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The impact of children on female earnings in Britain

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THE IMPACT OF CHILDREN ON FEMALE EARNINGS IN BRITAIN

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Abstract:

This paper examines the impact of children on female wages in the UK using the National Child Development Study. Empirically this involves using an extension of the Roy model, which simultaneously corrects for the endogeneity of labour force participation and fertility. The wage differential between women without children and women with children is estimated to range between 19% and 22% not accounting for endogeneity. This result confirms the findings of many previous studies, however, the results indicate substantial non-random selection into employment for women hence leading to biased OLS estimates. The wage differential reduces to 16%-18% instrumenting participation and fertility, however, using the estimates obtained from the double-selection model, the wage differential between mothers and childless women reduces to just 10%-13%.

The data was supplied by the Economic and Research Council's Data Archive at the University of Essex and are used with permission of the Controller of Her Majesty's Stationery Office.

1 Introduction

The past 30 years have witnessed an increase in women's labour force participation rates in the UK from 56% to over 70%[1]. Furthermore, women are expected to fill two thirds of all new job creations between 1998 and 2009 in the UK (Wilson and Green (2001)). Graph 1 illustrates the recent trend in female labour supply clearly indicating increased participation for all women regardless of their fertility[2]. The increase has been explained by, for example, higher levels of educational qualifications, rising divorce probabilities, wider availability of non-maternal childcare and better control of fertility through improved contraception (see, for example, Goldin and Katz (2000) for the US or Sprague (1988) for the UK).

[Graph 1 about here]

Concomitantly to the increase in participation, Western economies have witnessed a decrease in the fertility rate over the same period. The right-hand side axis in Graph 2 shows that over the past 30 years the total fertility rate (TFR) has dropped drastically in the UK falling below the replacement rate, while the female labour force participation has increased (depicted in the left-hand side axis of Graph 2). Although the two events may be unrelated, it may indicate that many women find it difficult to combine career and fertility decisions. As an example, the 1998 Family Resources Survey reveals that over 20% of UK mothers of pre-school age children, aged 18-44, stated that childcare obligations restricted them from working. Similarly, for the US, Mason and Kuhlthau (1992) find that up to 30% of mothers of pre-school age children felt constrained in their employment due to child care problems.

[Graph 2 about here]

[1] Labour Force Survey, 1971-1998, including women aged 16-59.
[2] Fertility is defined as a dummy variable taking value 1 for mothers and 0 for non-mothers throughout the paper.

The impact of children on various economic decisions has generated much empirical research among economists[3]. Furthermore, many studies have found that a significant portion of the gender wage gap can be explained by a "family gap" or the difference in earnings between women with children and women without children (see Table 1 for summary of results). Two major hypotheses explaining the mechanism by which mothers earn less than childless women with similar characteristics include: (1) individual heterogeneity e.g. commitment to work or career orientation, and (2) human capital theory i.e. women with children have less accumulated human capital investment due to reduced work experience.

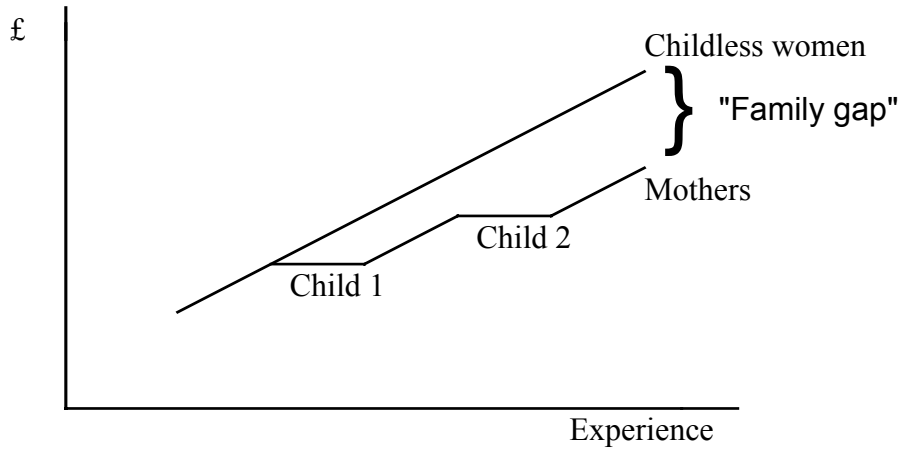
[Table 1 about here]

The first explanation for the "family gap" sees no causal link between fertility status and pay but instead both motherhood and lower pay result from idiosyncratic preferences regarding employment and household production. This heterogeneity explanation includes the traditional models of selection/self-selection into employment as well as selection/self-selection into motherhood and household production. As an example, this explanation of individual preferences includes mothers trading off higher pay for mother-friendly, e.g. part-time, employment. Korenman and Neumark (1992), using US data, find that fixed unobservables bias cross-sectional estimates of the effects of children on wages. They conclude that assuming the fixed effects estimates are correct, women would not experience any adverse effects from motherhood on wages by remaining employed. The same conclusion is reached with Danish data by Datta Gupta and Smith (2001), who find that children do not seem to impose any negative effects on mother's pay in the long run when controlling for fixed effects. These conclusions are not confirmed by studies for the US and UK by Waldfogel (1995, 1997, 1998b), who concludes that lack of opportunities or discrimination, instead of heterogeneity, may explain most of the "family gap".

[3] See, for example, Browning (1992) for an extensive literature review of the effects of children on the allocation

The second explanation relies on the human capital theory (see Becker (1981)). The theory predicts that women will have lower wages due to time taken off the labour market due to childbearing and specialisation in household production (see Figure 1 for an illustration) as well as being less productive at work (see Becker (1985)). Figure 1 depicts how time taken off the labour market can lead to a difference in earnings between mothers and childless women. If each year of employment experience increases wages by, say, 1% then women who spend a year out will have a 1% wage differential compared to those with continuous employment, ceteris paribus. According to the human capital theory, therefore, the effects of children are mostly indirect i.e. reducing wages by reducing mothers' labour force attachment. This theory is supported by a finding by Datta Gupta and Smith (2001) who discovered that the loss of human capital accumulation during childbirth period could result in temporary negative effects on wages, while the long run effects are zero. Korenman and Neumark (1992) find that controlling for experience eliminates much of the "family gap", however, they conclude that employment experience is endogenous with respect to wages.

Figure 1 Earnings growth according to the human capital theory



of expenditure within households and female labour supply.

There has been much talk recently on family friendly policies in the UK in the form of in-work tax credits, and improved maternity and childcare provision. The Guardian newspaper (9.6.2001) highlights Britain's paid maternity leave lagging behind all other European countries. The poor record of family friendly policies is topped by a finding by Harkness and Waldfogel (1999) that the "family gap" is largest in the UK, followed by US and Germany. The "family gap" is found to be virtually non-existent in the Nordic countries. According to their estimation the "family gap" in the UK is approximately 11%. Browning (1992) states that the "family gap" could be eliminated by reducing the cost of childcare to parents while Waldfogel (1998a, 1998b) suggests that, as well as affordability and availability of childcare, maternity leave can act as an effective remedy for the "family gap" in pay by preventing breaks in employment[4].

Previous research has established the importance of the possible unobserved heterogeneity among women in their decision to enter the labour force (see, for example, Heckman and Willis (1977) or Shaw (1994)) as well as the potential endogeneity of the fertility status with respect to wages (Korenman and Neumark (1992)). This study differs from the previous studies by accounting for both selection into labour force and the endogeneity of fertility in the wage equation simultaneously. Hence this method gives estimates of the impact of children on female wages unaffected by the potential heterogeneity and endogeneity biases.

In the following section, I describe the econometric method used in the analysis. Section 3 contains a description of the data, while Section 4 presents the results and Section 5 concludes.

2 Econometric model

[4] See, for example, Jacobsen and Levin (1995) or Ruhm (1998) for the impact of breaks in employment at

This paper investigates the impact of children on female wages in the UK. The wage effect of motherhood is estimated by comparing the wages between women with children and women without children; the dichotomous variable F_i is 1 for the former and 0 for the latter group of women and i refers to an individual. The econometric method involves using an extension of the Roy model, which allows double-selection (see, for example, Fishe et al. (1981) or Maddala (1983)) as wages are only observed for participating women. The two selections, fertility and participation, are not assumed to be independent and are hence estimated simultaneously.

For each individual i, we want to calculate the difference in wages between mothers and childless women. The wage equations are estimated as follows[5]:

$$\begin{aligned} w_{1i} &= \delta_1 X_{1i} + \eta_{1i} \quad if \ F_i = 1 \& P_i = 1 \\ w_{2i} &= \delta_2 X_{2i} + \eta_{2i} \quad if \ F_i = 0 \& P_i = 1 \end{aligned} \tag{1}$$

where w_1 and w_2 denote the log wages, X_1 and X_2 are vectors of controls and η_1 and η_2 are independent and identically distributed disturbances for each individual i.

However, this is still not a correct estimate of the family gap because mothers and other women may also differ by some other characteristics that may explain their fertility decision and the wages they obtain. Therefore the model needs to account for participation in the labour force as well as fertility participation. Participation in labour force for individual i can be specified as a latent variable model:

$$P_i^* = \gamma_1 Z_i + \varepsilon_{1i} \tag{2}$$

with the decision to enter workforce given by:

$$P_i = \begin{cases} 1 & if \quad P_i^* > 0 \\ 0 & otherwise \end{cases} \tag{3}$$

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childbirth, or parental leave, for women's pay.

[5] The assumption of pooling of the samples of women with children and those without children is tested using the Chow test, the results of which indicate that the null hypothesis of pooling is rejected (p-value 0.003). Therefore, I estimate separate wage equations.

where P_i^* is a latent variable for the propensity to participate in the labour force, Z_i is a vector of personal, household and economic characteristics affecting individual i, and ε_{1i} are $N(0,1)$ disturbances. Similarly, individual i's decision to enter motherhood can be estimated using the following latent variable model:

$$F_i^* = \gamma_2 W_i + \varepsilon_{2_i} \tag{4}$$

with the decision to enter motherhood given by:

$$F_i = \begin{cases} 1 & if\ F_i^* > 0 \\ 0 & if\ F_i^* \leq 0 \end{cases} \tag{5}$$

where W_i includes controls for personal, household and economic characteristics affecting individual i and ε_{2i} are $N(0,1)$ disturbances.

Since we do not assume the independence of the various disturbance terms, the full stochastic specification of the error terms in equations (1), (2) and (4) assuming normality is given as follows:

$$\begin{bmatrix} \eta_{1i} \\ \eta_{2i} \\ \varepsilon_{1i} \\ \varepsilon_{2i} \end{bmatrix} \sim N \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}; \begin{matrix} \sigma^2_{\eta_1} & 0 & \sigma_{\eta_1\varepsilon_1} & \sigma_{\eta_1\varepsilon_2} \\ & \sigma^2_{\eta_2} & \sigma_{\eta_2\varepsilon_1} & \sigma_{\eta_2\varepsilon_2} \\ & & 1 & \sigma_{\varepsilon_1\varepsilon_2} \\ & & & 1 \end{matrix} \tag{6}$$

The four terms in the upper right-hand corner of the variance-covariance matrix determine the sample selection effects due to participation (indicated by subscript ε_1) and fertility (indicated by subscript ε_2) on the wage equations for women with children (indicated by subscript η_1) and childless women (indicated by subscript η_2). Furthermore, $\sigma_{\varepsilon 1 \varepsilon 2}$ represents the correlation between the participation decision and the fertility outcome that can originate from unobservable variables such as individual preferences or constraints such as lack of childcare facilities.

Modelling the two decisions simultaneously requires the estimation of (1), (2) and (4) jointly by maximum likelihood or by Heckman two-step method for consistent estimates. The estimation of γ_1, γ_2 and $\sigma_{\varepsilon 1 \varepsilon 2}$ in the selection equations (2) and (4) is performed using a bivariate probit estimation. These estimates are then used to construct Inverse Mills Ratios, which are included in the second step equation to correct the ordinary least squares (OLS) of selection biases. Hence the conditional expectations of the log wage equations for women with children and women without children are as follows:

$$\begin{aligned} E(\ln W_{1i} \mid F_i = 1, P_i = 1) &= \delta_1 X_{1i} + \sigma_{1\varepsilon_1} M_{12} + \sigma_{1\varepsilon_2} M_{21} \\ E(\ln W_{2i} \mid F_i = 0, P_i = 1) &= \delta_2 X_{2i} + \sigma_{2\varepsilon_1} M_{34} + \sigma_{2\varepsilon_2} M_{43} \end{aligned} \tag{7}$$

where M_{12} and M_{34} give the propensity to participate in the labour force for women with children and no children respectively, and M_{21} and M_{43} give the propensity to enter motherhood and not have children respectively[6]. Appendix 1 shows the special form that the Inverse Mills Ratios take when $\sigma_{\varepsilon 1 \varepsilon 2}$, or the correlation between the two selection equations, is significantly different from zero.

The double selection model corrects simultaneously for the endogeneity of labour force participation and fertility. However, besides the double-selection model results, I present OLS and IV estimates for comparison purposes to study the impact of children on female wages. The relationship between and discussion on selection models and IV approaches is reviewed in Blundell and Powell (2003).

3 Data

The National Child Development Study (NCDS) is a longitudinal survey following all individuals born in Britain during the first week of March 1958. The NCDS was planned as a perinatal mortality survey with follow-ups at age 7, 11, 16, 23 and 33. This analysis uses the

fifth wave, which was conducted in 1991 when the respondents were 33 years old[7]. The fifth wave includes 5799 women. The sample is selected by including women who are married or cohabiting, which brings the sample size to 4742 observations. I concentrate on married or cohabiting women only because a live-in partnership is more likely to maximise a collective utility function and hence take into account the activities and income of other household members[8]. It would be also interesting to include single women in the analysis, however, since their labour force participation decisions are so different from women with a partner this would cause modelling problems as well as problems with the sample size with the NCDS data.

The final sample size is reduced to 2414 observations because information on the wages for working women (419 observations), employment or marital status (227 observations), or the identifying variables used in the analysis (427 observations for participation identifier and 1255 observations for fertility identifier) are missing[9].

The variables used in the analysis are summarised in Table 2. The summary table indicates that the average number of children for the sample is 1.71. Table 2 also reports selected summary statistics from a sample drawn from the 1991 Labour Force Survey (LFS). LFS is used to check that the NCDS sample is representative of the general population. The sample is selected in such way that it can be compared to the NCDS sample used in the analysis. Due to relatively small sample sizes in the LFS when using only those born in 1958, I have instead used a five-year age band from the LFS. Hence the sample includes women aged 31-35, who are married or cohabiting.

[Table 2 about here]

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[6] The equations for the wages of women who do not work are omitted since they are not observed, however, the full model can be found in Fishe et al. (1981).

[7] An advantage of the data is that it looks at a cohort of women and is therefore exempt of cohort effects, see, for example, Blundell and Walker (1986) on the impact of cohort effects on female labour supply.

[8] I used the Chow test to examine the appropriateness of pooling. The null hypothesis of pooling cannot be rejected with a probability value of 0.161, hence concluding that pooling of the married and cohabiting women is appropriate.

[9] These variables are found to be missing at random hence not biasing the results.

The slight difference in the proportions of full-time and part-time workers and housewives is more likely to reflect the difference in the variable definitions between the datasets rather than any more serious bias. There are also problems with the fertility, number of children and the presence of pre-school age children variables when comparing the two datasets. The fertility rate and the number of children variables are at lower levels in the NCDS than in the LFS while the number of pre-school age children is higher in the NCDS. It is feasible that the women in the NCDS sample are further from their completed family size than the women in the LFS sample. However, since the discrepancy is not large, the sample is broadly representative of the population under study.

Table 3 summarises the economic status of women without any children, children older than five, or children less than five years of age. The cross-tabulation excludes the unemployed married (or partnered) women (48 observations). Only 1 in 6 married (or partnered) women have not entered motherhood by the age of 33. Table 3 clearly shows that the majority of women with no children are employed full-time. However, the presence of children seems to increase participation in part-time employment as opposed to full-time employment regardless of the age of the youngest child. Furthermore, 1 in 4 women with school-age children are housewives. This proportion jumps to over 50% when the children are pre-school age. Hence, according to this preliminary analysis, the presence of children has a clear effect on women's employment outcomes.

[Table 3 about here]

4 Model identification and results

4.1 Model identification

The impact of the presence of children on women's earnings is estimated using the model presented in Section 2. The advantage of this method is that it simultaneously accounts for the

selection into motherhood and selection into labour force participation thus correcting any bias resulting from individual heterogeneity and the endogeneity of fertility. Previous studies by Korenman and Neumark (1992) and Waldfogel (1995, 1997, 1998b) have relied on removing the individual heterogeneity with fixed effects, however, this relies on a strong identifying assumption that the unmeasured variable is fixed over time with a constant coefficient.

I also report an instrumental variable (IV) model (Model 2) using as instruments the same variables that are used as identifying variables in the selection model (Model 3). Furthermore, Model 1 presents estimates using Ordinary Least Squares (OLS). The main difference between Model 2 and Model 3 is the transformation of the predicted probabilities of participation. The appropriateness of both methods relies on the identifying ability of the exclusion variables. The exclusion variables need to identify: (1) the propensity to participate in the labour force and (2) the propensity to have entered motherhood by age 33. I will next explain the identifying variables used in the analysis and justify their appropriateness below.

Studies by Heckman and Willis (1977) and Shaw (1994) find that the majority of women tend to be either workers or non-workers during their lifecycle. Furthermore, Shaw (1994) states that this lifestyle persistence "results from heterogeneity in person-specific fixed or semi-fixed factors such as basic tastes for home-oriented versus career-oriented life style" (p.349). To account for the heterogeneity, Model 2 and Model 3 correct for self-selection into the labour force. Identification is obtained by using attitude to working as an instrument. This is a dichotomous variable indicating the labour force participation of the mother, which can be thought to influence daughter's attitudes towards working or intergenerational transmission of preferences in general[10]. The variable is coded 1 if the mother was working when the NCDS child was age 11, which is highly correlated with participation in the labour force at age 33

[10] Albrecht et al. (2000), using the International Social Survey Project, compare attitudes towards working mothers across countries and examine whether there is a link between the attitudes and actual experience. They find that for women working full-time, their own attitude does not affect the earnings; however, own attitude does

while not being correlated with wages at age 33. Simple cross-tabulation (not shown but results are available upon request from the author) reveals that 65% of those women whose mothers in 1970 had been at work since 1965 are working themselves. This proportion is only 60% for daughters whose mother was not working (the corresponding figures for part-time work at age 33 are 34% and 29%, respectively).

Models 2 and 3 also correct for the possible endogeneity of fertility and the identification strategy relies on the desired size of own family at age 16, which reflects the desired demand for children[11]. Graph 3 shows that the probability of having entered motherhood at age 33 is higher for those women for whom the desired demand for children was higher at age 16. Since I only have one identifying variable per equation, the commonly used over-identifying restrictions tests are unsuitable to test these identifying variables. However, the identifying variables have been tested using procedures proposed by Bound et al. (1994) and Cameron and Taber (2000)[12].

4.2 Results

Tables 4 and 5 present the results of the wage equations (Equation (1) and Equation (7) respectively) with alternative model specifications. The model specifications do not include tenure since previous research (see, for example, Korenman and Neumark (1992)) has found it to be endogenous[13]. Furthermore, I have not included work experience in the wage equations since the women are all the same age and hence the differences in actual work experience vary

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affect whether woman will participate in the labour force, hence one can use the attitude as an instrument to identify the probability of participation.

[11] This identification strategy may be criticised due to the belief that the life-time decisions regarding fertility and education are made at 16, however, the correlation between the identifying variable and years of education is negative as expected but not significant with a p-value of 0.9058.

[12] The former states that "partial R^2 and F statistic on the excluded instruments in the first stage regression are useful as rough guides to the quality of estimates" while the latter believes that "it is informative to examine the relationship between the excluded variables and the observables in the wage equation [whereas a lack of relationship] can lend some credence [to the use of the instruments]." The results of these tests are available on request from the author.

only by the level of education and the number of children, the latter of which may be endogenous. Additionally, this study does not account for the part-time wage penalty (see, for example, Joshi et al. (1999)) since part-time work is likely to be endogeneous. This omission may lead to an over-estimation of the "family gap". The endogeneity of part-time work status may result from (1) women preferring to spend more time with her offspring, especially when the children are young, and (2) difficulties in finding childcare or full-time employment.

The results of the ordinary least squares (OLS) specification treating fertility and participation as exogenous covariates are reported in the first and second columns of Table 4, for childless women and mothers respectively. As expected, the level of qualification has a significant positive relationship with hourly wages at age 33 for both women with children and childless women. Furthermore, the size of the workplace is a significant positive function of earnings while union membership is significant only for women with children.

[Table 4 about here]

The first column of Table 6 shows the wage differential between women with children and childless women not accounting for selection. The differential is calculated at both groups' mean characteristics and it suggests that women with children are faced with a 19% to 22% pay penalty compared to their childless counterparts. This is a substantial drop from the 40.5% raw wage differential observed between these two groups. These OLS results confirm the findings of previous research by Waldfogel (1995, 1998b), who finds an average wage penalty of 20% (for the 1995 study) and 22% (for the 1998b study), both of which use the NCDS with fixed effects estimation. However, since the OLS results are not corrected for the potential sources of bias resulting from endogeneity of fertility, individual heterogeneity and employment selectivity, they may not estimate the true effect of fertility on wages[14].

[13] It is worth noting that alternative tenure-inclusive model specifications were estimated but tenure was not found to be significant.
[14] A Durbin-Wu-Hausman test was performed to test endogeneity of fertility. The results indicate that OLS is not consistent. The test statistic is available from the author on request.

Model 2 and Model 3 in columns 1 through 4 of Table 5 estimate a wage equation, using an IV model and a double-selection model respectively, that correct for the potential sources of bias associated with unobservable characteristics. The results of the bivariate probit used in the first step of both models is presented in Appendix 1. This first-step equation controls for the qualification level, health, and region at age 16. They also include the identifying variables i.e. whether your mother worked when you were age 11 for the participation equation and the number of children wanted at age 16 for the fertility equation. Also, the correlation between the two first-step equations, $\sigma_{\varepsilon 1 \varepsilon 2,}$ is highly significant and negative indicating that separate probit equations in the first step would bias the results. Therefore, the Inverse Mills Ratios take the form shown in Equations (10) and (11).

Columns 3 and 4 in Table 5 show that qualifications, union status and workplace characteristics remain to have a similar effect on wages than in the previously estimated OLS specification. The qualification level and firm size variables give expected results, while the union status variable is significant for mothers only. The selection terms, or the Inverse Mills ratios, account for the correlated unobservable characteristics. By economic theory, these unobservables that explain participation should be positively correlated with wages. Hence, lambda for participation gives an estimate for the propensity to participate in the labour force accounting for the endogeneity of fertility. This is significant for women with children i.e. $F_i=1$ in Model 3. This result is supported by a similar finding of the IV model (Model 2), but in this case the coefficients of the instrumented participation are not of the expected sign. Nevertheless, these results seem to indicate that labour force participation of mothers is endogenous and especially that women with children are constrained in their employment.

The correction terms for fertility i.e. the propensity for childless women not to have children and the propensity for mothers to have children by age 33 are not significantly different from zero in either Model 2 or Model 3. Therefore rather than fertility being

endogenous, it is possible that the timing of the intertwined decisions to participate in the labour force and to enter motherhood that is endogeneous. Accounting for this endogeneity, Table 6 confirms that the "family gap" may have been previously over-estimated; the wage differential is estimated to fall to 17%-18% using IV estimation and even further to 10%-13% using the double-selection model, which is my preferred specification[15]. In other words, accounting for selection the "family gap" reduces by half. This result supports the finding of Harkness and Waldfogel (1999), however, it is significantly smaller than the "family gap" estimated by Waldfogel (1995), Waldfogel (1998b), or Joshi et al. (1999). Finally it should be noted that the "family gap" estimates might reduce further when accounting for part-time work status.

[Table 6 about here]

5 Conclusions

This paper has investigated the impact of children on women's wages in Britain. Since the prime years of fertility and career development coincide, the estimation method accounts for the simultaneity of both decisions. Furthermore, self-selection issues complicate the analysis and since the wages of women who abstain from working are non-observable, the econometric modelling has to account for the resulting bias.

This study has re-confirmed the earlier finding of heterogeneity between women who participate in the labour force and those who do not. Selection into employment is found to be significant and hence OLS results without correcting for selection are biased. Simultaneously correcting for the selection into employment and motherhood, children are not found to reduce the wages between women who have entered motherhood and childless women by as much as

[15] It should be noted that models that include terms for work experience still result in a wage differential between -5.9% and –10.7% using the double-selection model, while models further including a term for part-time work status leads to a differential between –6.8% and –13.5%. However, due to the potential endogeneity of experience and part-time work status terms they are excluded from the preferred specification.

previously estimated. However, although the "family gap" in wages reduces significantly when accounting for individual heterogeneity and the endogeneity of fertility, there still remains a 10% to 13% gap in pay between mothers and childless women in the UK. Further research should be undertaken to investigate the reasons for this discrepancy and especially whether it may be due to preferences not captured by this analysis, pure discrimination, or to policy related issues such as maternity leave and childcare legislation. It is of policy interest to examine whether maternity leave legislation and the availability or the price of childcare have an effect on the "family gap". However, this analysis cannot shed further light to answer these questions.

This study raises some interesting issues for further research. First, a method should be found to enable the inclusion of variables such as experience and part-time work status in the analysis, which are excluded from this analysis due to their potential endogeneity. Furthermore, the data used in the analysis does not allow the childcare dimension to be included in the analysis. Second, the measure of fertility used in this study is not ideal and instead it would be interesting to incorporate completed fertility or the timing of fertility in the model and consequently include women of all ages. Another data that would serve these purposes would also allow examining whether growth in earnings around childbirth is the cause for the "family gap".

References:

Albrecht, J.W., Edin, P.-A. and Vroman, S.B. (2000). "A Cross-Country Comparison of Attitudes Towards Mothers Working and Their Actual Labor Market Experience", *Labour*.

Becker, G.S. (1981). *A Treatise on the Family*. Cambridge: Harvard University Press.

--- (1985). "Human Capital, Effort, and the Sexual Division of Labor", *Journal of Labor Economics*, 3: S33-S58.

Blundell, R. and Walker, I. (1986). "A Life-Cycle Consistent Empirical Model of Family Labour Supply Using Cross-Sectional Data", *Review of Economic Studies*, 53(4): 539-558.

--- and Powell, J. (2003). "Endogeneoty in Nonparametric and Semiparametric Regression Models", in Dewatripont, M., Hansen, L. and Turnsovsky, S.J. (Eds.), *Advances in Economics and Econometrics*, Cambridge: Cambridge University Press.

Bound, J., Jaeger, D.A. and Baker, R.M. (1994). "Problems With Instrumental Variables Estimation When the Correlation Between the Instruments and the Endogenous Explanatory Variable Is Weak", *Journal of the American Statistical Association*, 90(430): 443-450.

Browning, M (1992). "Children and Household Economic Behavior", *Journal of Economic Literature*, XXX: 1434-1475.

Budig, M.J. and England, P. (2001). "The Wage Penalty for Motherhood", *American Sociological Review*, 66: 204-225.

Cameron, S. and Taber, C. (2000). "Borrowing Constraints and the Returns to Schooling", NBER Working Paper No. 7761.

Datta Gupta, N. and Smith, N. (2001). "Children and Career Interruptions: The Family Gap in Denmark", IZA Discussion Paper No. 263.

Fishe, R.P.H., Trost, R.P. and Lurie, P.H. (1981). "Labor Force Earnings and College Choice of Young Women: An Examination of Selectivity Bias and Comparative Advantage", *Economics of Education Review*, 1(2): 169-191.

Goldin, C. and Katz, L.F. (2000). "Career and Marriage in the Age of the Pill", *American Economic Review*, 90(2):461-465.

The Guardian (2001). "Lagging Behind in the Pregnant Pause", June 9.

Harkness, S. and Waldfogel, J. (1999). "The Family Pay Gap in Pay: Evidence from Eight Industrialized Countries", CASE Working Paper No. 29, Centre for Analysis of Social Exclusion, London School of Economics, London, England. Unpublished manuscript.

Heckman, J.J. and Willis, R.J. (1977). "A Beta-logistic Model for the Analysis of Sequential Labor Force Participation by Married Women", *Journal of Political Economy*, 85(1): 27-58.

Jacobsen, J. and Levin, L. (1995). "The Effects of Intermittent Labor Force Attachment on Female Earnings", *Monthly Labor Review*, 118: 14-19.

Joshi, H., Paci, P and Waldfogel, J. (1999). "The Wages of Motherhood: Better or Worse?", *Cambridge Journal of Economics*, 23: 543-564.

Korenman, S. and Neumark, D. (1992). "Marriage, Motherhood and Wages", *Journal of Human Resources*, 27(2): 233-255.

Maddala, G.S. (1983). *Limited-Dependent and Qualitative Variables in Econometrics*. Cambridge University Press, Cambridge.

Mason K.O. and Kuhlthau, K. (1992). "The Perceived Impact of Child Care Costs on Women's Labor Supply and Fertility", *Demography*, 29(4): 523-543.

Ruhm, C. (1998). "The Economic Consequences of Parental Leave Mandates: Lessons from Europe", *Quarterly Journal of Economics*, 113(1): 285-317.

Shaw, K. (1994). "The Persistence of Female Labor Supply: Empirical Evidence and Implications", *Journal of Human Resources*, 29(2): 348-378.

Sprague, A. (1988). "Post-War Fertility and Female Labour Force Participation Rates", *Economic Journal*, 98(392): 682-700.

Waldfogel, J. (1995). "The Price of Motherhood: Family Status and Women's Pay in a Young British Cohort", *Oxford Economic Papers*, 47: 584-610.

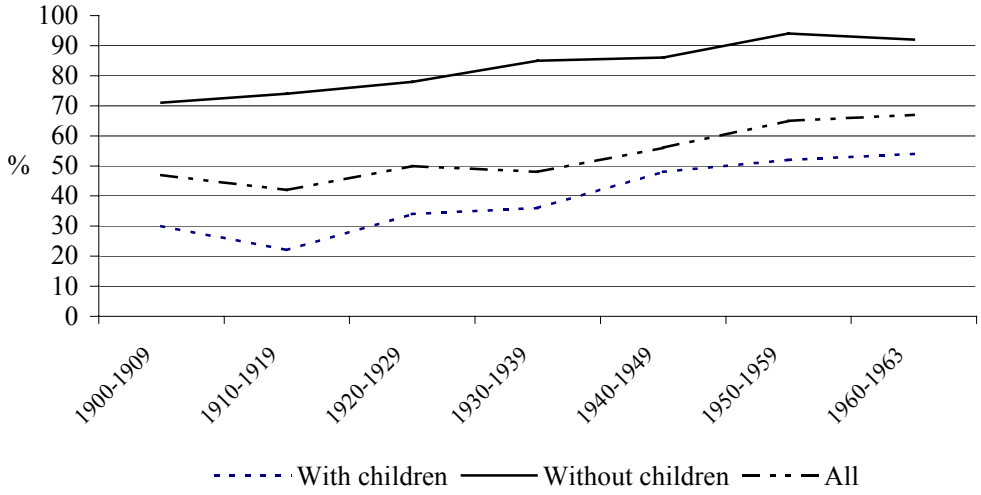
--- (1997). "The Effect of Children on Women's Wages", *American Sociological Review*, 62: 209-217.

--- (1998a). "Understanding the 'Family Gap' in Pay for Women with Children", *Journal of Economic Perspectives*, 12(1): 137-156.

--- (1998b). "The Family Gap for Young Women in the United States and Britain: Can Maternity Leave Make a Difference?", *Journal of Labor Economics*, 16: 505-545.

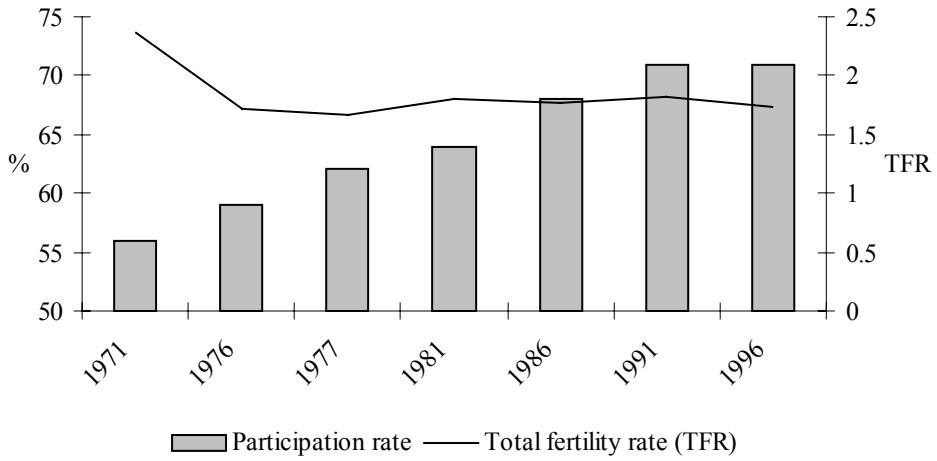
Wilson, R. and Green, A.E. (2001) "*Projections of Occupations and Qualifications: 2000/2001: Research in Support of the National Skills Taskforce*", Sheffield: Department for Education and Employment.

Graph 1: Labour force participation rate for women according to birth year and fertility



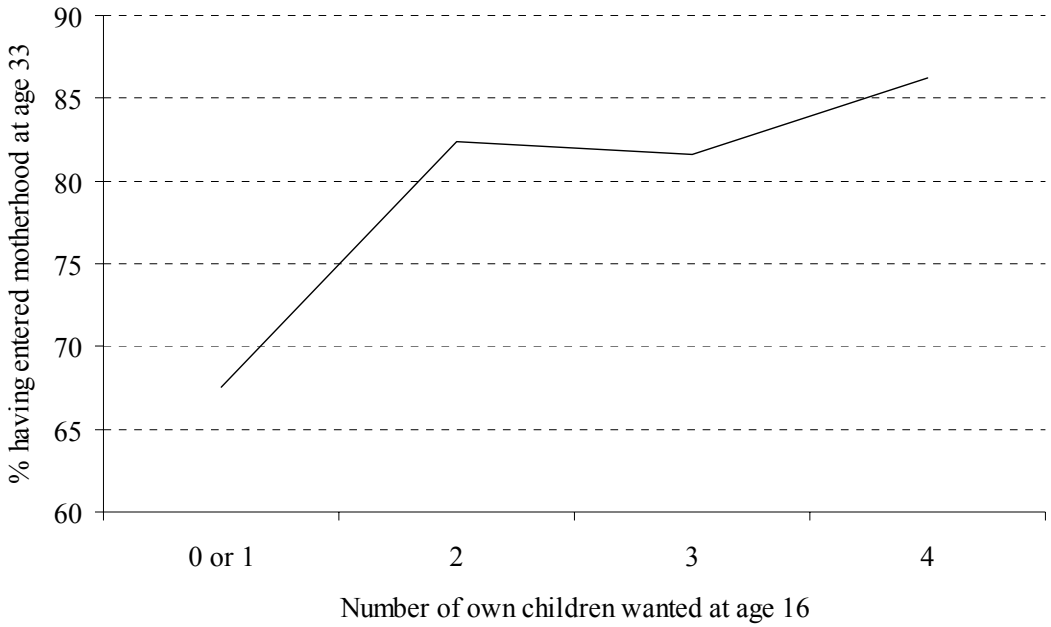
Source: Social Trends Dataset

Graph 2: Female labour force participation rate and total fertility rate



Note: Labour force participation rate for the UK.
Total fertility rate for England and Wales (seasonally adjusted).
Source: Social Trends Dataset

Graph 3 Appropriateness of the identifying variable for fertility



Note: Desired demand for 0 or 1 children at age 16 are combined due to small number of observations (40 and 28, respectively).
Source: NCDS

Table 1 Selected literature on the wage penalty of motherhood

Study	Data	Method	Results
Budig, M.J. and England, P. (2001)	1982-1993 NLSY	Fixed effects and OLS	Wage penalty 7% per child (5% controlling for work experience) Penalty larger for married than for unmarried women
Datta Gupta and Smith (2001)	1980-95 Danish panel	Fixed effects	Temporary negative effects
Hill, M.S. (1979)	1976 PSID	OLS	Wage penalty 6-7% per child Penalty disappears when controls included for tenure and work experience
Joshi, H. et al. (1999)	MRC and NCDS	Selection model	Wage penalty for motherhood 33% for both cohorts
Korenman, S. and Neumark, D. (1992)	1982 NLS-YW	OLS, first difference, fixed effects, and IV	Wage penalty 7% for one child and 22% for two or more children
Waldfogel, J. (1995)	NCDS	OLS, first differences, and fixed effects	Average wage penalty for motherhood 22%
Waldfogel, J. (1997)	1968-1988 NLS-YW	OLS, first differences and fixed effects	Wage penalty 4% for one child and 12% for two or more children controlling for work experience and part-time employment status
Waldfogel, J. (1998a)	1980 NLS-YW and 1991 NLSY	OLS	Wage penalty at age 30 17% in 1980 and 25% in 1991
Waldfogel, J. (1998b)	NLSY and NCDS	OLS, first differences, and fixed effects	Wage penalty 20% for US at age 30 and 20% for UK at age 33

NB. If one of above studies has more than one sample or method for which analysis is conducted, the results are reported from the one that most closely resembles the sample or method of this study.

Data abbreviations:

MRC	Medical Research Council's National Survey of Health and Development
NCDS	National Child Development Survey
NLSY	National Longitudinal Survey of Youth
NLS-YW	National Longitudinal Survey of Young Women
PSID	Panel Study of Income Dynamics

Table 2 Summary statistics (NCDS and LFS)

	All women			Working women		
	Mean	SE	95% CI (LFS)	Mean	SE	95% CI (LFS)
Full-time worker	0.3107	(0.4629)	[0.2843, 0.3111]	0.4928	(0.5001)	[0.4416, 0.4779]
Part-time worker	0.3198	(0.4665)	[0.3359, 0.3638]	0.5072	(0.5001)	[0.5221, 0.5584]
Housewife	0.3505	(0.4772)	[0.2485, 0.2742]	n/a	n/a	n/a
Fertility	0.8227	(0.3820)	[0.8231, 0.8449]	0.7444	(0.4363)	[0.7605, 0.7908]
Number of children	1.7129	(1.1098)	[1.7437, 1.8120]	1.4665	(1.0753)	[1.5046, 1.5842]
Presence of pre-school children	0.5994	(0.7254)	[0.4478, 0.4769]	0.4146	(0.6278)	[0.3520, 0.3871]
Years of education	12.1689	(0.0391)	[12.075, 12.2081]	12.2068	(0.0507)	[12.1203, 12.2854]
Bad health	0.1239	(0.3295)	-	0.1091	(0.3118)	-
Participation identifier	0.6205	(0.4854)	-	-	-	-
Fertility identifier	2.5365	(0.8795)	-	-	-	-
Log pay per hour	n/a	n/a	n/a	1.6161	(0.5413)	-
Union status	n/a	n/a	n/a	0.2786	(0.4484)	[0.31227, 0.3466]
Number of observations	2414		[4488]	1522		[2906]

Note: Standard errors in parentheses. The square brackets display a 95% confidence interval for similarly defined sample, using a five-year age band, from the 1991 Labour Force Survey (LFS).

Table 3 Economic status of women according to level of fertility, number of women

	Employed full-time	Employed part-time	Housewife	Total
Women with no offspring	352	37	25	414
Women with offspring older than 5	227	380	238	845
Women with offspring younger than 5	171	353	583	1107
Total	750	770	846	2366

Note: Table omits the category of unemployed women (48 observations)
Source: National Child Development Study (NCDS)

Table 4 Log hourly wages at 33, NCDS (females)

	Model 1			
	$F_i=0$		$F_i=1$	
O levels	0.1936 (0.0717)	***	0.1927 (0.0302)	***
Mid vocational	0.2552 (0.0744)	***	0.1969 (0.0312)	***
A levels	0.4125 (0.0663)	***	0.4724 (0.0334)	***
Degree	0.5910 (0.0660)	***	0.8508 (0.0606)	***
Medium firm (25-100)	0.1400 (0.0598)	**	0.0687 (0.0297)	**
Medium large (100-500)	0.1042 (0.0583)	*	0.1251 (0.0327)	***
Large (>500)	0.2114 (0.0637)	***	0.2470 (0.0403)	***
Union status	-0.0304 (0.0367)		0.1936 (0.0291)	***
Lambda: participation	n/a		n/a	
Lambda: fertility	n/a		n/a	
Constant	1.4125 (0.0783)	***	1.0809 (0.0379)	***
Observations	445		1317	
R^2/Pseudo R^2	0.18		0.33	

Note: Model 1 estimates OLS; specification includes regional dummies, and dummies for missing bad health and qualification variables.
Standard errors in parentheses.
Standard errors in Model 1 corrected for heteroscedasticity.
*, **, and *** denote significance at 10%, 5%, and 1% level respectively.

Table 5 Log hourly wages at 33, NCDS (females)

	Model 2				Model 3			
	$F_i=0$		$F_i=1$		$F_i=0$		$F_i=1$	
O levels	0.2442	**	0.1993	***	0.2458	**	0.1983	***
	(0.1132)		(0.0534)		(0.1162)		(0.0520)	
Mid vocational	0.3143	**	0.2396	***	0.3155	**	0.2387	***
	(0.1249)		(0.0540)		(0.1274)		(0.0530)	
A levels	0.5305	***	0.5613	***	0.5229	***	0.5587	***
	(0.1381)		(0.0780)		(0.1384)		(0.0764)	
Degree	0.7069	***	0.9099	***	0.7083	***	0.9011	***
	(0.1944)		(0.1057)		(0.1944)		(0.1097)	
Medium firm (25-100)	0.1527	**	0.0456		0.1531	**	0.0456	
	(0.0679)		(0.0350)		(0.0681)		(0.0350)	
Medium large (100-500)	0.0930		0.0929	**	0.0913		0.0929	***
	(0.0627)		(0.0362)		(0.0627)		(0.0361)	
Large (>500)	0.2132	***	0.2191	***	0.2134	***	0.2192	***
	(0.0728)		(0.0414)		(0.0728)		(0.0414)	
Union status	-0.0308		0.2131	***	-0.0313		0.2129	***
	(0.0407)		(0.0325)		(0.0407)		(0.0324)	
$\hat{P}$	-0.2579		-0.2602	*	n/a		n/a	
	(0.1935)		(0.1498)					
$\hat{F}$	0.0126		-0.0325		n/a		n/a	
	(0.1852)		(0.1056)					
Lambda: participation	n/a		n/a		0.7085		0.4112	*
					(0.5782)		(0.2304)	
Lambda: fertility	n/a		n/a		-0.1668		-0.0475	
					(0.2488)		(0.2067)	
Constant	1.4291	***	1.1692	***	0.9673	**	0.7748	***
	(0.2733)		(0.1586)		(0.4962)		(0.1760)	
Observations	389		1133		389		1133	
R^2/Pseudo R^2	0.14		0.32		0.14		0.32	

Note: Model 2 estimates an instrumental variable model; model 3 estimates a double-selection model; both are identified with the following variables: participation with variable "mother worked since age 11" and fertility with variable "size of own family wanted at age 16".
Specifications include regional dummies, and dummies for missing bad health, region and qualification variables.
Standard errors in parentheses.
Standard errors in model 2 and model 3 obtained by bootstrapping (1000 replications).
*, **, and *** denote significance at 10%, 5%, and 1% level respectively.

Table 6 Wage differentials between women with children and women without children

	Raw differential	OLS	IV	Double selection
$\overline{X}$ evaluated at *F=0*	-40.5%	-18.8%	-15.6%	-10.2%
$\overline{X}$ evaluated at *F=1*	-40.5%	-22.1%	-18.4%	-13.1%

Appendix 1: Determinants of participation and motherhood for Model 2 and Model 3 using a bivariate probit

	Coefficient	Standard Deviation	
Participation			
Participation identifier	0.1732	(0.0524)	***
O levels	0.1272	(0.0751)	*
Mid vocational	0.1778	(0.0788)	**
A levels	0.4055	(0.0834)	***
Degree	0.3809	(0.0989)	***
Bad health	-0.1726	(0.0794)	**
Constant	-0.0617	(0.1273)	
Fertility			
Fertility identifier	0.0915	(0.0335)	***
O levels	-0.3549	(0.0965)	***
Mid vocational	-0.3716	(0.0997)	***
A levels	-0.5174	(0.1009)	***
Degree	-0.8944	(0.1106)	***
Bad health	0.0902	(0.0992)	
Constant	1.0573	(0.1754)	***
Observations	2414		
$\sigma_{\varepsilon 1 \varepsilon 2}$	-0.5510	(0.0339)	***
Log likelihood	-2541.52		

Note: Model 2 estimates an instrumental variable model; model 3 estimates a double-selection model; both are identified with the following variables: participation with variable "mother worked since age 11" and fertility with variable "size of own family wanted at age 16".
Specifications include dummies for region at age 16, and dummies for missing bad health, region and qualification variables.
Standard errors in parentheses.
Standard errors in model 2 and model 3 obtained by bootstrapping (1000 replications).
*, **, and *** denote significance at 10%, 5%, and 1% level respectively.

Appendix 1: Construction of the Inverse Mills Ratios

The construction of the Inverse Mills ratios depends crucially on the significance of the covariance term $\sigma_{\varepsilon 1 \varepsilon 2}$. If $\sigma_{\varepsilon 1 \varepsilon 2}=0$, the inverse Mills ratio for participation is defined as:

$$M_{12} = \frac{-\phi(\gamma_1 Z_i)}{\Phi(\gamma_1 Z_i)} \quad ; \quad M_{34} = \frac{-\phi(\gamma_2 Z_i)}{\Phi(\gamma_2 Z_i)} \tag{A1}$$

and the inverse Mills ratios for fertility are defined as:

$$M_{21} = \frac{-\phi(\gamma_1 W_i)}{\Phi(\gamma_1 W_i)} \quad ; \quad M_{43} = \frac{\phi(\gamma_2 W_i)}{1-\Phi(\gamma_2 W_i)} \tag{A2}$$

where ϕ and Φ are, respectively, the density and cumulative distribution function of the Normal distribution. However, if $\sigma_{\varepsilon 1 \varepsilon 2} \neq 0$ the Inverse Mills ratios take a special form in order to correct the estimates for the correlation between the two selection equations:

$$\begin{aligned} M_{12} &= (1-\sigma^2_{\varepsilon_1\varepsilon_2})^{-1}\left[P_1 - \sigma_{\varepsilon_1\varepsilon_2} P_2\right] \\ M_{21} &= (1-\sigma^2_{\varepsilon_1\varepsilon_2})^{-1}\left[P_2 - \sigma_{\varepsilon_1\varepsilon_2} P_1\right] \\ M_{34} &= (1-\sigma^2_{\varepsilon_1\varepsilon_2})^{-1}\left[P_3 - \sigma_{\varepsilon_1\varepsilon_2} P_4\right] \\ M_{43} &= (1-\sigma^2_{\varepsilon_1\varepsilon_2})^{-1}\left[P_4 - \sigma_{\varepsilon_1\varepsilon_2} P_3\right] \end{aligned} \tag{A3}$$

where

$$\begin{aligned} P_1 &= \frac{\int_{-\infty}^{\gamma_2 W}\int_{-\infty}^{\gamma_1 Z} \varepsilon_1 \phi(\varepsilon_1\varepsilon_2)\, d\varepsilon_1 d\varepsilon_2}{\Phi(\gamma_1 Z, \gamma_2 W)} \\ P_2 &= \frac{\int_{-\infty}^{\gamma_1 Z}\int_{-\infty}^{\gamma_2 W} \varepsilon_2 \phi(\varepsilon_1\varepsilon_2)\, d\varepsilon_2 d\varepsilon_1}{\Phi(\gamma_1 Z, \gamma_2 W)} \\ P_3 &= \frac{\int_{-\infty}^{\gamma_2 W}\int_{\gamma_1 Z}^{\infty} \varepsilon_1 \phi(\varepsilon_1\varepsilon_2)\, d\varepsilon_1 d\varepsilon_2}{\Phi(-\gamma_1 Z, \gamma_2 W)} \\ P_4 &= \frac{\int_{\gamma_1 Z}^{\infty}\int_{-\infty}^{\gamma_2 W} \varepsilon_2 \phi(\varepsilon_1\varepsilon_2)\, d\varepsilon_2 d\varepsilon_1}{\Phi(-\gamma_1 Z, \gamma_2 W)} \end{aligned} \tag{A4}$$

where ϕ and Φ are defined above.