FERTILITY AND FEMALE LABOUR SUPPLY

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Further information about the BHPS and other longitudinal surveys can be obtained by telephoning +44 (0) 1206 873543.

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ABSTRACT

The estimated relationship between the number of children and female labour supply is often negative; however, it is not clear whether this arises because of a causal effect of children on labour supply, or whether it is the result of heterogeneous preferences (women who have a preference for home-based activities have more children and a lower preference for market work). The fact that parents in industrialized countries prefer their families to consist of roughly equal numbers of girls and boys, and are therefore more likely to have a third child if their first two children are of the same sex, is used as an exogenous instrument for the birth of a third child in the female labour supply equation. This paper shows that heterogeneity is likely to be important in the female labour supply function, and that failure to account for heterogeneity leads to exaggerated estimates of the negative effect of children on female labour supply. A similar effect in the female hours of work equation is also demonstrated.

NON-TECHNICAL SUMMARY

Economists and other social scientists are interested in the relationship between the number of children a woman has, and her labour supply: how likely she is to go out to work, and if she does go out to work, for how many hours.

There is no reason to believe *a priori* that the effect should go in either direction: one may argue that a woman with more children will be less inclined to go out to work, since the time she spends at work will be time foregone with her children, and the expense of childcare will reduce her effective wage. On the other hand, children are extremely expensive, and a mother may have to work *more* with every additional child to maintain the family income.

Nevertheless, most estimates of this relationship have found a negative relationship between the number of children and a woman's labour supply: that is, that women with more children on average go out to work less than women with fewer children. The problem with these estimates is that most are not able to say anything about causality, since the observed relationship may be due (A) to more children may 'causing' women to work less; or (B) to some third factor driving both the desire to have children and the desire to go out to work, so that the two appear to be related but in fact they are not causally related at all. In the language of econometrics, if women did indeed constitute a heterogeneous population, with some having a preference for family-based activity while others had a preference for market-based work, then fertility variables would be 'endogenous' in the labour supply function, and estimates of the relationship between the number of children and labour supply would yield no information about the effect of children on labour supply.

This paper uses a technique called instrumental variables to get round this problem. This technique relies on finding a variable which is correlated with the number of children a woman has, but *not* with her likelihood of going out to work. Demographers have known for a long time that women whose first two children are of the same sex (two girls or two boys) are more likely to go on to have a third child than women whose first two children are of different sexes (one boy and one girl). These variables can be used to

predict the probability that a woman with two children will go on to have a third child, and this predicted probability can be used in regressions instead of the observed ‘third child’ variable, to obtain estimates of the relationship between children and female labour supply, which more truly reflect the *effect* of children on whether a woman goes out to work, and for how many hours.

This paper finds that under ‘standard’ techniques which do not take account of the endogeneity of fertility variables, having a third child is associated with a reduction in the probability that a woman will go out to work of between 12% and 15%. On the other hand, if endogeneity is accounted for, having a third child is associated with an *increase* in the probability of going out to work, of between 7% and 13%. This second set of estimates is rather imprecise and statistical tests do not rule out that the estimated effects are in fact equal to zero. However, the second set of estimates *is* significantly different from the first set, which shows that if the researcher fails to correct for the endogeneity of fertility variables, the estimated effect of fertility on female labour supply will be exaggerated in a negative direction.

1. INTRODUCTION

A woman's allocation of time is likely to change according to the number of children she has for several reasons. First, there is an income effect arising from the fact that children consume part of the household income; thus, the income of the parents falls, and one or both parents respond by increasing their labour supply. Second, if both parents work outside the home after the arrival of a new child, the costs of alternative child care must be met; this is equivalent to a fall in the mother's wage, which has both an income effect (the mother works more) and a substitution effect (the mother works less); thus, the net direction of the effect of an additional child is uncertain and may mean that the mother chooses not to work at all. These effects do not represent a comprehensive description of the effect of children on their mothers' labour supply, which is extremely complex. However, they are sufficient to illustrate that women's labour supply may be expected to change with the arrival of children, and that the direction of this change is not clear *a priori*.

In estimates of the effect of children on their mothers' labour market participation and hours of work, the coefficient on the number of children is typically negative and significant, and the magnitude of the coefficient is larger for younger children. This may be interpreted as indicating that the substitution effect outweighs the income effect. However, it may *also* arise because fertility and labour supply are both determined by some unobserved third characteristic. For example, heterogeneous preferences among women, with one type of woman having a greater preference for children and less of a preference for market work; and a second type having less of a preference for children and a greater preference for market work, would mean that a negative relationship between fertility and labour supply would be observed, even in the absence of any causal effect of children on labour supply.

Additionally, if fertility and labour supply are somehow jointly determined, with women planning the number and timing of their children according to labour market factors such as their wages or other expected outcomes (Waite and Stolzenberg 1976; Cain and Dooley 1976), this would also mean that the estimated relationship between children and female labour supply could not be interpreted as indicating the "effect" of children on their mothers' labour supply.

Several studies have used instrumental variables to check for the endogeneity of fertility variables; Browning (1992) gives a comprehensive overview of work in this area.

The majority of these studies find some evidence that children variables are endogenous in the female labour supply function[1]. Their results vary considerably, which is unsurprising given that they use different sets of instruments to estimate different labour supply variables, that some use static models while others use a dynamic framework, and that some consider expected behaviour while others consider reported behaviour. Some consistent findings do emerge, however, chief of which is that the familiar significant negative effects of fertility on labour supply are reduced or disappear completely if one allows for endogenous fertility. Indeed, Cain and Dooley (1976) and Hout (1978) find a small (although insignificant) positive effect.

Mroz (1987) uses area characteristics and polynomials in parents' ages and education as instruments for fertility as instruments for fertility, and does not reject the exogeneity of children variables[2]. However, it is not clear that the instruments used are without their own effect on labour supply.

Indeed, it is rather difficult to find suitable variables with which to instrument fertility, which fulfil the joint requirements of being exogenous and having the required degree of explanatory power. Some instruments which have been used are quite highly correlated with fertility, but are difficult to use except in very large data sets, because they are very

[1] Waite and Stolzenberg (1976) find that employment plans strongly affect expected fertility, and only a weak effect in the opposite direction; Smith-Lovin and Tickamyer (1978) find a strong effect of fertility on years employed and only a weak effect in the opposite direction; Cramer (1980) replicates both these studies with a common data set, finding evidence of causality in both directions, and suggesting that actual employment and fertility status are much more important than planned employment and fertility, and noting that the results are sensitive to the choice of instruments used.

[2] Using a variant of the test proposed by Durbin (1954), Wu (1973), Hausman (1978) and White (1982), based on the fact that if one has a consistent estimator for the labour supply equation, then if children are exogenous to labour supply, one's estimates will be similar whether children are included or excluded from the instrument set.

rare events. Variables which fall into this category include the birth of twins, and the presence of fecundity problems.

Another variable which has been used as an instrument for fertility is membership of the Catholic faith. However, as contraceptive use among Catholics has increased, (Ryder and Westoff 1972) this instrument is no longer very useful.

Some instruments (including religion, ethnic group, the mother's number of siblings, the mother's opinions on ideal family size, and duration of marriage) are highly correlated with fertility variables but it is difficult to argue that they have no effect on labour market behaviour other than via fertility. Additionally, if one suspects that some unobservable factor (eg a 'homebody/ career girl' divide) is driving both fertility and labour supply, then many of these variables will be correlated with the unobservables and hence with the error term in the labour supply equation.

Angrist and Evans (1998) have used the sex of the first two children born to a woman, as an instrument for the birth of a third child. This follows from the finding, well-documented in the demography literature, that parents prefer 'balanced' families in terms of the sex composition of their children, and are more likely to have a third child if their first two children are of the same sex. This has the disadvantage of limiting the analysis to women with at least two children, but the advantage that the instrument is clearly exogenous.

In this paper, the sex of the first two children and experiencing a multiple second birth are used as instruments for the birth of a third child, and the female labour supply equation is estimated under three different specifications, using two British data sets. Under all specifications with both the data sets, fertility variables are found to be endogenous in the female labour supply equation, and failing to account for this endogeneity leads to exaggerated estimates of the negative effect of children on labour supply. Hours of work equations are also estimated for working women, and evidence is found to suggest that fertility is also endogenous in the hours of work decision.

The paper is structured as follows: in Section 2 the two data sets are presented, and some summary statistics given. In Section 3 parents' preferences over the sex composition of their families are discussed, demonstrating that sex composition is useful as an instrument for fertility and preferable to a number of conventionally used instruments. Section 4 sets out a model of female labour supply, and presents and discusses results from estimation; Section 5 concludes.

2. DATA AND DESCRIPTIVE STATISTICS

Two data sets are used: the National Child Development Study and the British Household Panel Study.

The National Child Development Study (NCDS)

The NCDS is a panel study which takes as its subjects all children born in the week of 3rd - 9th March 1958. It was originally conceived as a one-off perinatal mortality study, and the first wave of data, collected shortly after the birth of the subjects, contains detailed medical and socioeconomic histories of their parents. Five follow-up studies were carried out when the cohort was aged 7, 11, 16, 23 and 33. The areas covered by these studies are shown in Table1. The studies between ages 7 and 16 contain information on educational attainment, health, and family circumstances. Those at ages 23 and provide detaild histories of the subjects' health, labour market behaviour and family and household situation since age 16. The data used in this study are mainly from the 5th follow-up when the cohort is aged 33.

TABLE 1

INFORMATION IN NCDS

Year	Age of Cohort	Number in Sample	Information
1958	birth	17,414	maternal health, socioeconomic conditions
1965	7	15,468	
1969	11	15,503	health, educational attainment, family circumstances
1974	16	14,761	
1981	23	12,537	education and training, family formation, housing,
1991	33	11,178	income, health, employment and unemployment

One problem with the NCDS data is that the sample is not representative, due to non-random attrition. Table A1 in the Appendix shows how attrition after the 4th wave is related to personal characteristics. Two factors are evident: more educated women were more likely to stay in the panel, and those who have chosen less ‘conventional’ lifestyles (cohabitation rather than marriage, spells of lone parenthood, and teenage motherhood) were more likely to drop out. The women in the NCDS sample are therefore more educated, ‘middle class’, and ‘conventional’, than a totally representative sample.

The British Household Panel Study (BHPS)

The BHPS is a household-based paned data set, the first wave of which was collected around October 1991 and the second wave, which collected detailed information about fertility histories, was collected one year later in 1992. It is based on a nationally representative sample of approximately 5,000 households comprising 10,000 individuals. Because the BHPS in 1992 was a relatively “young” panel, it is more likely to be representative than the NCDS. Additionally, the BHPS has the advantage of sampling women through a range of ages (the NCDS women are all the same age: 33 years old at Wave 5).

Summary statistics

Table 2 gives information on key variables from the two data sets. Some differences between the two data sets arise because of the attrition described above; others are due to the NCDS women being all the same age (33) while the BHPS women range in age from 21 to 49. Although the mean age of the BHPS women is similar to that of the NCDS women, this may mask some of the differences between the samples. For example, the NCDS women are better educated than the BHPS women of their own age. But the BHPS women appear to be better educated on average because the sample contains a number of younger women who are better educated still. The mean number of children appears to be almost identical between the samples, but it is not clear that the women will go on to have identical completed fertility: many women in the NCDS will not have completed their families, but many of the younger women in the BHPS will not yet have *started* theirs.

TABLE 2

SUMMARY STATISTICS

	NCDS	BHPS
Mean age	33	35.3
Number of children		
0	24.76%	31.52%
1	18.60%	16.40%
2	38.38%	32.05%
3	14.22%	13.70%
4 +	4.04%	6.33%
Mean	1.58	1.53
Marital status		
Married or cohabiting	81.92%	63.6%
Separated/ divorced/ widowed	8.32%	12.95%
Single	9.75%	23.45%
Education		
Degree	11.56%	12.27%
‘A’ levels (age 18)	19.14%	12.42%
‘O’ levels (age 16)	27.18%	45.53%
Labor force status		
Full time market work	35.9%	37.65%
Part time market work	32.0%	29.59%
Unemployed	2.1%	3.64%
Working in the home	27.5%	23.48%
Other[1]	2.5%	5.65%
Total in Sample	5680	2640[2]

1: including temporary and permanent sickness and full time education

2: women aged between 21 and 50

Labour market status and fertility

Some simple cross-tabulations from the NCDS (Tables 3 and 4 below) confirm that there is a negative relationship between labour market status and fertility at all levels of fertility. Among women with no children, almost 80% are engaged in full-time market work. The number in full-time work falls to 37% for women with one child, to 18% for women with two children, 14% for three children and 10% for mothers of four or more. For mothers of one or two children, part-time work is a favoured option (46% of women with two children work part-time), but it becomes less popular with mothers with larger numbers of children. Only a very few childless women spend their time at home, and nearly all of those are married women. It is likely that some of the married women in this category do not report themselves as unemployed because they are ineligible for state benefits.

Two features of the data are of particular interest. First, there appears to be enough difference between the behaviour of mothers of two children and those with three children, to provide adequate variation for the proposed purpose. Second, married women behave in a similar way to women in other marital states, and thus one may work with all the data, rather than a subsample of married women. This is preferable for two reasons. The first is that there is an obvious advantage to working with as many observations as possible. The second reason is that as marriage (or even permanent cohabitation) becomes less and less the norm, studies which consider only married women, or only those in families which have remained stable over a particular period, are likely to be less and less useful in explaining the behaviour of the population as a whole.

TABLE 3

LABOUR MARKET ACTIVITY BY NUMBER OF CHILDREN: ALL WOMEN

Number of children	0	1	2	3	4 +
Full time market work[1]	79.84%	36.83%	18.17%	13.58%	10.00%
Part time market work[1]	8.59%	30.50%	45.90%	39.14%	26.52%
Unemployed	3.69%	2.08%	1.33%	1.60%	1.30%
Working in the home	3.97%	28.71%	32.63%	43.33%	61.30%
Other[2]	3.91%	1.89%	1.97%	2.35%	0.87%
	1409	1059	2185	810	230

1: employment and self-employment

2: including temporary and permanent sickness and full-time education

Sample: 5693 women aged 33 from the National Child Development Study, Wave 5, 1992

TABLE 4

LABOUR MARKET ACTIVITY BY NUMBER OF CHILDREN: MARRIED WOMEN

Number of children	0	1	2	3	4 +
Full time market work[1]	76.4%	34.8%	17.8%	13.4%	12.9%
Part time market work[1]	12.8%	33.5%	46.8%	41.4%	28.3%
Unemployed	1.7%	1.6%	1.2%	1.7%	1.2%
Working in the home	7.1%	28.5%	32.4%	41.2%	57.1%
Other[2]	2.0%	1.7%	1.9%	2.3%	0.6%
Number of women	602	765	991	694	170

1: employment and self-employment

2: including temporary and permanent sickness and full-time education

Sample: 4092 married women aged 33 from the NCDS, Wave 5 (1992)

3. PARENTS' PREFERENCES OVER THE SEX OF CHILDREN

The preference for balanced families

There is a large body of research, mainly in the demography literature, on parents' preferences over the sex composition of their offspring. Preferences vary between cultures, and within the same culture over time.

Williamson (1983) gives a summary of the findings of over 50 studies of sex preference. In developing countries, a marked preference for sons is usually found, though this tends to have an effect on total fertility only when relatively small family sizes are preferred and couples have some access to contraception. This is also found by Das (1987)

In developed countries, the main finding is a preference for 'balanced' families with equal numbers of boys and girls, sometimes with a secondary preference for sons if families want an odd number of children. Typically, among families who have reached parity[3] *n*, a U-shaped relationship is found between the number of sons and the parity progression ratio (the proportion of families progressing from parity n to parity *n+1*. *F*amilies with more equal numbers of boys and girls are less likely to have another child than those with more unequal numbers of boys and girls. This relationship is most marked at parity 2 and is not always evident at higher parities.

This paper examines only the preferences relating to the progression from parity 2 to parity 3. This is partly because at this parity the preference for balanced families is particularly strong, but mainly because the modern trend towards smaller families means that few families in more developed countries progress to parities higher than 3.

Several studies using US data (for example, Ben-Porath and Welch 1976; Pebley and Westoff 1982) have found that among mothers with two children, those with one boy and one girl are less likely to have a third child than those with two boys or two girls[4].

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[3] Parity here refers to the total number of children born to a woman.
[4] See Ben-Porath and Welch (1976); Pebley and Westoff (1982)

Information on the sex preferences of the British is much more limited. Thomas (1951) examines the family histories of medical students and finds that both their parents and their grandparents were more likely to have stopped at two children when those two children were of different sexes. The sample is small (230) but the results are significant. Peel (1970) notes that 45.7% of 350 couples in the Hull Family Survey express a preference for one boy and one girl, with an additional 34.9% preferring two boys and one girl, two of each sex, or two girls and one boy. Both these studies are small but they are indicative of some degree of preference for 'balanced' families.

In Table 5 below, the NCDS and BHPS data are compared with the US data sets used by Ben-Porath and Welch (1976) and Pebley and Westoff (1982). In each case the parity progression ratio (PPR) at parity 2 is shown for different sex compositions of the first two children.

TABLE 5 PARITY PROGRESSION RATIOS: THE FRACTION OF MOTHERS WITH TWO CHILDREN WHO HAD ANOTHER CHILD, BY SEX OF FIRST TWO CHILDREN

	2 girls	2 boys	One of each	Aggre-gate PPR	Sample Size	χ^2 statistic (1)
US Census, 1970 (2)	0.56	0.56	0.51	-	131866	249.1[4]
US National Fertility Study, 1970 (3)	0.622	0.632	0.548	-	4032	26.4[5]
BHPS, 1992	0.497	0.492	0.412	0.453	2609	17.8
NCDS, 1991	0.375	0.379	0.267	0.322	3227	45.0

(1) Associated 0.05 critical value is 6.0

(2) Ben-Porath & Welch, 1976

(3) Pebley & Westoff, 1982

(4) χ^2 statistic reported in study

(5) χ^2 statistic computed from figures given in study

In all cases the PPR is significantly higher for two-girl or two-boy families than it is for families with one boy and one girl. For example, in the NCDS, 38% of mothers with two girls or two boys have gone on to have a third child, compared with only 27% of mothers with a girl and a boy. In the BHPS, 49% of mothers with two boys or two girls have had a third child, compared to only 41% of those with a girl and a boy.

Although for all data sets the PPR is lower for mothers of 'one of each' rather than 'two the same', the aggregate PPR varies between the NCDS and the BHPS. In aggregate, 45% of mothers in the BHPS had a third child compared with only 32% of mothers in the NCDS. This difference in aggregate PPR might be explained in a number of ways:

1. By differences in *age* between the samples (the women in the NCDS sample are all aged 33, while the women in the BHPS have a mean age of 51). This means that the NCDS women are less likely to have completed their families.

2. The NCDS women are from a younger *cohort* than the BHPS women, when fertility is trending downwards over time. Given the data available here, it is not possible to distinguish between age and cohort effects.

3. The more educated and "middle class" women remaining in the NCDS sample after non-random attrition (described in Section 2), may be expected to have lower completed fertility than the more representative BHPS women.

Table 6 below gives PPRs for subsamples of the BHPS broken down by age. The subsample of BHPS women who are about the same age as the NCDS women have an aggregate PPR of about 41%, suggesting that the difference between the aggregate PPRs in the two samples is due to a combination of age/cohort effect and an effect due to non-random attrition from the NCDS.

TABLE 6 PARITY PROGRESSION RATIO: THE FRACTION OF MOTHERS WITH TWO CHILDREN WHO HAD ANOTHER CHILD, BY SEX OF FIRST TWO CHILDREN

	2 the same	2 different	Aggregate PPR	Sample Size
BHPS: Whole Sample	0.494	0.412	0.453	2609
BHPS: Women aged over 36	0.511	0.447	0.479	2067
BHPS: Women aged ≤ 36	0.427	0.280	0.352	542
BHPS: Women aged 30-36	0.476	0.351	0.414	379
NCDS (All Women aged 33)	0.377	0.267	0.322	3227

Instruments for the third birth

Table 7 shows the results of OLS regressions with the birth of a third child as the dependent variable, on several dependent variables which have been used as instruments for fertility in the past, as well as the instruments (multiple births and sex of children) which will be used later in the paper.

Some variables (ethnic group, the presence of current fecundity problems, and being a Catholic) do not predict fertility well. Other variables (mother's number of siblings, duration of marriage, and the mother's opinion at age 23 over the number of children she would like to have) are well correlated with fertility but it is difficult to argue that they have no effect on labour supply except via fertility.

The two instruments used in this paper: the sex of the first two children, and multiple second birth[5], are highly correlated with fertility, and it is relatively easy to argue that they have no independent effect on labour supply.

[5] Compare with Rosenzweig and Wolpin (1980), who use a multiple first birth as an instrument.

TABLE 7 INSTRUMENTS FOR THE THIRD BIRTH

Instrument	Coefficients (1)	(2)	(3)	Means
First 2 children boys	0.111 (0.031)	0.136 (0.024)	0.109 (0.020)	0.239
First 2 children girls	0.105 (0.030)	0.112 (0.024)	0.105 (0.020)	0.242
Multiple 2nd birth	0.677 (0.141)	0.687 (0.101)	0.672 (0.079)	0.009
Current fecundity problems	-0.070 (0.067)	-0.021 (0.052)	-	0.020
Catholic	0.058 (0.041)	0.079 (0.032)	-	0.102
Nonwhite	-0.068 (0.151)	-0.108 (0.134)	-	0.007
Mother's no. of siblings	0.027 (0.007)	0.032 (0.005)	-	3.336
Duration of marriage	0.012 (0.004)	-	-	10.671
Ideal no. of children (1)	0.161 (0.015)	-	-	2.568
Constant	-0.409 (0.064)	0.126 (0.023)	0.262 (0.012)	
R-squared	0.144	0.059	0.035	
F-statistics for joint significance of regressors*	21.43	19.81	39.48	
Sample Size	1157	2208	3227	

(1) Question asked at age 23

All P-values are 0.0000

Dependent variable: third child

Standard errors in parentheses

Sample: National Child Development Study; women with two or more children

Mean of dependent variable: 0.2785

4. ESTIMATION AND RESULTS

Over a sample of all women with two or more children, a probability model is estimated of the form:

$$\boldsymbol{Z_i^*} = \alpha_0 + \alpha_1 \boldsymbol{THIRD_i} + \alpha_2 \boldsymbol{X_i} + \varepsilon_i$$

$$\boldsymbol{WORK_i} = 1 \text{ if } \boldsymbol{Z}_{\mathrm{i}}^* > 0 \qquad 5.1$$

$$\boldsymbol{WORK_i} = 0 \text{ if } \boldsymbol{Z}_{\mathrm{i}}^* <= 0$$

where $\boldsymbol{Z_I^*}$ is a latent variable, ***THIRD*** is a dummy variable indicating whether the woman has a third child; ***X*** is a vector of personal characteristics, assumed exogenous, and ***WORK*** is an indicator of the woman's labour market participation, taking the value 1 if she goes out to work and 0 if she stays home. The error term may be written as

$$\varepsilon_i = \alpha_3 \theta_i + u_i \qquad 5.2$$

where ε is composed of a random component u and the effects of an unobservable parameter θ. Following from the previous discussion, θ is a parameter affecting both fertility and labour supply, and accounting for some of the observed (and spurious) relationship between the two.

To identify the model the assumption is used that the sex of the first two children affects a woman's propensity to have a further child but does not affect her labour supply conditional on the number of children. Additionally, it is assumed that a multiple birth bestows an 'extra' child on a woman, but that the presence of twins does not affect labour supply conditional on a woman's total number of children.

Three specifications for the model are considered, each with different exogenous regressors in X. In the first specification (Table 8) X contains only linear and squared terms in age. Education variables are added in the second specification (Table 9), and non-labour income variables (including partner's income) in the third specification (Table 10). One variable standard in the analysis of female labour supply is not used in these regressions: the age of the woman's youngest child. Because the NCDS cohort are all the same age, the age of the youngest child is correlated with all the variables which determine the age at which a woman has her *first* child, and including this variable in regressions may cause more problems than it solves. The age of the youngest child may be more meaningfully included in regressions the BHPS sample; however, this would make comparisons between the samples more difficult. Therefore, regressions on the BHPS sample including the age of the youngest child are not reported; however, they were estimated, yielding coefficients on the *THIRD* variable almost identical to those reported.

For each specification, the coefficients obtained by OLS regression are compared with those obtained using two-stage least squares, instrumeting the *THIRD* variable with an instrument set consisting of *BOYS* (first two children are both boys), *GIRLS* (first two children are both girls), and *TWINS* (multiple second birth).

Exogeneity of the *THIRD* variable is tested using the method proposed by Smith and Blundell (1986). This involves inserting the residuals from the reduced form instrumenting equations into the OLS regression; the t-statistic on the coefficient for the residual constitutes a test for the exogeneity of the variable in question. The test is repeated twice for each specification: on the NCDS sample, and the BHPS sample.

The results (shown in Tables 8 – 10) are qualitatively consistent across specifications and data sets. In each case, the coefficient on *THIRD* is significantly negative when the equation is estimated under OLS, and in each case the coefficient becomes positive, although less precise, under 2SLS. For all specifications with the NCDS sample, the hypothesis that the *THIRD* variable is exogenous is rejected by the augmented regression test procedure described above: the t-statistics associated with this test are all greater in magnitude than 2 for the NCDS sample. For the BHPS sample they are smaller in magnitude, ranging from –1.75 to –1.20 (associated with significance levels of 10% to 25%). The lesser precision in the BHPS is in part due to the much smaller sample size, and possibly also to the greater heterogeneity within the sample. Two further tests were carried out: an F-test for the joint significance of instruments in the first-stage regressions, which in all cases indicate that the instruments are jointly significant with associated P-values of 0.000 in all cases; and a Sargan test of overidentifying restrictions which fails to reject the validity of the instruments in all cases.

TABLE 8

EFFECT OF A THIRD CHILD ON LABOUR MARKET PARTICIPATION: OLS AND 2SLS ESTIMATES (SPECIFICATION I)

	NCDS		BHPS	
	OLS	2SLS	OLS	2SLS
Third child	-0.149	0.134	-0.128	0.091
	(0.019)	(0.101)	(0.026)	(0.129)
Age	-	-	0.101	0.086
			(0.017)	(0.019)
Age^2 x 100	-	-	-0.103	-0.085
			(0.023)	(0.025)
Constant	0.640	0.549	-1.639	-1.435
	(0.010)	(0.034)	(0.311)	(0.336)
Mean of dependent variable		0.592		0.606
Sample size		3227		1375
T-statistic for exogeneity of 'third child'		-3.03		-1.75
Sargan statistic		0.329		2.585
F-test for validity of instruments		F(3,3223)=39.5		F(3,1369)=17.2
		(0.000)		(0.000)

Dependent variable: labour market participation

Sample: all women with two or more children between the ages of 21 and 49

Instruments for third child in 2SLS regressions are 'boys', 'girls' (first two children are boys/girls), and 'twins' (multiple second birth).

White (1980) corrected standard errors in parenthese below coefficients.

Sargan statistic is distributed with a chi-squared (2) distribution, with a critical value of 5.99

Figures below F-test statistics are associated P-values

TABLE 9

EFFECT OF A THIRD CHILD ON LABOUR MARKET PARTICIPATION: OLS AND 2SLS ESTIMATES (SPECIFICATION II)

	NCDS		BHPS	
	OLS	2SLS	OLS	2SLS
Third child	-0.149	0.123	-0.118	0.073
	(0.019)	(0.096)	(0.026)	(0.127)
Age	-	-	0.101	0.088
			(0.017)	(0.019)
Age^2 x 100	-	-	-0.103	-0.087
			(0.023)	(0.025)
Degree	0.021	0.063	0.087	0.111
	(0.034)	(0.038)	(0.044)	(0.047)
'A' levels	-0.013	0.051	0.056	0.068
	(0.025)	(0.029)	(0.047)	(0.049)
'O' levels	0.053	0.075	0.071	0.080
	(0.021)	(0.023)	(0.029)	(0.030)
Technical qualifications	-0.028	-0.007	0.044	0.063
	(0.020)	(0.022)	(0.027)	(0.030)
Constant	0.629	0.520	-1.725	-1.559
	(0.015)	(0.041)	(0.312)	(0.332)
T-statistic for exogeneity of 'third child'		-2.92		-1.54
Mean of dependent variable		0.592		0.606
Sample size		3188		1374
Sargan statistic		0.092		2.756
F-test for validity of instruments		F(3,3180)=40.3		F(3,1369)=17.9
		(0.000)		(0.000)

Dependent variable: labour market participation.. Sample: all women with two or more children between the ages of 21 and 49

Instruments for third child in 2SLS regressions are 'boys', 'girls' (first two children are boys/girls), and 'twins' (multiple second birth).

'Degree', 'A levels' and 'O levels' are mutually exclusive: omitted category is no qualifications.

Technical qualifications are not mutually exclusive to academic qualifications.

White (1980) corrected standard errors in parentheses below coefficients.

Sargan statistic is distributed with a chi-squared (2) distribution, with a critical value of 5.99

Figures below F-test statistics are associated P-values.

TABLE 10: EFFECT OF A THIRD CHILD ON LABOUR MARKET PARTICIPATION: OLS AND 2SLS ESTIMATES (SPECIFICATION III)

	NCDS		BHPS	
	OLS	2SLS	OLS	2SLS
Third child	-0.117 (0.019)	0.068 (0.092)	-0.063 (0.027)	0.079 (0.120)
Age	-	-	0.090 (0.018)	0.080 (0.019)
Age^2 x 100	-	-	-0.093 (0.024)	-0.081 (0.025)
Degree	0.037 (0.035)	0.063 (0.038)	0.096 (0.045)	0.111 (0.047)
‘A’ levels	0.005 (0.025)	0.028 (0.028)	0.042 (0.049)	0.046 (0.050)
‘O’ levels	0.047 (0.021)	0.060 (0.022)	0.074 (0.029)	0.078 (0.029)
Technical qualifications	-0.033 (0.020)	-0.020 (0.021)	0.043 (0.027)	0.057 (0.030)
Single	-0.190 (0.042)	-0.156 (0.047)	-0.081 (0.058)	-0.075 (0.060)
Partner not Earning	-0.278 (0.044)	-0.275 (0.046)	-0.316 (0.048)	-0.327 (0.049)
Partner’s Earnings x 100	-0.060 (0.009)	-0.060 (0.009)	-0.036 (0.011)	-0.034 (0.011)
Other Unearned Income x 100	-0.156 (0.036)	-0.200 (0.043)	-0.258 (0.073)	-0.282 (0.081)
Constant	0.851 (0.027)	0.791 (0.040)	-1.278 (0.323)	-1.130 (0.342)
T-statistic for exogeneity of ‘third child’		-2.05		-1.20
Mean of dependent variable		0.591		0.595
Sample size		3105		1253
Sargan statistic		0.880		3.608
F-test for validity of instruments		F(3,3093)=42.9 (0.000)		F(3,1239)=16.3 (0.000)

Dependent variable: labour market participation. Sample: all women with two or more children aged 21-49. Instruments for third child in 2SLS regressions are ‘boys’, ‘girls’ (first two children are boys/girls), and ‘twins’ (multiple second birth).‘Degree’, ‘A levels’ and ‘O levels’ are mutually exclusive: omitted category is no qualifications.Technical qualifications are not mutually exclusive to academic qualifications.‘Single’ is a dummy indicating that the woman does not live with a partner.‘Partner not Earning’ is a dummy indicating that the woman lives with a partner who is not earning.‘Partner’s Earnings’ are weekly earnings measured net of tax and NI contributions.‘Other Unearned Income’ is weekly benefit and investment income.

White (1980) corrected standard errors in parentheses below coefficients.

Sargan statistic is distributed with a chi-squared (2) distribution, with a critical value of 5.99

Figures below F-test statistics are associated P-values

The assertion that these results are consistent between samples and across specifications requires some qualification. Firstly, the OLS coefficient on *THIRD* does become less negative as more variables are included in the regression. This may be explained as follows: the bias on the estimated α_1 arises as a result of θ being unobservable. If θ were observable, OLS estimation would yield an unbiased estimate of this coefficient. A number of variables (such as, here, those relating to non-labour income) may be correlated with θ, and may therefore control for the unobservable parameter in such a way as to reduce the bias on the estimated coefficient. This may also account for the differences between NCDS and BHPS coefficients, since the BHPS women are of different ages; if θ has been changing over time, then age will control for part of the effect of θ.

There are also differences between the two-stage least squares coefficients on *THIRD* under different specifications: the coefficients tend to be closer to zero when more variables are included in the regression, although in this case the standard errors are such that the hypothesis of no difference between the coefficients obtained from different specifications is not rejected. None of the coefficients on other variables change significantly from one specification to another.

Finally, there are differences in the coefficients on *THIRD* between the NCDS and BHPS samples, with the coefficient under OLS being more negative for the NCDS than the BHPS sample, while under 2SLS the coefficient is larger for the NCDS sample in the first two specifications but not the third.

It is interesting to compare these estimates with those obtained by Angrist and Evans (1998). Using subsamples of the US census for 1980 and 1990, they report OLS coefficients on the third child variable of –0.176 (0.002) and –0.155 (0.002) for the 1980 and 1990 samples respectively; and IV coefficients of –0.120 (0.025) and –0.092 (0.024) for the two samples. Thus, the IV coefficients are significantly less negative than the OLS estimates; however, they are still negative and precisely estimated.

The OLS coefficients estimated in this paper, ranging from -0.117 to –0.149 for NCDS and –0.128 to –0.063 for BHPS, are not far different from those estimated by Angrist and Evans. However, the 2SLS coefficients estimated in this paper are all positive, and although none of them are significantly different from zero, they are significantly different to Angrist and Evans' negative estimates. The difference in precision is almost certainly caused by different sample sizes: the US census subsamples are over 100 times larger than the NCDS sample. But what of the different signs? One possible explanation is that the dependent variable is differently measured in the two papers: here, the variable relates to whether the mother is going out to work at the time of the interview, whereas Angrist and Evans use a variable based on whether the woman worked at all for pay in the preceding year, which may have been before the birth of the third child. In fact it is hard to see how this difference in measurement could account for the different estimates: if it really is the case that having a third child has a negative effect on the probability that a mother goes out to work in the US, but that a third child makes no difference to this probability in the UK, the reason may lie in differences between welfare systems between the two countries, in different provisions for maternity leave, or in the relative availability of part-time work.

Looking briefly at other coefficients in the regression, the participation function is concave in age, peaking at around age 50 (age does not appear in the NCDS regressions since all the NCDS women are 33). The age and age squared coefficients do not give a great deal of information about the 'true' effects of age on participation because of the composition of this sample. Since women with two or more children are considered, the younger women in the sample have younger children, and therefore the age coefficients reflect more the effect of the age of the youngest child than the effect of age in itself, especially for the younger women.

The education coefficients are in general of the expected sign (positive) sign, and in general they have a higher magnitude for higher qualifications (a degree is the highest qualification, followed by 'A' levels, which are obtained at the age of 18, and then 'O' levels, obtained at age 16. Technical qualifications may be held in addition to any of the other qualifications). Not all the education coefficients are of the expected sign, but those of the "wrong" sign are not significantly different from zero. In the fist-stage equations, the education coefficients are all well-determined and of the expected sign and relative magnitude, while the standard errors are rather large in the participation equations.

The non-wage income coefficients are again of the expected signs. The large negative coefficients on *single* and *partner not earning* may be interpreted as disincentive effects brought about by the benefits system, since the withdrawal of benefits when these women begin to earn brings about a high effective marginal rate of taxation. The effect of non-wage household income on women's labour supply is also negative: the fact that the effect of *other income* is so much larger than that of *partner's earnings* again reflects the disincentive effects of the withdrawal of state benefits.

Failing to account for the endogeneity of regressors may lead to biased estimates, not only of the coefficient on the variable in question, but also of other coefficients correlated with the endogenous variable. In this case, however, none of the coefficients except *THIRD* differ significantly between OLS and 2SLS estimates. So, although failure to account for fertility as endogenous *will* lead to biased estimates of the effect of fertility on labour supply, it appears that estimates of other coefficients may not be affected.

It is clear that the 2SLS coefficients on *THIRD* are significantly different from the OLS coefficients, but how should their sign and magnitude be interpreted? None of the coefficients is statistically significant from zero at the conventional 5% level, but given that the R^2 in the instrumenting equations is never greater than 10%, this is entirely unsurprising. What *is* remarkable is that the coefficient is positive *every time*, and is relatively stable in magnitude. The fact that these findings are consistent with those of some other researchers[6] may lead one to infer very tentatively that the marginal effect of the third child is actually to *increase* labour market participation, perhaps because of an income effect. Alternatively, researchers such as Hill and Stafford (1985) who maintain that fertility has no effect on labour supply may not be far wrong in their assumptions.

[6] Cain and Dooley (1976); Hout (1978)

Hours of work

Similar results to those obtained for female labour force participation also apply for hours of work; results for the hours of work equations are reported in Table 11. For hours of work, Tobit equations are estimated, as follows:

$$\begin{aligned} &\boldsymbol{Y_i^*} = \alpha_0 + \alpha_1 \boldsymbol{THIRD_i} + \alpha_2 \boldsymbol{X_i} + \boldsymbol{\varepsilon_i} \\ &\boldsymbol{HRSW_i} = \boldsymbol{Y_i^*} \quad \text{if} \quad \boldsymbol{Y}_\text{i}^* > 0 \qquad\qquad 5.2 \\ &\boldsymbol{HRSW_i} = 0 \quad \text{if} \quad \boldsymbol{Y}_\text{i}^* <= 0 \end{aligned}$$

Where $\boldsymbol{Y_i^*}$ is an unobserved latent variable, *HRSW*$_i$ are the hours of work observed for the *i*th woman, and other variables and parameters are as described for equation 5.1. The 'two-stage' version of the Tobit regressions is obtained by first regressing the probability of having a third child on the instruments 'boys', 'girls' and 'twins'; and inserting the predicted values of 'third' into the Tobit regression in place of the observed values of the variable.

The results in Table 11 report estimates for the NCDS sample (as before, estimates from the BHPS sample are qualitatively similar but less precise). These estimates tell essentially the same story as those in the previous three tables: if endogenous fertility is not taken into account, the third child appears to be associated with a significant decrease in weekly hours of work, with coefficients ranging from –7.505 to – 5.894. Controlling for endogenous fertility the third child is associated with an *increase* in hours of work, with coefficients ranging from 4.650 to 7.092. As in the participation equation, these estimates fall short of significance at the 5% level; however, the t-statistics from the augmented regressions show that they are significantly different from the OLS estimates. As was the case for the participation estimates, the estimates presented here which are not adjusted for the endogeneity of the 'third child' variable are comparable to those obtained by Angrist and Evans (1998); however, when endogeneity of the third child variable is taken into account, the positive and insignificant estimates obtained here are significantly different from the negative and significant estimates obtained by Angrist and Evans.

Table 11

Effect of a third child on hours of work

	Specification I		Specification II		Specification III	
	B	C	B	C	B	C
Third child	-7.505 (0.948)	7.092 (4.914)	-7.687 (0.966)	6.429 (4.922)	-5.894 (0.968)	4.650 (4.661)
Degree	-	-	0.595 (1.761)	2.850 (1.928)	2.951 (1.777)	4.359 (1.879)
'A' levels	-	-	1.406 (1.253)	3.260 (1.435)	1.499 (1.254)	2.797 (1.377)
'O' levels	-	-	1.581 (1.065)	2.730 (1.142)	1.921 (1.052)	2.609 (1.094)
Technical qualifications	-	-	-1.686 (1.006)	-0.534 (1.081)	-1.587 (0.988)	-0.928 (1.028)
Single	-	-	-	-	-8.410 (1.949)	-6.809 (2.069)
Partner not Earning	-	-	-	-	-11.607 (2.144)	-11.569 (2.142)
Partner's Earnings x 100	-	-	-	-	-3.773 (0.420)	-3.790 (0.420)
Other Unearned Income x 100	-	-	-	-	-9.233 (1.263)	-11.535 (1.620)
Constant	7.259 (0.541)	2.561 (1.658)	7.028 (0.771)	1.384 (2.096)	19.486 (1.285)	16.259 (1.912)
T-statistic for exogeneity of 'third child'		-3.01		-2.90		-2.28
Sample size	1640 women with hours > 0		1616 women with hours > 0		1571 women with hours > 0	
	1316 women with hours = 0		1302 women with hours = 0		1270 women with hours = 0	

Dependent variable: weekly hours of work.

Sample: all women in NCDS

Instruments and variable definitions as in Tables 8-10

5. CONCLUSIONS

This paper has investigated the endogeneity of fertility variables in the female labour supply and hours of work equations using family sex composition as an instrument for the third birth. These results suggest that fertility *is* endogenous in both the labour market participation and hours of work decisions of women, either because labour market participation affects the decision as to whether to have additional children, or because some third unobservable factor is driving both participation and fertility.

This study suggests clearly that failing to account for the endogeneity of fertility variables at parity 2 leads to overestimates the negative effect of children on female labour supply, both in terms of labour force participation and hours of work. What is less clear is the direction of the 'true' effect of the third child on labour supply once the endogeneity of the fertility variables has been taken into account. The estimates in this paper are all positive but not significantly different from zero, contrasting with estimates from the US which suggest that endogeneity of fertility variables does lead to exaggerated estimates of the effect of children on female labour supply, but that the 'true' effect is still significantly negative.

It is entirely possible that differences between labour market conditions in the US and the UK mean that an extra child would have a different effect on mothers' labour supply in the two countries. Policies which enable women to return to work more easily after having children (such as easily available or subsidized daycare; more generous maternity leave provisions; having the right to take time off work to look after a sick child, and so on) will mean that additional children have less of a depressing effect on participation and hours of work. A plentiful supply of part-time jobs, giving mothers a choice of hours, will mean that more mothers choose to go out to work, although since many of them will work shorter hours than they would if part-time jobs were not available, the net effect on hours of work is not clear. The welfare system will also play a part, particularly where single mothers are concerned: where welfare benefits are low and/or not means-tested, children will have less of a depressing effect on their mothers' labour supply than where welfare benefits are higher and/or means tested. All these considerations mean it is quite possible that the effect of an additional child affects labour supply differently in different countries.

Further research with larger data sets should provide more precise estimates for the UK; in the meantime, this paper has found that failing to account for the endogeneity of fertility in the female labour supply function generates biased estimates of the effect of children on female labour supply; and suggests that either children have no effect on their mothers' labour supply, or possibly that when additional children enter a family, an income effect may outweigh the substitution effect and children actually have a positive effect on labour supply.

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6. APPENDIX

TABLE A1: PROBABILITY OF ATTRITION AFTER WAVE 4 OF NCDS

	Probit Coefficients	Sample Means
Stayed at school after 16	-0.147	0.293
	(0.047)	
Any ‘O’ levels	-0.194	0.643
	(0.042)	
Married by age 23	-0.105	0.594
	(0.041)	
Cohabited by age 23	0.167	0.113
	(0.058)	
Lone parent by age 23	0.099	0.080
	(0.072)	
Had a child by age 19	0.167	0.120
	(0.063)	
Constant	0.685	-
	(0.043)	

$R^2 = 0.016$

$F(6, 6256) = 16.99$

Sample size: 6263 females.

Dependent variable: Left sample after Wave IV

Mean of dependent variable = 0.1964

TABLE A2
FIRST-STAGE REGRESSIONS FOR PROBABILITY OF HAVING A THIRD CHILD

	SPECIFICATION I		SPECIFICATION II		SPECIFICATION III	
	NCDS	BHPS	NCDS	BHPS	NCDS	BHPS
Boys	0.109	0.093	0.108	0.090	0.107	0.074
	(0.020)	(0.031)	(0.020)	(0.031)	(0.019)	(0.032)
Girls	0.105	0.116	0.102	0.114	0.112	0.121
	(0.020)	(0.033)	(0.020)	(0.032)	(0.020)	(0.034)
Twins	0.672	0.613	0.679	0.636	0.691	0.638
	(0.079)	(0.107)	(0.078)	(0.107)	(0.078)	(0.111)
Age	-	0.067	-	0.068	-	0.071
		(0.020)		(0.020)		(0.021)
Age^2 x 100	-	-0.083	-	-0.084	-	-0.083
		(0.027)		(0.026)		(0.027)
Degree	-	-	-0.157	-0.123	-0.139	-0.098
			(0.032)	(0.046)	(0.032)	(0.048)
'A' levels	-	-	-0.140	-0.076	-0.125	-0.039
			(0.023)	(0.050)	(0.023)	(0.052)
'O' levels	-	-	-0.082	-0.065	-0.068	-0.042
			(0.020)	(0.030)	(0.020)	(0.031)
Technical	-	-	-0.079	-0.094	-0.065	-0.102
Qualifications			(0.018)	(0.028)	(0.018)	(0.290)
Single	-	-	-	-	-0.179	-0.029
					(0.036)	(0.053)
Partner not Earning	-	-	-	-	-0.006	0.091
					(0.038)	(0.049)
Partner's Earnings	-	-	-	-	0.001	-0.013
x 100					(0.007)	(0.011)
Other Unearned Income x 100	-	-	-	-	0.235	0.158
					(0.022)	(0.041)
Constant	0.262	-1.005	0.342	-0.922	0.251	-1.109
	(0.012)	(0.367)	(0.015)	(0.367)	(0.024)	(0.378)
Mean of dep. variable	0.322	0.385	0.322	0.384	0.320	0.382
Adjusted R^2	0.035	0.045	0.057	0.060	0.100	0.086
F-statistics*	39.48	17.15	40.34	17.87	43.19	16.33
	(3, 3223)	(3, 1369)	(3, 3180)	(3, 1364)	(3, 3093)	(3, 1239)
F-statistics**	39.48	13.97	28.46	10.66	32.49	10.07
	(3, 3223)	(5, 1369)	(7, 3180)	(9, 1364)	(11, 3093)	(13, 1239)
Sample Size	3227	1375	3188	1374	3105	1253

*Dependent variable: whether the woman has a third child. Sample: women with two or more children aged between 21 and 49.F-stats marked * refer to the joint significance of the three instruments used (boys, girls and twins). Those marked ** refer to joint significance of all regressors. Degrees of freedom in square brackets. All P-values for * and ** are 0.0000*