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THE IMPACT OF CHILDREN ON WAGES, JOB TENURE, AND THE DIVISION OF HOUSEHOLD LABOUR*

Daniel L. Millimet

In the absence of typical exclusion restrictions, covariance restrictions are used to obtain estimates of the effects of children on household behaviour. Using data from the PSID on two age samples, children are found to have a significant impact on many household decisions. However, while in the young sample exogenous fertility cannot be rejected, in the older sample this is not the case. Finally, if the average household had one less child, the male-female wage differential would decrease by 9.5%.

There has been enormous interest in learning the impact of children on various household behaviours, especially those of the mother. In particular, there has been much empirical research on the effect of fertility on female *allocation* and *value* of time (Angrist and Evans, 1998; Gronau 1988, 1977, 1976; Mroz, 1987; Rosenzweig and Wolpin, 1980; Fleischer and Rhodes, 1979; Cain and Dooley, 1976; Heckman, 1974; Gronau, 1973; etc.).[1] In either case, the inability to find appropriate instruments for fertility is troublesome. Fleischer and Rhodes (1979) conclude that their 'inability to represent the fertility variable with a suitable instrument is disappointing' and Willis (1987) wrote: '[I]t has proven difficult to find enough well-measured exogenous variables to permit cause and effect relationships to be extracted from correlations among factors such as the delay of marriage, decline of childbearing, growth of divorce, and increased female labour force participation.' Of related interest is the effect of fertility on market wages (Waldfogel, 1998; Hersch and Stratton, 1997; Korenman and Neumark, 1992; Hersch, 1991; Moore and Wilson, 1982; Hill, 1979; Cain and Dooley, 1976) and male behaviour (Browning, 1992; Pencavel, 1986).

Controlling for the endogeneity of fertility is likely to be vital in any model of household time allocation. Browning (1992) stated: 'Finally, labor supply and fertility may be jointly determined; either by ''basic economic principles'' or because in the population preferences for having children and for working at a job are negatively correlated.' Despite the theoretical claims, the empirical question of whether or not fertility is endogenous has yet to be answered conclusively. In particular, if there are household unobservables corresponding to gender preferences or equality within a household, relatively inegalitarian households may have higher fertility and the inegalitarian nature of the household may restrict the job opportunities 'available' for the woman to pursue or limit her income due to the energy requirements of household

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[1] *Fertility* is used interchangeably with *number of children*.

responsibilities (Hersch and Stratton, 1997; Hersch, 1991; Becker, 1985). In addition, these unobservables may impact the division of time within a household, as households with certain gender preferences, *ceteris paribus,* allocate more female time to the home and male time to the labour market.

The model presented in this paper jointly estimates time allocation, the value of non-market time, job tenure, and market wages for married couples conditional on completed fertility, and a reduced form equation for fertility. The estimation strategy relies on restrictions on the exact structure of the household error covariance matrix to identify the effect of children on various outcomes. This method was popularised by Chamberlain and Griliches (1975).[2]

The key to this identification technique is the joint estimation of many behaviours for multiple 'types' of people. However, there should be some unobserved commonalties in either the agents or behaviours to link the outcomes analysed. As a result, four outcomes are examined – market wages, value of non-market time, time spent doing housework, and job tenure – separately for husbands and wives. The model is estimated using married couples from the 1976 wave of the Panel Study of Income Dynamics (PSID).

Because placing exclusion restrictions on the correlation structure of the errors from the nine equations estimated is difficult to conceptualise, Section 1 provides an economic model of household behaviour which places a behavioural interpretation on the restrictions. In short, the theoretical basis for identification arises from the assumption of only a single source of correlated heterogeneity within the household. This source of correlation represents an aggregation of tastes, innate ability, motivation, gender equity within the household, etc. While the unobservable factor is permitted to have a differential effect on each of the outcomes analysed, as well as across spouses within each behaviour, this does impose some restrictions on behaviour.[3] Although other restrictions arise during the actual estimation of the model, the 'exclusion' restrictions generated by the factor structure are sufficient to obtain consistent estimates of the effects of children.

The remainder of the paper is organised as follows: Section 1 presents an economic model of household behaviour; Section 2 presents the econometric model; Section 3 discusses the data; Section 4 presents the results; and, Section 5 contains some concluding remarks.

1. Theoretical Model

Consider a static model of household behaviour, where each household is an independent economic agent maximising

[2] Refer to Bound *et al.* (1986), Rosenzweig and Wolpin (1994), and Pitt *et al.* (1998) for other applications.

[3] If one rejects the notion of unitary household preferences for a collective bargaining model (Chiappori, 1988; Apps and Rees, 1997), then the single unobserved factor is a weighted average of a husband unobservable and a wife unobservable. Estimating a model with only a single factor requires the ratio of the husband's unobservable to his wife's unobservables be constant across outcomes and equal to the bargaining weight.

$$U = U(l_m, l_f, n, q; \mathbf{Z}, \mu), \tag{1}$$

where l_i, $i = m, f$, is male and female leisure, n is the number of children, and q is the 'quality' of each child (assumed to be constant across children).[4] Preferences are allowed to vary across households based on observed characteristics of the household, **Z**, and unobserved (to the econometrician) characteristics, μ, which represents innate ability, motivation, and gender equality within the household.

Households maximise (1) subject to time, production, and budget constraints:

$$\overline{T} = l_i + h_i + L_i \quad i = m, f \tag{2}$$

$$q = q_k + \frac{1}{n^{\alpha}} q(h_m, h_f; \mathbf{Z}, \mu) \equiv q_k + q_h \quad \alpha \in (0, 1)$$

$$n(p_n + p_q q_k) = w_m L_m + w_f L_f + y,$$

where $\overline{T}$ is the total time endowment, q_k is quality per child purchased in the market at price p_q, $q(.)$ is the production function for home-produced total child quality which is assumed to satisfy the Inada conditions, h_i and L_i, $i = m, f$, are male and female home time and labour supply respectively, α reflects returns to scale in the production of q, q_h is home-produced per child quality, p_n is the price of market inputs required by children, and y is non-labour income.[5]

Firms are heterogeneous, profit-maximisers which equate the offered wage, w_i, to the value of the individual's marginal product. An individual locates a job and receives a wage commensurate with his or her marginal product which is assumed to be a function of children, n, non-labour income, y, an individual's characteristics, **Z** and μ, the price of the firm's output, p, and a mean zero term reflecting measurement error in the reporting of wages, ϵ^w:

$$w_i = \overline{w}_i(n, y, \mathbf{Z}, p, \mu, \epsilon^w).^6 \tag{3}$$

The motivation for including children in (3) is twofold. First, the physical requirements of childrearing may cause one to expend more energy at home, causing one's labour productivity to suffer. Second, the time requirements of children may also restrict one's flexibility in terms of the hours available to work, again lowering productivity, as an individual is unable to work overtime or travel, for example.

Once an individual decides on a job, hours, L_i^*, are chosen such that the benefit of foregoing a unit of non-market time is equal to the opportunity cost (i.e., the shadow wage) given by $\nu_i(L_i, n, y, p_n, p_q; \mathbf{Z}, \mu)$, which is increasing

[4] A static model is used to simplify exposition.
[5] The only benefit of home time is in the production of child quality.
[6] This is partially a technological relationship. Assume μ is observed by firms since, in the long-run, only firms which correctly infer μ will remain competitive. Other characteristics of the individual which may affect either productivity or job search behaviour also enter the wage equation.

in L given the concavity of the utility function and also depends on the number of children, non-labour income, other market prices, and the individual's characteristics. Obtaining L_i^* by equating ν_i and w_i – assuming market hours are perfectly flexible – yields the following conditional labour supply function for individual i:

$$L_i^* = \overline{L}_i(n,\ y,\ \mathbf{Z},\ p,\ p_n,\ p_q,\ \mu,\ \epsilon_i^v), \tag{4}$$

where ϵ^v is an error term with mean zero reflecting optimisation errors on the part of the individual or *unforeseen* rigidities in the ability to optimally set one's work hours.

If an individual is working, they may seek a new job offering a higher wage. Another job will pay a higher wage if the individual's skills are a better match and, therefore, his or her marginal product is higher. In addition, exiting the labour force to care for children or for other reasons is possible. From this, an individual's job tenure should depend on the current wage, w_i, the number of children, non-labour income, and a new stochastic element, ϵ^T, reflecting idiosyncratic shocks which may impact one's employment status such as an illness. Consequently, an individual's conditional job tenure is

$$T_i = \overline{T}_i[w_i(n,\ y,\ \mathbf{Z},\ p,\ \mu),\ n,\ y,\ \mathbf{Z},\ \mu,\ \epsilon_i^T] = \overline{T}_i(n,\ y,\ \mathbf{Z},\ p,\ \mu,\ \epsilon_i^T), \tag{5}$$

where ϵ^T is uncorrelated with the other stochastic elements of the model.[7]

Each household must also decide upon the desired number and quality of children. Conditional on the total quality demanded, the household must choose how much should be purchased in the market and how much should be produced at home and by whom. The price of market purchased quality is constant and given by p_q. The shadow price for home-produced quality by individual i is π_q^i. Given that market purchased and home-produced quality are substitutes, a household will produce child quality at home until π_q^m and π_q^f both equal p_q, at which point all remaining child quality is purchased through the market. Specifically, the shadow price of home-produced quality for each individual is given by

$$\pi_q^i = w_i \frac{n^{1-\alpha}}{q_{h_i}(h_m,\ h_f;\ \mathbf{Z},\ \mu)}, \tag{6}$$

where q_{h_i} is the marginal product of home time for individual i. Assuming $q(.)$, the home production function, satisfies the Inada conditions, initially $\pi_q^i < p_q$ for both adults. Given the diminishing marginal product of home time, $\partial\pi_q^i/\partial h_i > 0$, implying that π_q^i will eventually exceed p_q. While it is possible the household will demand a sufficiently small level of child quality that π_q^i will remain below the market price, this is typically unobserved in the United States. All children receive some form of market purchased quality, such as medical care or schooling. Consequently, each individual's conditional home time is

[7] The omission of ϵ^w is intentional, as it reflects solely measurement error.

$$h_i^* = \overline{h}_i[w_i(n, y, \mathbf{Z}, p, \mu), p_q, \epsilon_i^h] = \overline{h}_i(n, y, \mathbf{Z}, p, p_q, \mu, \epsilon_i^h), \tag{7}$$

where ϵ^h is a mean zero error term reflecting measurement error or errors in 'calculating' the appropriate shadow price of quality. Assuming the marginal product of individual i's home time is independent of the home time supplied by individual j, $\text{cov}(\epsilon_m^h, \epsilon_f^h) = 0$. This requires that the production function, $q(.)$, be additively separable in its arguments, although it may still be concave in each input.[8] In addition, $\text{cov}(\epsilon_i^v, \epsilon_i^h) = \text{cov}(\epsilon_i^v, \epsilon_j^h) = 0$, $i, j = m, f$, as conditional on w_m and w_f deviations from optimal labour supply will not affect the breakdown of child quality between market purchased and home-produced.

Finally, given the solutions to (4) and (7) by both adults, the reduced form demand for children, n^*, is

$$n^* = \overline{n}_i(y, \mathbf{Z}, p, p_n, p_q, \mu, \epsilon_m^h, \epsilon_f^h, \tilde{\epsilon}^n) = \overline{n}_i(y, \mathbf{Z}, p, p_n, p_q, \mu, \epsilon^n), \tag{8}$$

where ϵ^n is a mean zero error term capturing deviations from desired fertility. Because of the dependence of the shadow price of children on the quality of each child, ϵ_m^h and ϵ_f^h appear in (8). Therefore, $\text{cov}(\epsilon_i^h, \epsilon^n) \neq 0$. However, it is necessary to assume that the correlation between ϵ_m^h and ϵ^n and the correlation between ϵ_f^h and ϵ^n are equal. This implies that a shock to fertility (such as twins) affects male and female home time in the same direction, but not necessarily the same magnitude given differences in the relevant factor loadings.

2. Econometric Analysis

2.1. *The Model*

The model used to estimate the effect of completed fertility on market wages, the shadow value of time, and time allocation for both married men and women consists of the following system of conditional (on fertility) equations, as well as a reduced form for the number of children:

$$\begin{aligned}
W_{ih} &= \mathbf{X}_{ih}\boldsymbol{\beta}_w^i + \mathbf{Z}_h\boldsymbol{\gamma}_w^i && + N_h\psi_w^i + (\lambda_w^i\mu_h + \delta_w^i\epsilon_{ih}^w)\\
V_{ih} &= \mathbf{X}_{ih}\boldsymbol{\beta}_v^i + \mathbf{Z}_h\boldsymbol{\gamma}_v^i + \mathbf{X}_{i'h}\boldsymbol{\pi}^i + L_{ih}\theta^i && + N_h\psi_v^i + (\lambda_v^i\mu_h + \delta_v^i\epsilon_{ih}^v)\\
H_{ih} &= \mathbf{X}_{ih}\boldsymbol{\beta}_H^i + \mathbf{Z}_h\boldsymbol{\gamma}_H^i + \mathbf{X}_{i'h}\boldsymbol{\pi}_H^i && + N_h\psi_H^i + (\lambda_H^i\mu_h + \delta_H^i\epsilon_{ih}^H)\\
T_{ih} &= \mathbf{X}_{ih}\boldsymbol{\beta}_T^i + \mathbf{Z}_h\boldsymbol{\gamma}_T^i && + N_h\psi_T^i + (\lambda_T^i\mu_h + \delta_T^i\epsilon_{ih}^T)\\
N_h &= \mathbf{X}_h^m\mathbf{v}_1 + \mathbf{X}_h^f\mathbf{v}_2 + \mathbf{Z}_h\mathbf{v}_3 && + (\lambda_n\mu_h + \delta_n\epsilon_h^n),
\end{aligned} \tag{9}$$

where $i = m, f$ indexes male or female and h indexes households, W is the log hourly wage, $\mathbf{X}$, $\mathbf{Z}$ are exogenous regressors, V is the value of non-market time, H is home time, N is the number of children, T is tenure with current job, $\mathbf{X}_{i'}$ includes an individual's spouse's exogenous characteristics, L is time spent in the labour market, μ is a household random effect, and the ϵ's are

[8] In general, optimal home time conditional on fertility will depend on the price of children, p_n. This no longer holds if the production function is additively separable.

random shocks. The econometric specification is based on linear approximations to (3), (4), (5), and (7) separately for men and women, along with (8).[9] Explicitly, **X** includes education, experience, and union status and **Z** includes household variables such as non-labour income, race, and regional dummies.[10]

To estimate the model, given that the value of non-market time is unobserved (by the econometrician), assume that L can be adjusted such that the market wage is equal to the shadow value of time (Section 1; Heckman, 1974). Solving for L^* yields:

$$L^*_{ih} = \frac{1}{\theta^i}[\mathbf{X}_{ih}(\boldsymbol{\beta}^i_w - \boldsymbol{\beta}^i_v) + \mathbf{Z}_h(\boldsymbol{\gamma}^i_w - \boldsymbol{\gamma}^i_v) - \mathbf{X}_{i'h}\boldsymbol{\pi}^i + N_h(\psi^i_w - \psi^i_v)] + \frac{1}{\theta^i}[(\lambda^i_w - \lambda^i_v)\mu_h - \delta^i_v \epsilon^v_{ih}], \qquad (10)$$

where the final bracketed term is the new error.[11] Thus, estimation of the market and reservation wage equations yields estimates of the parameters from the labour supply equations as well.

2.1.1. *Identification*

Each household error covariance matrix contains 45 unique terms. The following cross-equation restrictions are imposed, where $i = m, f$, prior to calculating the number of parameters identified through the error covariance matrix:

- $\text{var}(\mu) = \text{var}(\epsilon^k) = 1, \qquad k = w, v, H, T$

which states that all errors are normalised to have unit variance as the variances cannot be separately identified from the factor loadings;

- $\text{cov}(\mu, \epsilon^k) = 0, \qquad k = w, v, H, T$

which indicates that the household unobservable is independent of the idiosyncratic shocks;

- $\text{cov}(\epsilon^k_i, \epsilon^{k'}_{i'}) = \begin{cases} 1 & i = i', k = k' \\ 0 & i = i', k \neq k' \\ 0 & i \neq i' \end{cases} \quad k = w, v, H, T$

which states that the idiosyncratic shocks in the four outcomes are uncorrelated; and,

[9] Estimating linear equations is another assumption, although one found in most studies relying on observable instruments for identification. Thus, even in the face of mis-specification, the model is useful for comparison to previous studies.

[10] Questions about race are only asked of the husband. In addition, assuming the household random effect, μ, is time invariant, experience cannot be exogenous. This is a shortcoming of many studies and is ignored (Korenman and Neumark, 1992).

[11] Since ϵ^w_i represents solely measurement error, it does not appear in (10).

- $\text{cov}(\epsilon^n, \epsilon_i^k) = \begin{cases} \tilde{\rho}_{nH} & k = H \\ 0 & \text{otherwise,} \end{cases}$

which indicates that the random component of the fertility equation is correlated with the idiosyncratic components of the male and female home time equations, but this correlation is constant across gender. In addition, all of the remaining idiosyncratic components are assumed to be uncorrelated with ϵ^n.

Given these restrictions, there are 23 parameters identified solely through the covariance matrix. The coefficients on fertility in the wage and tenure equations – ψ_k^m, ψ_k^f, $k = w$, T – are identified outside the covariance matrix since there are exclusion restrictions in the usual sense. Specifically, one's spouse's characteristics are valid instruments for the number of children as they do not affect one's own wage and job tenure conditional on completed fertility. However, counting up the number of parameters is a necessary, but not sufficient, condition for identification. For example, θ^m and θ^f are not identified; therefore, they are normalised to one, and the remaining parameters from the reservation wage equations are identified up to a scalar multiple.

2.1.2. *Maximum likelihood estimation*

Estimation is by maximum likelihood. The likelihood function is $f(\mathbf{W}, \mathbf{H}, \mathbf{L}, \mathbf{T}, N)$, where **W**, **H**, **L**, **T** are vectors of market wages, time allocations, and job tenure for both men and women within a household and N is the number of children in the household. Assuming the errors are normally distributed and the outcomes are continuous, the likelihood for a household is

$$ln\,\mathscr{L} = \frac{1}{2}\ln|\boldsymbol{\Omega}_h^{-1}| - \frac{1}{2}\epsilon'\boldsymbol{\Omega}_h^{-1}\epsilon - \frac{\overline{k}}{2}\ln(2\pi), \tag{11}$$

where ϵ is a vector of reduced form errors and $\overline{k}$ is the dimension of $\boldsymbol{\Omega}_h$, the error covariance matrix. If either member of the household does not work in the labour market, **W** will be unobserved for that individual and **L** will be truncated at zero. As a result, the labour supply equations must be estimated as tobits. In addition, if time spent working in the home is truncated at zero for any individuals, these must also be estimated as tobits. For censored observations in the data, the likelihood is appropriately altered and if **W** is unobserved, the dimension of $\boldsymbol{\Omega}_h$ is also adjusted. Thus, the actual likelihood maximised is more complicated than that given by (11).

3. Data

The data are from the 1976 wave of the PSID. The PSID provides information on a large number of households, and includes all of the relevant variables mentioned in Section 2.1 as well as separate questions for annual labour supply and home time. In addition, the 1976 wave provides survey responses directly from both the head of the household as well as the spouse, as opposed to permitting the head to respond for all members of the household.

Table 1 provides the summary statistics from the data set after splitting the sample into two age cohorts (discussed in Section 4). Households containing an individual who is self-employed, in the military, working in agriculture, in school, or permanently disabled are excluded. After dropping households with missing information, 860 households remained in the young sample; 467 in the older sample. In addition, only children under 18 years of age are included as older children most likely reside outside the home. Finally, except for the expected differences across samples due to the age difference (e.g., larger family size, more experience, higher job tenure, and more assets in the older households), the attributes do not diverge significantly. The younger sample is, however, better educated on average and men in the younger sample spend more time doing housework than the older cohort.

4. Results

The model presented in Section 2.1 is estimated separately for households where the wife is between the ages of 21 and 30 and between the ages of 35 and 49. The motivation behind dividing the sample is that younger couples are still in their reproductive years. In the older sample, however, the number of children is more likely to correspond to completed fertility.[12] Finally, within each sample, two versions of the model are estimated; one restricting the λ factor loadings to zero (imposing exogeneity) and one allowing the factor loadings to be non-zero.

Table 2 presents the results of Wald tests for the joint significance of the λ factor loadings for each sample. For both samples, one rejects the hypothesis that all 9 factor loadings are jointly zero ($\chi^2_9 = 1259.19$, p = 0.00 in the young sample and $\chi^2_9 = 233.77$, p = 0.00 in the older sample). As a result, the focus will be on the parameter estimates from the endogenous fertility model. However, testing if the λ parameters are non-zero is not the proper test for endogeneity; rather, one must test if the correlation coefficients are non-zero.[13] While these tests are discussed below, it should be noted that the λ factor loading in the fertility equation for the young sample is not significant ($\lambda_n = 0.057$, t = 0.322), while it is in the older sample ($\lambda_n = -0.732$, t = −4.110).

Tables 3–7 contain the results from the market and reservation wage, labour

[12] Couples where the wife is between 31 and 34 years of age are omitted to maintain a buffer between the two samples. Results from the younger sample appear robust to changing the upper age cutoff. In the older sample, while 35 may be young to assume fertility is completed, raising this age limit risks making the sample size too small.

[13] Children are endogenous if $\mathrm{Cov}(n, \tilde{\epsilon}_i^k) \neq 0$, $k = w, v, H, T$ and $i = m, f$, where $\tilde{\epsilon}$ is the compound error from each equation (i.e., $\tilde{\epsilon} = \lambda^i_k \mu + \delta^i_k \epsilon^k_i$). In the model, $\mathrm{Cov}(n, \tilde{\epsilon}^k_i) = \lambda_n \lambda^i_k + \delta^i_k \delta_n \mathrm{Cov}(\epsilon^n, \epsilon^k_i)$. Testing if this is non-zero is analogous to testing if $\rho_{nk} \neq 0$, as $\rho_{nk} = \mathrm{Cov}(n, \tilde{\epsilon}^k_i)/(\sigma^i_k \sigma_n)$, where σ^i_k and σ_n are the standard deviations of the appropriate errors.

Table 1

Summary Statistics: PSID, 1976

Variable	Young Cohort Obs	Mean	Std Dev	Min	Max	Older Cohort Obs	Mean	Std Dev	Min	Max
Number of children, age 0–17	860	1.45	1.25	0	7	467	2.30	1.70	0	10
Log market wage, males	849	1.55	0.44	−0.24	2.70	463	1.79	0.51	−1.02	3.28
Log market wage, females	609	1.15	0.63	−1.83	4.26	299	1.20	0.60	−1.83	3.12
Annual labour supply, males	860	2013.96	671.36	0	5096	467	2127.82	607.25	0	5742
Annual labour supply, females	860	906.48	823.59	0	3060	467	900.95	881.53	0	4284
Annual home time, males	860	346.20	421.59	0	4368	467	260.21	322.93	0	2080
Annual home time, females	860	1389.78	829.86	0	4368	467	1589.30	828.88	0	5200
Tenure in years, males	860	3.50	3.20	0	23	467	10.48	8.07	0	30
Tenure in years, females	860	1.41	2.16	0	12	467	2.73	4.15	0	25
Age, males	860	27.80	4.16	21	49	467	42.80	4.57	25	49
Age, females	860	25.35	2.76	21	30	467	40.92	4.07	35	49
Education in years, males	860	12.67	2.29	4	17	467	11.40	3.42	0	17
Education in years, females	860	12.36	2.28	0	17	467	11.72	2.57	0	17
Experience in years (full-time), males	860	7.90	4.50	0	30	467	22.52	5.67	3	31
Experience in years (full-time), females	860	3.55	2.79	0	12	467	8.55	6.76	0	30
Union, males (1 = yes)	860	0.31	0.46	0	1	467	0.36	0.48	0	1
Union, females (1 = yes)	860	0.07	0.25	0	1	467	0.09	0.29	0	1
Household non-labour income (1/100)	860	8.94	16.70	−20.00	125.55	467	27.57	45.41	−32.5	498
White (1 = yes)	860	0.66	0.47	0	1	467	0.65	0.48	0	1
Black (1 = yes)	860	0.30	0.46	0	1	467	0.29	0.45	0	1
Other race (1 = yes)	860	0.03	0.18	0	1	467	0.06	0.25	0	1
Reside in northeast (1 = yes)	860	0.17	0.37	0	1	467	0.19	0.39	0	1
Reside in north-central (1 = yes)	860	0.27	0.44	0	1	467	0.25	0.43	0	1
Reside in south (1 = yes)	860	0.42	0.49	0	1	467	0.41	0.49	0	1
Reside in other region (1 = yes)	860	0.14	0.34	0	1	467	0.15	0.36	0	1

Table 2

Wald Tests for Joint Significance of the Factor Loadings on the Household Unobservable μ

Dependent Variable	Ages 21–30 Male	Ages 21–30 Female	Ages 21–30 Both genders	Ages 35–49 Male	Ages 35–49 Female	Ages 35–49 Both genders
Wages	0.98	48.76	50.23	119.59	3.13	122.45
	(p = 0.32)	(p = 0.00)	(p = 0.00)	(p = 0.00)	(p = 0.08)	(p = 0.00)
Value of non-market time	0.40	138.08	144.28	28.13	12.94	36.16
	(p = 0.53)	(p = 0.00)	(p = 0.00)	(p = 0.00)	(p = 0.00)	(p = 0.00)
Home time	0.57	25.26	36.39	1.23	5.23	5.37
	(p = 0.45)	(p = 0.00)	(p = 0.00)	(p = 0.27)	(p = 0.02)	(p = 0.07)
Tenure	4.36	875.40	882.41	20.54	2.44	21.59
	(p = 0.04)	(p = 0.00)	(p = 0.00)	(p = 0.00)	(p = 0.12)	(p = 0.00)
All 4 dependent variables	13.31	1151.40	1259.19†	140.73	19.08	232.77†
	(p = 0.01)	(p = 0.00)	(p = 0.00)	(p = 0.00)	(p = 0.00)	(p = 0.00)

† Also includes the λ factor loading from the fertility equation.

supply, home time, and tenure equations for males and females in both samples. Each table contains the estimate for the effect of children, the λ factor loading from the particular equation, the ratio of the λ factor loading from the particular equation to λ_n, the factor loading from the fertility equation, as well as the correlation coefficient between the error in the particular equation and the error in the fertility equation. While the other parameters are self-explanatory, the ratio of the λ factor loadings (i.e., λ_k^i/λ_n, $k = w, v, H, T$; $i = m, f$) gives the change in the particular behaviour if the unobservable μ were to change by the magnitude required to induce the household to have one more child.

4.1. *Young Sample*

A few interesting results emerge from the young sample (refer to Tables 3–7). First, as stated previously, λ_n, the factor loading in the fertility equation, is not significant. Consequently, none of the correlation coefficients between the errors in the outcome equations and the fertility equation are significant; thus, exogeneity *cannot* be rejected in any equation for either gender. In addition, the effects of children are of the usual sign and magnitude. For women, children decrease labour supply and increase home time; there is no impact on market wages or tenure. For husbands, children decrease labour supply, but the effect is of smaller magnitude than the effect on women. Again, there is no impact on market wages and tenure. Finally, as λ_n is not significant, changing μ to induce the household to demand another child has no effect on the outcomes.

4.2. *Older Sample*

The results in the older cohort differ considerably from those in the young cohort. Table 3 reports the results from the market wage equation. In the endogenous fertility model, children have a significant, positive effect on male wages and no effect on female wages. In addition, one rejects the hypothesis that fertility is exogenous in the male wage equation ($\rho^m_{nw} = -0.494$, t = -4.179), but not in the female equation ($\rho^f_{nw} = -0.077$, t = -1.581). Finally, allowing for this endogeneity significantly alters the estimates obtained. For both males and females, treating fertility as exogenous biases the estimates down.

The fact that children have no effect on female wages is contrary to much of the literature which predicts a negative effect of children on female wages (Waldfogel, 1998; Hersch and Stratton, 1997; Hersch, 1991; Becker, 1985). However, the positive effect on male wages may be reconciled if men with many children are more likely to have non-working wives and, therefore, the wife performs the majority of household tasks, freeing up the husband to devote more energy to work. In addition, firms may assume men with children are more reliable and are less likely to relocate. Even if firms make a similar assumption about women, this positive effect may be outweighed by the negative effect of children in terms of energy and flexibility. Finally, the wage equations do not condition on tenure. As discussed below, fertility increases male job tenure and lowers female tenure. Thus, children may be capturing the positive effect of tenure on wages. Regardless, the implications are still consistent with the underlying hypothesis; namely, children adversely affect women in the labour market *relative* to men.

Changing unobservable household attributes such that the household has one more child significantly lowers both the husband's and wife's market earnings ($\lambda^m_w/\lambda_n = -0.631$, t = -3.159; $\lambda^f_w/\lambda_n = -0.113$, t = -1.733). Note the opposite result one obtains for men in the older sample from the following

Table 3

Effect of Fertility on Male and Female Wages by Cohort†

	Ages 21–30				Ages 35–49			
	Exogenous fertility		Endogenous fertility		Exogenous fertility		Endogenous fertility	
Covariate	Male	Female	Male	Female	Male	Female	Male	Female
Fertility	0.009	−0.049	0.008	−0.051	−0.014	−0.047	0.123	−0.020
	(0.646)	(−1.308)	(0.540)	(−1.522)	(−1.059)	(−1.894)	(2.501)	(−0.682)
λ_w			0.015	−0.165			0.462	0.082
			(0.990)	(−6.983)			(10.936)	(1.770)
λ_w/λ_n			0.256	−2.881			−0.631	−0.113
			(0.193)	(−0.321)			(−3.159)	(−1.733)
ρ^i_{nw}			0.002	−0.015			−0.494	−0.077
			(0.275)	(−0.325)			(−4.179)	(−1.581)

† Asymptotic t-ratios in parentheses. t-ratios for ρ and λ_w/λ_n computed by the delta method.

two thought experiments: (i) What is the impact of another child on market wages *conditional* on the household unobservable μ? and (ii) What is the impact of a change in the common household unobservable μ associated with having one more child *conditional* on the number of children? Another child (conditional on μ) raises the husband's market earnings by 12.3%, while changing the household unobservable in order to induce the household to have one more child lowers the husband's market earnings by over 63%. Thus, while the presence of children, *ceteris paribus*, in the household may be advantageous in terms of male market earnings, unobserved attributes of the household associated with larger family sizes are detrimental to the husband's market wage.

Table 4 reports the results from the value of non-market time equation. Children have a significant, positive effect on the value of non-market time for both husbands and wives (again at the 10% level of significance for males). In addition, one rejects the exogeneity of fertility in both the male and female equations ($\rho^m_{nv} = -0.215$, t = −3.045; $\rho^f_{nv} = -0.105$, t = −2.509). Finally, the point estimates differ significantly from those obtained imposing exogeneity. The effect of children on male value of non-market time changes sign and becomes significant and the point estimate of the effect of children on the value of non-market time by females, while significant in both models, nearly doubles when endogeneity is properly handled. Shifting the household unobservable such that the household would have another child lowers the value of non-market time for both the husband and the wife ($\lambda^m_w/\lambda_n = -1.046$, t = −4.528; $\lambda^f_w/\lambda_n = -0.850$, t = −3.100). Thus, while another child (conditional on the unobserved attributes of the household) increases the shadow value of time, a change in unobserved characteristics such that the household would opt to have another child decreases the value of non-market time for both parents.

Table 5 reports the results from the male and female labour supply equa-

Table 4

Effect of Fertility on Male and Female Value of Non-Market Time by Cohort†

	Ages 21–30				Ages 35–49			
	Exogenous fertility		Endogenous fertility		Exogenous fertility		Endogenous fertility	
Covariate	Male	Female	Male	Female	Male	Female	Male	Female
Fertility‡	0.126	0.705	0.128	0.647	−0.068	0.222	0.169	0.425
	(1.906)	(8.096)	(1.903)	(5.198)	(−1.044)	(1.981)	(1.686)	(3.075)
λ_v‡			−0.044	0.831			0.766	0.622
			(−0.635)	(11.751)			(5.303)	(3.598)
λ_v/λ_n‡			−0.768	14.493			−1.046	−0.850
			(−0.261)	(0.323)			(−4.528)	(−3.100)
ρ^i_{nv}			−0.001	0.019			−0.215	−0.105
			(−0.310)	(0.322)			(−3.045)	(−2.509)

† Asymptotic t-ratios in parentheses. t-ratios for ρ and λ_v/λ_n computed by the delta method.
‡ Coefficients are scaled by $1/\theta^i$, $i = m, f$.

Table 5

Effect of Fertility on Male and Female Labour Supply by Cohort†

	Ages 21–30				Ages 35–49			
	Exogenous fertility		Endogenous fertility		Exogenous fertility		Endogenous fertility	
Covariate	Male	Female	Male	Female	Male	Female	Male	Female
Fertility	−0.117	−0.754	−0.120	−0.698	0.054	−0.269	−0.046	−0.445
	(−1.913)	(−8.290)	(−1.945)	(−5.046)	(0.851)	(−2.393)	(−0.617)	(−3.265)
λ_L			0.059	−0.997			−0.304	−0.540
			(0.918)	(−14.540)			(−2.183)	(−3.066)
λ_L/λ_n			1.025	−17.374			0.415	0.737
			(0.918)	(−5.006)			(2.183)	(3.043)
ρ^i_{nL}			0.001	−0.029			0.020	0.075
			(0.001)	(−0.174)			(0.374)	(1.790)

† Asymptotic t-ratios in parentheses. All t-ratios for ρ and λ_L/λ_n computed by the delta method.

tion. The estimates of the effect of children, as well as the λ factor loadings, were obtained by estimating (10).[14] Children have a significant, negative effect on female labour supply, but no effect on male hours of work. In addition, exogenous fertility is rejected for the female equation ($\rho^f_{nL} = 0.075$, t = 1.790) at the 10% level of significance, but cannot be rejected for the male equation ($\rho^m_{nL} = 0.020$, t = 0.374). Finally, failure to account for endogenous fertility in the female labour supply equation leads one to *understate* the impact of children by approximately 65%. This is in contrast to many studies on children and female supply which tend to find that OLS estimates overstate the effect of children.[15]

As for the changes in the household unobservable, shifting μ to induce the household to have one more child has the opposite impact as exogenous changes in fertility (conditional on unobservable attributes). Specifically, changing the unobservable attributes of the household to increase the number of children by one would significantly increase the labour supply of both parents ($\lambda^m_w/\lambda_n = 0.415$, t = 2.183; $\lambda^f_w/\lambda_n = 0.737$, t = 3.043). Thus, while the presence of children in the household lower the hours of work by both parents, unobservable attributes which are associated with larger family size increase the labour supply of the parents as these attributes are associated with a lower opportunity cost of time.

Table 6 shows the results from the male and female home time equations. Children significantly increase female time spent in the home and have no effect on male home time. Exogeneity is rejected in both equations

[14] From (10), the parameters from the wage and value of time equations are mapped into the parameters from the labour supply equation. The standard errors are obtained via the delta method.

[15] Rosenzweig and Wolpin (1980) also find their estimate imposing exogeneity to be biased up (in absolute value).

Table 6

Effect of Fertility on Male and Female Home Time by Cohort†

	Ages 21–30				Ages 35–49			
	Exogenous fertility		Endogenous fertility		Exogenous fertility		Endogenous fertility	
Covariate	Male	Female	Male	Female	Male	Female	Male	Female
Fertility	0.049	0.639	0.051	0.619	−0.055	0.293	0.149	0.769
	(1.096)	(7.909)	(0.221)	(1.734)	(−1.499)	(4.033)	(1.560)	(3.791)
λ_H			−0.038	0.374			0.108	0.444
			(−0.753)	(5.026)			(1.109)	(2.288)
λ_H/λ_n			−0.667	6.527			−0.148	−0.606
			(−0.217)	(0.333)			(−0.278)	(−2.781)
ρ^i_{nH}			−0.046	0.085			−0.268	−0.315
			(−0.014)	(0.185)			(−2.113)	(−2.570)

† Asymptotic t-ratios in parentheses. t-ratios for ρ and λ_H/λ_n computed by the delta method.

($\rho^m_{nH} = -0.268$, t = −2.113; $\rho^f_{nH} = -0.315$, t = −2.570).[16] For females, failure to control for this endogeneity leads one to *underestimate* the effect of children on home time by over 160%. For males, the point estimate changes sign across the two models, but is not significant in either. Finally, changes in the household's unobserved attributes such that the couple would demand another child significantly lowers the home time of the mother, but has no impact on the father ($\lambda^m_w/\lambda_n = -0.148$, t = −0.278; $\lambda^f_w/\lambda_n = -0.606$, t = −2.781). Again, this impact is the opposite of changes in family size.

Table 7 presents the results from the job tenure equations. Children have a significant, negative effect on female job tenure and significantly increase male tenure (at the 10% level). In addition, one rejects exogenous fertility in the male tenure equation ($\rho^m_{nT} = -0.119$, t = −2.845), but not in the female tenure equation ($\rho^f_{nT} = 0.046$, t = 1.452). Failure to account for this endogeneity in the male equation dramatically alters the results; from negative and insignificant to positive and significant.

The positive effect of children on male job tenure is consistent with the explanation that children limit one's geographic mobility. The negative effect on female job tenure is most likely attributable to previous periods outside the labour force during and after pregnancy. Finally, while having another child (conditional on the household's unobservable characteristics) makes it more likely that the father will retain his current job, a shift in the unobservables associated with the household having another child significantly lowers his job stability, dropping average tenure by nearly 2.5 years. There is no significant effect from this change on female tenure ($\lambda^m_w/\lambda_n = -2.444$, t = −4.110; $\lambda^f_w/\lambda_n = 0.454$, t = 1.488).

[16] In the home equations, the correlation coefficient reflects not only correlation through the common unobservable μ, but also correlation among the idiosyncratic shocks. In the older sample, $\mathrm{corr}(\epsilon^m_H, \epsilon_n) = \mathrm{corr}(\epsilon^f_H, \epsilon_n) = -0.254$ (t = −2.828); in the young sample, $\mathrm{corr}(\epsilon^m_H, \epsilon_n) = \mathrm{corr}(\epsilon^f_H, \epsilon_n) = -0.000$ (t = −0.000), where the equality across gender is a restriction imposed.

Table 7

Effect of Fertility on Male and Female Job Tenure by Cohort†

	Ages 21–30				Ages 35–49			
	Exogenous fertility		Endogenous fertility		Exogenous fertility		Endogenous fertility	
Covariate	Male	Female	Male	Female	Male	Female	Male	Female
Fertility	−0.004	−0.093	0.013	−0.014	−0.051	−0.247	0.472	−0.356
	(−0.038)	(−1.885)	(0.050)	(−0.051)	(−0.264)	(−2.273)	(1.645)	(−2.797)
λ_T			−0.244	−1.843			1.789	−0.332
			(−2.087)	(−29.587)			(4.532)	(−1.561)
λ_T/λ_n			−4.245	−32.125			−2.444	0.454
			(−0.322)	(−0.323)			(−4.110)	(1.488)
ρ^i_{nT}			−0.005	−0.054			−0.119	0.046
			(−0.325)	(−0.323)			(−2.845)	(1.452)

† Asymptotic t-ratios in parentheses. t-ratios for ρ and λ_T/λ_n computed by the delta method.

4.3. *Implications and Comparison Across Gender and Cohort*

The most noticeable difference across the two samples is the failure to reject exogenous fertility in the young sample. As stated previously, fertility in the younger sample is not likely to reflect completed fertility for many households. The contrast in results may therefore indicate that the timing of early childbirth is exogenous, although completed fertility is not. In addition, it could signal that the majority of households have at least one child (so that this decision is exogenous with respect to the other behaviours analysed), but the decision to have more than two children is endogenous and this decision is not observed until fertility is completed. Finally, the difference may simply be attributable to cohort effects.

Table 8 provides a summary of the predicted effects of the two thought experiments discussed previously; the effect of the average household having one less child conditional on the household's unobservable and observable attributes and the effect of a change in the household's unobservable attributes such that the household would have one less child conditional on the number of children (and other observable characteristics). The two most interesting results are, first, that changes in the number of children and changes in the unobservables which lead a household to desire children have the opposite effect in the older sample. For example, while decreasing the actual number of children in the household, *ceteris paribus*, closes the male – female wage differential, changes in the unobservable attributes of households such that the household desires fewer children significantly widens the wage gap. The second important result is that if the average couple in the older sample has one less child, the male-female wage gap would fall by 9.5%. The gap would also fall in the young sample, although this is not statistically significant.

Table 9 presents the Wald test results for the joint significance of fertility for both samples. In the younger cohort, children are significant determinants of

Table 8

Predicted Effects of Changes in the Number of Children and Household Unobservable Characteristics

	Ages 21–30†		Ages 35–49			
	Effect of one less child		Effect of one less child		Effect of change in household unobservable such that household has one less child	
Outcome	Male	Female	Male	Female	Male	Female
Wages ($/hr)	−0.1%	−5.1%	−12.3%	+2.0%	+63.1%	+11.3%
Labour supply (hrs/yr)	+44	+255	+17	+162	−151	−269
Home time (hrs/yr)	−19	−226	−54	−281	+54	+221
Leisure (hrs/yr)	−25	−29	+37	+119	+97	+48
Job tenure (yrs)	0	0	−0.5	+0.4	+2.4	−0.5
%Δ Male – Female Wage differential	−4.3%		−9.5%		+18.5%	

† Changes in the unobservable are omitted since the factor loading on the household unobservable is insignificant in the younger sample; as a result, predicted effects are unreasonably large, yet not significant.

Table 9

Wald Tests for Joint Significance of Fertility by Cohort

	Ages 21–30			Ages 35–49		
Dependent Variable	Male	Female	Both genders	Male	Female	Both genders
Wages	0.29	2.32	3.02	6.25	0.47	8.52
	(p = 0.59)	(p = 0.13)	(p = 0.22)	(p = 0.01)	(p = 0.50)	(p = 0.01)
Value of non-market time	3.62	27.02	35.23	2.84	9.45	9.79
	(p = 0.06)	(p = 0.00)	(p = 0.00)	(p = 0.09)	(p = 0.00)	(p = 0.01)
Home time	0.05	3.01	31.31	2.43	14.37	19.92
	(p = 0.82)	(p = 0.08)	(p = 0.00)	(p = 0.12)	(p = 0.00)	(p = 0.00)
Tenure	0.00	0.00	0.05	2.71	7.83	9.25
	(p = 0.96)	(p = 0.96)	(p = 0.98)	(p = 0.10)	(p = 0.01)	(p = 0.01)
All 4 dependent variables	4.36	90.98	116.26	8.56	25.42	30.33
	(p = 0.36)	(p = 0.00)	(p = 0.00)	(p = 0.07)	(p = 0.00)	(p = 0.00)

all four outcomes examined for both males and females ($\chi^2_8 = 116.26$, $p = 0.00$). This result is primarily driven, however, by the significant impact on females ($\chi^2_4 = 90.98$, $p = 0.00$). Examining the effects of children solely on male behaviour, one cannot reject the hypothesis of no children effects ($\chi^2_4 = 4.36$, $p = 0.36$). In the older cohort, not only are children a significant determinant of all four outcomes for both males and females ($\chi^2_8 = 30.33$, $p = 0.00$), but fertility also has significant impacts on the behaviours separately tested for each gender ($\chi_4^2 = 25.42$, $p = 0.00$ for females and $\chi_4^2 = 8.56$, $p = 0.07$ for males). Finally, testing for effects of children on each outcome individually for either gender, one rejects the hypothesis of no fertility effects for each of the four behaviours ($\chi_2^2 = 8.52$, $p = 0.01$ for wages; $\chi_2^2 = 9.79$, $p = 0.01$ for the value of non-market time; $\chi_2^2 = 19.92$, $p = 0.00$ for home time; and, $\chi_2^2 = 9.25$, $p = 0.01$ for job tenure).

Finally, Table 10 presents results from Wald tests for the equality of children effects across gender within each cohort. Equal effects are rejected for each outcome except job tenure in the young sample.

5. Conclusion

The effect of children on female labour supply, and to a lesser extent other time allocations, market and shadow wages, and male behaviour, has been the subject of much empirical research. An unresolved issue continues to be whether fertility is jointly determined with these other household outcomes, and, if so, how this should be treated empirically. Although numerous instruments have been utilised, no consensus has been reached about the validity of these exclusion restrictions or the conclusions they yield.

This paper offers a new approach to this problem. In the absence of observable exclusion restrictions, identification of the impact of children on market wages, the value of non-market time, time allocation, and job tenure of males and females is achieved by simultaneously estimating these outcomes for married couples using the 1976 wave of the PSID and placing restrictions on the error covariance matrix. The restrictions needed to identify the model are interpreted in a theoretical model of household behaviour. Identification arises (in part) from the assumption that all correlated heterogeneity within a household is captured by a single unobservable.

The results are interesting. In a sample of younger households, where the wife is between 21 and 30 years of age, there is no evidence of endogenous

Table 10
Wald Tests for Equality of Fertility Effects Across Gender by Cohort

Dependent variable	Ages 21–30	Ages 35–49
Wages	3.00	8.49
	($p = 0.08$)	($p = 0.00$)
Value of non-market time	11.73	3.49
	($p = 0.00$)	($p = 0.06$)
Home time	14.48	19.60
	($p = 0.00$)	($p = 0.00$)
Tenure	0.05	6.19
	($p = 0.83$)	($p = 0.01$)
All 4 dependent variables	17.98	25.04
	($p = 0.00$)	($p = 0.00$)

fertility. In addition, children are found to have the expected effects of increasing female home time and decreasing female labour supply, as well as a negative effect on male hours of work, but children have no significant impact on the remaining behaviours examined. In a sample of older households, where the wife is between the ages of 35 and 49, there is significant evidence of endogenous fertility for all of the outcomes examined. In addition, besides the usual effects of children on female labour supply and home time, children are also found to affect male wages significantly as well as job tenure for both men and women in such a way that if the average household had one less child, the male-female wage differential would close by 9.5%. Finally, throughout the older sample, the results are significantly different if endogenous fertility is ignored. However, the bias found when imposing exogeneity *a priori* is of the opposite direction found by most studies relying on typical instruments.

Southern Methodist University

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