-time	-0.438	-0.802	0.364
			(2.150)
Father's employment	-0.001	-0.180	-0.179
			(1.094)

Note: SMS=siblings from the Main Sample; SRS=siblings from the Restricted Sample. *N* is number of sibling pairs. The last column reports the difference between the values in the first and the second columns. The absolute value of the *t*-statistics, that tests the significance of such differences, is reported in parentheses.

Table 3: Effects on the probability of achieving A level or more of the time parents employed when the child was aged 0-5 (Absolute ratios of coefficient to standard error are shown in parentheses)

A. Sibling-difference estimates

Child aged 0-5	Original samples with father's variables excluded		Excluding cases with missing father's information	
	SMS	SRS	SMS	SRS
Mother's part-time employment	-0.028 (1.837)	-0.061 (1.706)	-0.039 (1.743)	-0.051 (1.513)
Mother's full-time employment	-0.079 (2.854)	-0.092 (3.193)	-0.071 (2.531)	-0.076 (2.413)
Father's employment			-0.017 (1.365)	-0.016 (1.049)
Log likelihood	-241	-112	-158	-70
N	381	187	256	122

B. Between-family estimates

Child aged 0-5	Original samples with father's variables excluded		Excluding cases with missing father's information	
	MS	RS	MS	RS
Mother's part-time employment	-0.002 (0.284)	-0.003 (0.312)	-0.004 (0.142)	-0.010 (0.658)
Mother's full-time employment	-0.014 (0.851)	-0.024 (1.063)	-0.015 (1.290)	-0.020 (1.237)
Father's employment			0.035 (2.341)	0.047 (2.697)
Log likelihood	-626	-380	-393	-232
N	1,026	647	688	433

Note: SMS = siblings from main sample; SRS = siblings from restricted sample; MS = main sample; RS = 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 siblings differences in SMS and SRS (Panel A) and number individuals in MS and RS (Panel B). Other variables included in the regressions performed with SMS and SRS (Panel A) 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 and father's age at birth was 37 or more. A constant term is also included because of non-random sorting of siblings. Marginal effects for these variables are shown in Appendix Table A1. Other variables included in the regressions performed with MS and RS (Panel B) 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), and a constant.

Table 4: Effects on the probability of achieving A level or more of the time mothers worked when the child was aged 0-5 and mother's education (Absolute ratios of coefficient to standard error are shown in parentheses)

	Between-family estimates		Sibling-difference estimates	
Child aged 0-5	MS	RS	SMS	SRS
Mother's part-time employment	-0.009	-0.011	-0.017	-0.054
	(0.800)	(0.776)	(0.921)	(0.963)
Mother's full-time employment	-0.005	-0.017	-0.089	-0.114
	(0.258)	(0.641)	(2.376)	(3.688)
Mother has A level or more interacted with:				
Mother's part-time employment	0.040	0.024	-0.018	-0.010
	(1.738)	(1.564)	(0.742)	(0.422)
Mother's full-time employment	-0.021	-0.022	0.025	0.061
	(0.874)	(0.449)	(1.553)	(2.239)
Significance of interaction terms ($\chi^2(2)$; [*p*-value])	5.05 [0.080]	3.24 [0.198]	2.61 [0.272]	5.69 [0.058]
Log likelihood	-623	-378	-234	-107

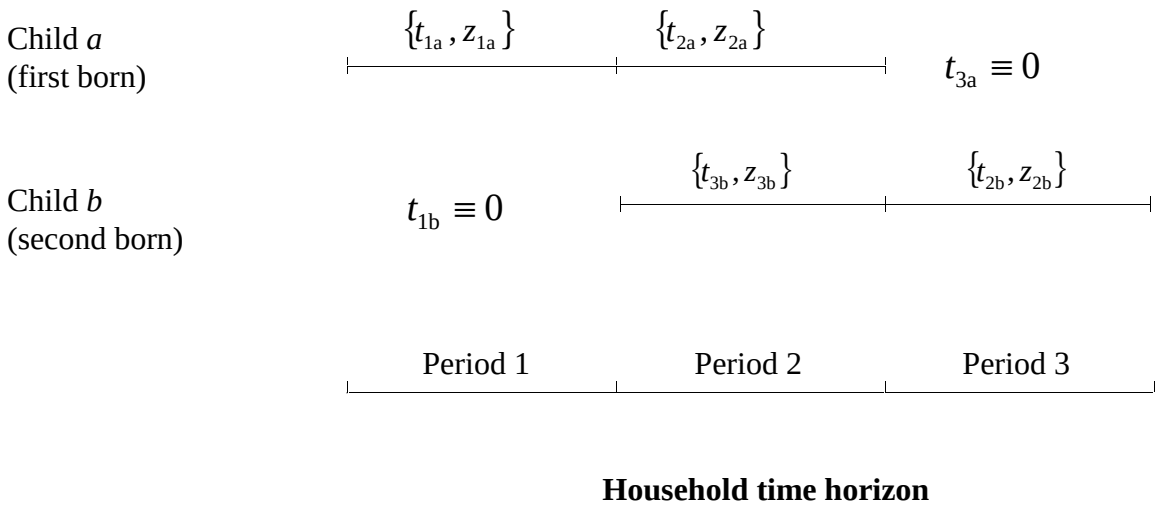
Note: "Significance of interaction terms" refers to χ^2 test of the significance of mother's education (whether mother has qualification of A level or more) interacted with the maternal employment variables. The critical value at the 95 percent level of $\chi^2(2)$ is 5.99. Father's variables are excluded from all regressions. For the other variables used in estimation, see note of Table 3.

Table A1: Effects of other variables on the child's probability of achieving A level or more – Sibling-difference estimates (Absolute ratios of coefficient to standard error are shown in parentheses)

Variable	Original samples with father's variables excluded		Excluding cases with missing father's information	
	SMS	SRS	SMS	SRS
Female	0.014	0.020	0.015	0.018
	(0.415)	(0.703)	(0.352)	(0.446)
Age	0.007	0.015	0.002	0.007
	(0.794)	(0.671)	(0.551)	(0.577)
Ever in single-parent family,	-0.152	-0.190	-0.149	-0.187
child aged 0-5	(2.384)	(2.242)	(2.062)	(2.218)
Age of mother at birth ≤21	-0.054	-0.078	-0.075	-0.084
	(0.798)	(1.884)	(0.792)	(1.563)
Age of mother at birth ≥35	0.080	0.057	0.079	0.061
	(1.231)	(0.521)	(1.060)	(0.464)
Age of father at birth ≤21			-0.038	0.139
			(1.094)	(1.588)
Age of father at birth ≥37			0.029	0.059
			(0.340)	(0.296)
Firstborn	0.035	0.060	0.021	0.049
	(0.748)	(1.326)	(0.478)	(1.210)
Log likelihood	-241	-112	-160	-71
N	381	187	262	122

Note: See Table 3 for the estimates of the effects of the parental employment variables.

Figure 1: The timing of the parents' decisions about child inputs



Household time horizon

Figure 2: Kernel density estimates of the differences in years of parental employment by sibling pairs with and without educational differentials, child aged 0-5

(a) SMS

(a) SRS