From the Labour Supply of Married Women

To Nash-Bargained Household Behaviour:

An Econometric Overview

Working Paper

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4 December 2002

Abstract - From the Labour Supply of Married Women

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Married women have progressed greatly in the labour market over the past 30 years. In the same time frame, economic theory has been progressively advancing to fill a rising need for the modelling of household behaviour. In this paper, I will show that the choice of econometric model results in vastly different estimates of wage, income, and other effect elasticities, critically evaluating the pros and cons of each.

The data on non-labour income was decomposed into three parts: transfer income; asset income derived from rents, interests, dividends, trust funds, alimony, or royalties; and the asset part of income from activities such as business, market gardening, or roomers/boarders. The results suggest that spurious correlation with the number of hours worked of this latter asset part of income may be responsible for wrong signed income effects in regressions using aggregated measures of asset income or non-labour income.

In the Nash-bargained game of household distribution, both parties have separate preferences or utility functions. Distribution within the family is also affected by the opportunity cost of marriage for each party. The income pooling hypothesis has been rejected in this paper and the Nash-bargained game empirically modelled with supporting evidence.

The results strongly support the use of the simultaneous equations approach, according more flexibility in the modelling and hypothesis testing of household behaviour. Interesting results obtained from such an approach include the positive effect on the husband's bargaining power within the family with increased housework contribution, and higher net family welfare with increased participation in the labour force of the wife.

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1. Introduction

Married women have progressed greatly in the labour market over the past 30 years. In the same time frame, economic theory has been progressively advancing to fill a rising need for the modelling of household behaviour. A key research area is the study of the labour supply of married men and women. Chaykowski and Powell (1999) summarize key empirical findings existing in the literature today. For example, the presence of children (especially of pre-school age) has been found to have a significant negative effect on the labour supply of married women. Higher levels of unearned income (such as the husband's income) reduce both the probability of labour force participation and the hours of work of those employed. Also, labour force participation decisions appear to have been affected greatly by childcare costs. Chaykowski and Powell (1999) also cite Hum and Simpson (1991) for a summary of labour supply elasticities for American and Canadian adult women and men based on cross-sectional data. For Canadian women, substitution effect wage elasticities range from -0.65 to 1.52, with a mean of 0.20; income elasticities from -0.25 to 0, with a mean of -0.10; and uncompensated wage elasticities from -0.65 to 1.28 with a mean of 0.11. It is also mentioned that men tend to have backward bending labour supply curves where the income effect dominates the substitution effect, and that the results for Canadian women imply that their labour supply curves may actually be closer to that of the men's, when compared to US women. The majority of US studies suggest positively sloped labour supply curves for women. In this paper, I will show that the choice of econometric model results in vastly different estimates of wage, income, and other effect elasticities, critically evaluating the pros and cons of each, and keeping in mind that economic theory predicts a positive substitution effect.

Phipps and Burton (1996) describe various economic theories of the family and cites various empirical tests of alternative models. The first models of family behaviour treat the household as a single economic unit with a single household utility function maximising pooled income, as was proposed early on by Samuelson (1956). This unitary approach to modelling family behaviour is probably most closely associated with Becker (1974) who argues that household preferences can be modelled as the preferences of the family head who is assumed to control the bulk of the family's resources and acts altruistically, while recognising the possibility of divergent interests within the family in his famous 'Rotten Kid' theorem. In contrast, McElroy and Horney (1981), and others in the literature have proposed collective models of household behaviour where the income-pooling hypothesis or common preference assumption in the unitary models are rejected. McElroy and Horney (1981) describe a divorce-threat bargaining model where household behaviour is modelled as a Nash-bargaining game. Also, Lundberg and Pollak (1993, 1996) offer an alternative Nash-bargaining game to the divorce-threat game by introducing a non-cooperative pareto-inferior equilibrium within the married state as the threat point in place of the divorced state.

This paper will begin by considering an instrumental variables approach to cross sectional analysis of the labour supply of married women in the pattern of Mroz (1987), testing for the endogeneity of labour market experience, children, non-labour income, and other explanatory variables. It will then continue with an attempt at correcting for sample self-selection bias as Mroz (1987) has done. I will then introduce a simultaneous equations approach proposed in Lundberg (1988), before extending the analysis to the Nash-bargained model described in McElroy (1990). Reference has been made to Lundberg and Pollak (1993, 1996) where it is relevant. The empirical work draws on the experience of Schultz (1990) and Biswal (1999) as examples. Focus has been placed on obtaining interesting results and comparisons rather than on complete modelling, in particular, the methodology used in modelling the Nash-bargaining game employs a simplification that permits analysis even in the absence of extensive data on the extra-household environmental parameters (EEPs) defined as a requirement in McElroy (1990).

2. Data Preparation

The cross-sectional data used is extracted from the raw PSID Family File for 1985 (Hofferth et al.) consisting of 7032 observations and 1346 variables. The publishers of the data warn that due to the panel selection process, the sample of US households may not be representative of the US population as a whole, and that in particular the probability of selection for lower income families are higher than representative. While family weights are provided, these have not been used but for one exception (in the probit regression run for the modelling of the Nash-bargained game), for the reason that income (both labour and non-labour) is represented as regressors in some form or other in all of the other regressions. The year 1985 was chosen because in that year, the wives were directly asked the questions in the survey. In other years, with the exception of 1975, which is the year Mroz (1987) used for the same reason, the family head answered the questions on the behalf of the wife. One suspects that personal answering of the questions will result in more accurate data collection. The other reason is that the recent data (1993 to 1999) has not yet been documented thoroughly and the work required for data processing would have increased exponentially.

The first step was to select a set of potentially useful variables. After this was done, a preliminary cleanup of the data involved removing records that seemed inconsistent or would be out of the scope of the study. These included family units that had female heads of households with husbands; both head and wife out of the labour force at time of survey (i.e. retired, student, or in prison or institution); heads or wives that answered that they are working and not unemployed, but have zero values for hours worked, or zero labour income values; heads or wives that have positive hours of work recorded, but zero labour income values; and records with other obvious inconsistencies.

The final dataset had 6372 observations. Transformations of values were then carried out, such as the taking of logarithms, calculation of ratios, quadratic and cubic terms, and the creation of dummy variables. The full list of variables available in this file is in Appendix A.

Regressions were done on subsets of this dataset in all cases and the number of observations used will be noted in the regression results for each case. In this data file there are 3413 "husband-wife" type family units. The rest are 2959 single head family units. Of the 2959 single head family units, 2045 are female led, and 914 are male led. There are 1229 divorced or separated heads, of which 421 are male, and 808 are female. Out of the 1229, 61 are considered long-term cohabiting with someone by the PSID, and these are considered part of the 3413 "husband-wife" type family unit as the PSID collects the same data about them as legally married wives. There are also 79 cohabiting singles that have never been married counted as part of the 3413.

The definition of "married" in this study includes those long-term cohabiting by the PSID and could include persons numerated above who have not yet been legally married, have been previously divorced from a previous legal wife or are separated from their current legal wife. It is my opinion that the key point in the study of their labour supply is that they are currently living as "husband and wife" in the same household. In any case, it does not make sense to reduce the number of observations used in regressions unnecessary. The definition of "divorced" includes those that have been divorced or separated from their legal wife and are currently not living as "husband and wife" with anyone. All of the remaining non-cohabiting singles in the sample was not used in any analysis.

3. Baseline Ordinary Least Squares (OLS) Model

$$(1)\ ln\, h_i = a_0 + a_1\, ln\, y_i + a_2 Y_i + a_3 X_i + e_i$$

The OLS model is (1) above, where h_i is the i[th] woman's hours of work during the year, y_i is the wage rate defined as the average hourly income provided by the PSID and in Mroz (1987), Y_i is a vector of *woman's asset ("own") income*, *w asset ("part") income*, *w transfer income*, *husband's labour income*, *h asset ("own") income*, *h asset ("part") income*, and *h transfer income*. The dataset distinguishes between *asset ("own") income* and *asset ("part") income*, where *asset ("own") income"* refers to income from rent, interest, dividend, trust fund, alimony and royalties, while *asset ("part") income* refers to the part of income from business, market gardening, or roomers/boarders attributable to the wife or the husband as the case may be. The PSID provides corresponding data on the "labour part" of income from business, market gardening, or roomers/boarders, which I have aggregated into labour income. The vector X_i is a vector of other explanatory variables listed here with the abbreviations used in this paper in brackets: age *(age)*, the quadratic *(age^2)* and cubic terms *(exp^3)*, full time experience *(exp)*, the quadratic *(exp^2)* and cubic *(exp^3)* terms, educational requirements of job *(jobedreq)*, education level attained *(ed)*, children in the household (0-5 years old) *(k0-5)*, children in the household (6-13 years old) *(k6-13)*, children in the household (14-17 years old) *(k14-17)*, union participation dummy *(union)*, proportion of total housework done by the woman *(hwkratio)*, natural logarithm of the amount spent on food *(lnfood)*, amount spent on eating out *(eatout)*, measure of excess room available in the household *(excessrm)*, proportion of people in the household working *(wkgratio)*, and amount spent on childcare *(childcare)*.

Mroz (1987) suspected measurement error in the hours worked. Any measurement error in the hours worked will cause a spurious negative effect on the coefficient of $ln\, y_i$ due to the denominator of the regressor appearing in the numerator of the dependant variable, since the wage rate is defined as the average hourly earnings. This is in addition to attenuation caused by traditional measurement error. The results are tabulated in Table 2 together with the results of the regression from the next section. The uncompensated wage elasticity is negative. As income elasticities are close to zero, except for the elasticity calculated using the husband's labour income as the measure, it is doubtful if compensated wage elasticities are in fact positive from this estimate, suggesting that the measurement error is indeed serious, which corresponds with Mroz's (1987) findings.

It is interesting to note that the coefficient for *k14-17* is positive (0.1% significance level), compared to that for *k0-5* (0.1% significance level) which is negative. The coefficient for *k6-13* is slightly negative, close to zero and not significant. This provides evidence for the theory that married women stay home to look after the children while they are young and are more likely to go back to work once they are older.

Also, it is important to note at this stage that heteroskedasticity of the errors has been detected, with the variances of the errors consistently and significantly lower with higher values of fitted values. A White test for heteroskedasticity confirms this with a p-value of 10^{-24}. All of the regressions will use the White estimated variances (White, 1980) where necessary.

4. Baseline Instrumental Variables (IV) Model

(2) $ln\ h_i = a_0 + a_1\ ln\ \hat{y}_i + \underline{a}_2 Yi + \underline{a}_3 X_i' + e_i$

(3) $ln\ \hat{y}_i = b_0 + b_1\ ln\ w_i + \underline{b}_2 Z_i + \underline{b}_3 Yi + \underline{b}_4 X_i' + \varepsilon_i$

The two-stage least squares (2SLS) estimate for the IV model is obtained by regressing (3) above and then using the estimate from (3) as a regressor in (2). In (3), $ln\ w_i$ is an alternative measure of the wage rate in the PSID that asked the respondent their wage rate at their current job. Due to missing values, the number of observations has been reduced from 1973 to 1780. This is still a very much larger sample than Mroz (1987) who had to reduce this from 428 to 326. Z_i is a vector of variables, which together with $ln\ w_i$, is a set of instruments which are included in the regression (3) and excluded from X_i in (1) to get X_i' in (2) and (3).

Instrument set options A to D below were tested for validity using the Hausman (1978) test as well as a test of over-identifying restrictions. The results are tabulated below in Table 1. Also, all of the instrument sets are correlated with the variable being instrumented. A regression of $ln\ y_i$ against the instruments generate R^2 of between 0.4970 to 0.5168 and an F-test of the coefficients of the instruments=0 lead to rejection with p-values <0.0001 in all cases. Instrument set A includes *age*, age^2 and age^3. Instrument set B includes *exp*, exp^2 and exp^3. Instrument set C includes *ed* and *jobedreq*. Instrument set D includes *lnfood* and *eatout*. Pooling and further testing of instrument sets could have been done to increase efficiency if multiple sets were found to be valid.

The Hausman (1978) test results are complicated by the existence of heteroskedasticity. If the White (1980) estimates of the variances are not used, the matrices of the difference between variance-covariance matrices of the two models, i.e. $var(\beta_{2SLS})$ - $var(\beta_{OLS})$, are negative definite for instrument sets B and C. The difference in the results for instrument C comparing with and without using White variances is surprisingly large but this may simply be the effect of serious heteroskedascity.

For the Hausman (1978) test, we are looking the reject the null hypothesis of $\beta_{2SLS} = \beta_{OLS}$, where the test statistic $(\beta_{2SLS} - \beta_{OLS})' [(var(\beta_{2SLS}) - var(\beta_{OLS})]^{-1}(\beta_{2SLS} - \beta_{OLS})$ is distributed chi-square with degrees of freedom equal to the number of potentially endogenous regressors. Instrument sets A, B, D pass.

The tests of over-identifying restrictions employed uses the test statistic nR^2 distributed as chi-square with degrees of freedom equal to the number of over-identifying restrictions, where nR^2 is the number of observations times the R^2 from the regression of the residuals from the 2nd stage IV regression against all the instrumented variables (including those reappearing in the 2nd stage regression). This simple form of the test actually assumes homoskedastic errors, which in our case is not fulfilled, but the simplification is maintained for computational considerations. The results are tabulated in Table 1 below. We are looking not to reject the null hypothesis of no correlation; a rejection will lead to the instrument set being treated as invalid. Identifying restrictions cannot be tested because their validity must be assumed for meaningful estimation. Kennedy (1998, p 171) mentions that tests of over-identifying restrictions, when undertaken, usually reject the over-identifying restrictions, casting doubt on the identifying restrictions. He writes, “A skeptic might use this fact to explain why economists seldom undertake such tests.” The problem here is that there is usually no recommendation what to do next if the tests of over-identifying restrictions fail, as it seldom pays to belabour the issue of looking for suitable instruments.

Table 1: Result of Hausman Test and Tests of Over-identifying Restrictions

Instrument Set	A	B	C	D
$var(\beta_{2SLS})_{white} - var(\beta_{OLS})_{white}$	positive def.	positive def.	positive def.	positive def.
$var(\beta_{2SLS})_{nonwhite} - var(\beta_{OLS})_{nonwhite}$	negative def.	positive def.	positive def.	negative def.
Hausman p-value (using White)	0.0000	0.0000	0.5566	0.0008
Hausman p-value (using standard)	-	0.0299	0.0000	-
Over-id test p-value	1.604×10^{-18}	1.462×10^{-25}	0.00003923	0.2877

The results show that instrument set D is the best instrument set on balance. Also, the regression results tabled below in Table 2, when compared to the OLS model show greater consistency with economic theory and are closer to the mean values cited in Chaykowski and Powell (1999), and the results of Biswal (1999). The above results also imply that age, education, and especially experience is endogenous, and could be correlated with unobserved characteristics of the women such as willingness and desire to work which is captured by the error term. The finding that experience is endogenous is consistent with Mroz (1987).

Table 2: Estimated Wage and Income Elasticities* and Coefficients for Other Variables (OLS/IV)

	wage	*w "own" asset y*	*w "part" asset y*	*w transfer y*	*h labour y*	*h "own" asset y*
OLS(1)	-.0340(0.300)	.0026(0.103)	.0027(0.011)	-.0015(0.533)	-.1544(0.000)	-.0023(0.721)
IV(2)	.1230(0.032)	.0027(0.093)	.00060(0.279)	-.0055(0.109)	-.1184(0.000)	-.0096(0.108)
	h "part" asset y	*h transfer y*	*age*	age^2	age^3	*exp*
OLS(1)	-.0026(0.397)	-.0061(0.180)	-.1738(0.001)	.0034(0.007)	-.00002(0.026)	.1216(0.000)
IV(2)	-.0056(0.083)	-.0064(0.167)	-.1698(0.001)	.0034(0.008)	-.00002(0.025)	.0984(0.000)
	exp^2	exp^3	*jobedreq*	*ed*	*k0-5*	*k6-13*
OLS(1)	-.0050(0.000)	.00006(0.000)	.0584(0.000)	-.0408(0.001)	-.1626(0.000)	-.0077(0.753)
IV(2)	-.0038(0.000)	.00005(0.000)	.0360(0.003)	-.0439(0.000)	-.1411(0.000)	-.0136(0.516)
	k14-17	*union*	*hwratio*	*lnfood*	*eatout*	*excessrm*
OLS(1)	.1086(0.000)	.0401(0.239)	-.3522(0.000)	-.0029(0.918)	0.00003(0.036)	-.0081(0.395)
IV(2)	.0871(0.002)	-.0351(0.344)	-.2983(0.000)	instrumented	instrumented	-.0056(0.547)
	wkgratio	*childcare*	*n*	*constant*	R^2	
OLS(1)	.4991(0.000)	0.00015(0.000)	1973	9.5034(0.000)	0.2686	
IV(2)	.3304(0.000)	0.00011(0.000)	1780	9.4387(0.000)	0.2332	

**Elasticities are calculated at the sample mean value, (p-values in brackets).*

5. Endogeneity Tests of Income and Other Explanatory Variables

The test of over-identifying restrictions used above is implemented below to test for the endogeneity of other variables. The procedure is to include the variable to be tested as an additional instrument in the IV 2SLS regression, and to repeat the test, recomputing the p-values. The results are tabulated below in Table 3.

Table 3: Endogeneity Test Results

Variable	*w "own" asset y*	*w "part" asset y*	*w transfer y*	*h labour y*	*h "own" asset y*
p-value	0.1091	0.3612	0.1376	2.462×10^{-11}	0.0496
Variable	*h "part" asset y*	*w transfer y*	*hwratio*	*excessrm*	*k0-5*
p-value	0.0582	0.1603	8.080×10^{-6}	0.4157	2.880×10^{-7}
Variable	*k6-13*	*k14-17*	*childcare*		
p-value	0.4157	0.0090	9.100×10^{-10}		

The test results show that *h labour y*, *hwratio*, *k0-5* are correlated with the error term of the regression at the 0.1% significance level, while *k14-17* is at the 1% level, and *h "own" asset y* at the 5% level. This suggests that the existence of children may be confounded with some unobserved characteristics of married women, and that a literal measure of the husband's income may be confounded with a more complicated collective household decision making process.

6. Adjusting for Censored Sample (CS)

Studies of labour supply of married women typically adjust for the censored sample in order to correct for attenuation of the OLS estimator due to the error generated by the missing observations of women that are out of the labour force because their market wages are below their reservation wages. In our case, the 2SLS estimator in the IV model will similarly be affected as the OLS regressions for both stages have dependant variables, the hours of work and the wage rate, that are both censored.

The approach taken here falls into the class of generalized Tobit estimators (Mroz, 1987), and will be using a multi-stage estimation procedure similar to that used in Biswal (1999). This involves the calculation of the inverse Mills ratio from the results of a probit selection equation in the first stage, an estimation of the wage against a set of variables and the inverse Mills ratio (Heckman, 1976) in the 2nd stage, and the regression of the structural labour supply equation in the final stage also with the Inverse Mills Ratio added as an additional regressor. This is in fact a repeated implementation of the Heckman 2-step procedure (Heckman, 1976). In Biswal (1999) though, there is no mention of any instrumentals variables that were dropped from the final stage regression, which is being done here to maintain the IV approach. I will continue to use the IV second stage equations (2) and (3) above, but with the Inverse Mills Ratio (λ) included. The new model is:

(4) $\ln h_i = a_0 + a_1 \ln \hat{y}_i + \underline{a}_2 Yi + \underline{a}_3 X_i' + \lambda + e_i$

(5) $\ln \hat{y}_i = b_0 + b_1 \ln w_i + \underline{b}_2 Z_i + \underline{b}_3 Yi + \underline{b}_4 X_i' + \lambda + \varepsilon_i$

(6) $i_i = c_0 + c_1 Q_i + u_i$

Equation (6) is the selection equation, where Q_i is a vector containing the variables thought to affect labour force participation of the married women, *age, ed, k0-5, k6-13, k14-17, h labour y, h "own" asset* *y, h "part" asset y, h transfer y, hwratio, excessrm, eatout, w non labour y*, where the last variable is the total of her non-labour income.

In Puhani (2000), some issues with the Heckman procedure is highlighted. In particular, when there is high correlation between the variances of the selection equation and the outcome equation, or if the collinearity between the inverse Mills ratio and the other regressors is high (usually due to the explanatory variables in the selection equation being the same as those in the outcome equation), this leads to serious efficiency problems. In our case, it is shown that the correlation is not unduly high, regressing the standard errors of the selection equation (6) with those of the 2SLS 1st stage (2) and 2nd stage (3) equations generate R^2 of 0.6118 and 0.5139 respectively. Regressing the inverse Mills ratio against the other regressors of the same two equations generate R^2 of 0.6830 and 0.6822 respectively. Furthermore, the sample size available is rather large to start off with. The critique of the Heckman procedure in Puhani (2000) is poignant, as he puts it, it is when the correlation is highest that is when the need is greatest, that is where the correction runs into problems. Certainly it is the case when the inverse Mills ratio is orthogonal to the other regressors that there is no efficiency impact. But if it is so, then it is also an irrelevant omitted variable by the Frisch-Waugh–Lovell theorem and can easily be dropped, meaning no correction is needed in the first place.

The other concern mentioned by Puhani (2000), citing past studies, is the loss of efficiency using the Heckman two-step procedure compared to a full-information maximum likelihood (FIML) implementation of the correction as a Tobit model. On the other hand, the Tobit model is extremely sensitive to heteroskedascity and in our case may result in untenable results. In order to test this possibility, the maximum likelihood regressions for the Tobit combining the 2SLS 1st stage (2) with the selection equation (6), and the 2SLS 2nd stage (3) equations with the selection equation (6) were run. While the regressions for the 2SLS 1st stage equation came up with coefficients close to the 2-step process, for the 2SLS 2nd stage equation, however, the results were not encouraging as the signs for the coefficients of certain key variables such as *wage* turned negative and *k0_5* turned positive with non-significance p-values. The results have been tabulated below in Table 4. It appears that the effect of heteroskedasticity may have affected the consistency of the Tobit estimates.

The other issue with the existence of heteroskedasticity is that it might have biased the regression coefficients of the probit selection equation (6). As a result, it really is unclear if the correction did any good after all. For comparison purposes, hypothesis testing done later will carry results from both cases.

Table 4: Estimated Wage and Income Elasticities* and Coefficients for Other Variables (CS)

	wage	*w "own" asset y*	*w "part" asset y*	*w transfer y*	*h labour y*	*h "own" asset y*	
Selection(6)	n.a.	n.a.	n.a.	n.a.	-.0781(0.000)	-.0044(0.119)	
2-step(4)	.1187(0.039)	.0026(0.108)	.00055(0.315)	-.0055(0.114)	-.1084(0.000)	-.0096(0.106)	
Tobit(4)	-.0293(0.396)	.0019(0.182)	.00031(0.585)	-.0042(0.078)	-.0425(0.028)	-.00035(0.941)	
2-step 1st s(5)	.7036(0.000)	-.0016(0.425)	.00029(0.734)	.0040(0.124)	-.0237(0.244)	.0048(0.199)	
Tobit 1st s(5)	.7047(0.000)	-.0016(0.213)	.00026(0.588)	.0037(0.126)	-.0292(0.080)	.0058(0.173)	
	h "part" asset y	*h transfer y*	*age*	age^2	age^3	*exp*	
Selection(6)	-.0021(0.233)	-.0058(0.070)	-.0228(0.000)	n.a.	n.a.	n.a.	
2-step(4)	-.0055(0.083)	-.0073(0.114)	-.1702(0.001)	.0034(0.009)	-.00002(0.030)	.0967(0.000)	
Tobit(4)	-.0030(0.262)	-.0034(0.416)	-.1338(0.001)	.0027(0.004)	-.00002(0.015)	.0764(0.000)	
2-step 1st s(5)	.0030(0.238)	-.0045(0.251)	.0080(0.852)	-.00027(0.796)	1.8×10^{-6}(0.828)	.0267(0.010)	
Tobit 1st s(5)	.0032(0.157)	-.0042(0.198)	.0080(0.845)	-.00027(0.791)	1.7×10^{-6}(0.836)	.0273(0.009)	
	exp^2	exp^3	*jobedreq*	*ed*	*k0-5*	*k6-13*	
Selection(6)	n.a.	n.a.	n.a.	.2238(0.000)	-.4923(0.000)	-.2100(0.000)	
2-step(4)	-.0037(0.000)	.00005(0.000)	.0356(0.003)	-.0513(0.000)	-.1498(0.000)	-.0306(0.156)	
Tobit(4)	-.0029(0.000)	.00004(0.001)	.0320(0.000)	-.0808(0.000)	.0110(0.678)	.0195(0.350)	
2-step 1st s(5)	-.00080(0.186)	9.4×10^{-6}(0.377)	.0324(0.008)	.0123(0.290)	-.0554(0.029)	-.0382(0.063)	
Tobit 1st s(5)	-.00083(0.201)	9.9×10^{-6}(0.377)	.0326(0.000)	.0155(0.134)	-.0547(0.029)	-.0336(0.068)	
	k14-17	*union*	*hwratio*	*lnfood*	*eatout*	*excessrm*	
Selection(6)	-.1002(0.098)	n.a.	-2.0359(0.000)	n.a.	.00010(0.006)	.0400(0.053)	
2-step(4)	.0819(0.004)	-.0353(0.342)	-.2286(0.000)	instrumented	instrumented	-.0038(0.683)	
Tobit(4)	.0706(0.023)	.0060(0.866)	.1606(0.017)	instrumented	instrumented	-.0122(0.229)	
2-step 1st s(5)	-.0517(0.047)	.1763(0.000)	-.0326(0.566)	.0644(0.027)	4.5×10^{-6}(0.692)	.0239(0.004)	
Tobit 1st s(5)	-.0505(0.040)	.1766(0.000)	-.0620(0.319)	.0652(0.005)	4.4×10^{-6}(0.707)	.0235(0.002)	
	wkgratio	*childcare*	*w non labour y*	*inverse mills*	*constant*	*n*	R^2
Selection(6)	n.a.	n.a.	.00029(0.886)	n.a.	2.1671(0.000)	2482	0.1947
2-step(4)	.1748(0.046)	.00011(0.000)	n.a.	-.1385(0.093)	9.5768(0.000)	1780	0.2359
Tobit(4)	.2197(0.000)	.00007(0.000)	n.a.	n.a.	9.2658(0.000)	1780	n.a.
2-step 1st s(5)	-.00037(0.997)	.00004(0.004)	n.a.	-.0446(0.446)	-.5085(0.372)	1780	0.5389
Tobit 1st s(5)	.0499(0.414)	.00004(0.003)	n.a.	n.a.	-.5585(0.295)	1780	n.a.

**Elasticities are calculated at the sample mean value, (p-values in brackets).*

7. Simultaneous Equations (SE) Approach

The simultaneous equations approach follows that proposed in Lundberg (1988). The main benefit of using the simultaneous equations approach is to accord more flexibility in the modelling of household behaviour, and in particular, to consider the labour supply of married women not in isolation, taking the husband's variables as given, but instead considering the labour supply decisions of both parties simultaneously. This allows for more extensive hypothesis testing especially with regards to alternative models of family behaviour, which will be carried out in the next section. This model also serves as a basis for modelling the Nash-bargained labour supply equations in a later section. The model proposed by Lundberg (1988) is a set of conditional labour supply functions, where the labour supply of the wife is conditional upon the labour supply of the husband, and vice versa. Variables ending with *m* refer to the husband's values, while those ending with *f* refer to the wife's. I have extended the set of 2 equations proposed by Lundberg to take into account the relationship of explanatory variables to the wage rate and average hourly income, while ensuring identification generally. This makes it possible to distinguish effects on labour supply working through the wage rate from those working directly.

(7) $\ln hm_i = a_0 + a_1 \ln ym_i + a_2 \ln hf_i + \underline{a}_3 Yh_i + \underline{a}_4 Xh_i + e_i$

(8) $\ln hf_i = b_0 + b_1 \ln yf_i + b_2 \ln hm_i + \underline{b}_3 Yf_i + \underline{b}_4 Xf_i + \varepsilon_i$

(9) $\ln ym_i = c_0 + c_1 \ln wm_i + \underline{c}_2 Z_i + u_i$

(10) $\ln yf_i = d_0 + d_1 \ln wf_i + \underline{d}_2 Z_i + v_i$

(11) $\ln wm_i = g_0 + \underline{g}_1 Qm_i + r_i$

(12) $\ln wf_i = h_0 + \underline{h}_1 Qf_i + s_i$

$\ln hm_i$ and $\ln hf_i$ are the hours worked, $\ln ym_i$ and $\ln yf_i$ are the average hourly earnings, Yh_i and Yf_i are vectors that both include *h "own" asset y, h "part" asset y, h transfer y, w "own" asset y, w "part" asset y, w transfer y*, and the labour income measure of the other person (i.e. Yh_i will have *w labour y* and Yf_i will have *h labour y*). Xh_i and Xf_i are vectors containing the person's respective measures of *ed, jobedreq, k0-5, k6-13, k14-17, excessrm, hwratio, wkgratio, lnfood, childcare*. As for *ln* wm_i and *ln* wf_i, these refer to the reported wage rate. Z_i is a vector containing *eatout* and *lnfood*. Qm_i and Qf_i are vectors containing the person's respective measures of *ed, jobedreq, union, age, age2, age3, exp, exp2, exp3* and a set of 12 occupational dummies (*occ1* ... *occ12*). Note that some variables appear in more than one equation by design. Estimating the model using 3 stage least squares (3SLS) results in the following results.

Table 5: Estimated Wage and Income Elasticities* and Coefficients for Other Variables (SE)

	wage	*other's labour ss*	*w "own" asset y*	*w "part" asset y*	*w transfer y*	*w labour y*	
Husband(7)	.3940(0.000)	.2601(0.000)	-.0014(0.298)	-.0017(0.006)	.0021(0.384)	-.1640(0.000)	
Wife(8)	.9179(0.000)	1.177(0.000)	-.00064(0.762)	.0016(0.107)	-.0085(0.029)	n.a.	
Husband(11)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
Wife(11)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
	ed	*jobedreq*	*h "own" asset y*	*h "part" asset y*	*h transfer y*	*h labour y*	
Husband(7)	-.0011(0.886)	-.0248(0.000)	-.0010(0.739)	.0061(0.000)	-.0197(0.000)	n.a.	
Wife(8)	-.0933(0.000)	-.0551(0.000)	-.0112(0.025)	-.0096(0.000)	.0201(0.000)	-.3766(0.000)	
Husband(11)	.0576(0.000)	.0615(0.000)	n.a.	n.a.	n.a.	n.a.	
Wife(11)	.0395(0.000)	.0709(0.000)	n.a.	n.a.	n.a.	n.a.	
	k0-5	*k6-13*	*k14-17*	*excessrm*	*hwratio*	*wkgratio*	
Husband(7)	.0912(0.000)	0.0445(0.006)	-.0209(0.350)	.0120(0.097)	-.1424(0.006)	.1887(0.005)	
Wife(8)	-.1759(0.000)	-.0879(0.001)	.0427(0.236)	-.0235(0.040)	-.2503(0.001)	-.1304(0.236)	
Husband(11)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
Wife(11)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
	eatout	*lnfood*	*childcare*	*union*	*age*	*age*^{2}	
Husband(7)	-3.7×10^{-6}(0.746)	0.2186(0.344)	-.00002(0.158)	n.a.	n.a.	n.a.	
Wife(8)	.00002(0.293)	-.1212(0.002)	.00006(0.008)	n.a.	n.a.	n.a.	
Husband(11)	n.a.	n.a.	n.a.	.2083(0.000)	-.1676(0.005)	.0045(0.003)	
Wife(11)	n.a.	n.a.	n.a.	.1649(0.000)	-.0203(0.584)	.00036(0.703)	
	age^3	*exp*	*exp*^{2}	*exp*^{3}	*occ1*	*occ2*	
Husband(7)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
Wife(8)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
Husband(11)	-0.00004(0.002)	.0502(0.001)	-.0020(0.008)	.00002(0.043)	3.2831(0.000)	3.3210(0.000)	
Wife(11)	-2.3×10^{-6}(0.766)	.0455(0.000)	-.0014(0.034)	.00001(0.374)	.1572(0.510)	.1764(0.462)	
	occ3	*occ4*	*occ5*	*occ6*	*occ7*	*occ8*	
Husband(7)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
Wife(8)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
Husband(11)	3.1852(0.000)	3.1150(0.000)	3.2860(0.000)	3.2098(0.000)	3.2051(0.000)	3.0346(0.000)	
Wife(11)	.0040(0.987)	.1116(0.640)	.1725(0.482)	.1024(0.669)	.2671(0.331)	.1479(0.562)	
	occ9	*occ10*	*occ11*	*occ12*	*constant*	*n*	*"R-sq"*
Husband(7)	n.a.	n.a.	n.a.	n.a.	4.749(0.000)	1310	-0.2962
Wife(8)	n.a.	n.a.	n.a.	n.a.	-.8271(0.409)	1310	-0.8134
Husband(11)	2.4031(0.001)	2.7717(0.000)	3.0530(0.000)	4.2055(0.000)	0(dropped)	1310	0.4119
Wife(11)	dropped	-.2394 (0.436)	-.0487(0.839)	-.1635(0.517)	1.3215(0.009)	1310	0.3370

**Elasticities are calculated at the sample mean value, (p-values in brackets).*

Comparing the results of the SE regressions to the OLS, IV, and CS regressions, the most striking difference is the much higher uncompensated wage elasticities estimated. The income elasticities are also generally higher in absolute values (more negative). These results fall into the higher range of values mentioned by Chaykowski and Powell (1999). Based on these estimates, it might be possible to obtain elastic labour supply curves for women, but not for men. The data calculates hours worked on an annual basis, and as a result, the increased prevalence of temporary or part-time work by married women will lead to higher estimated wage elasticities. The difference in wage elasticities between married men and women could then be reflecting the different rates of part-time/temporary vs. full time employment, the former being more wage elastic than the latter. This is an area that demands further research. Furthermore, from the elasticities with respect to the other person's labour supply, we find that increases in the husband's labour supply tend to have a much higher negative effect on the woman's labour supply than vice versa. This is consistent with the stylised (though a little dated) observation that men work regardless of whether their wives work or not, while wives work only when they need to. In the context of part-time/temporary work, this may have more weight. Significant increases in part-time work over the 1978-1998 period has been noted by Chaykowski and Powell (1999).

The coefficients on education, which appears in both the labour supply and wage equations, are instructive. Clearly, higher education has a positive effect on wages, and therefore an indirect positive effect on labour supply through the effect of higher wages, but the direct effect on hours worked appears to be negative. This lends support to the view that more educated people value leisure more, and would tend to work less, noting that estimates show that this effect applies more to women than to men, which also makes sense.

8. Hypothesis Testing

The primary tests involve testing if different sources of income affect the labour supply of married women differently. In all cases, the null hypothesis is that there is no difference. The joint test of whether the component parts of the husband's non-labour income affect the married woman's labour supply differently from the component parts of her own non-labour income is called the income pooling hypothesis test, and is the same test done in Biswal (1999) and Schultz (1990) to reject the unitary models of household family behaviour. This has policy implications, for example, in determining if issuing government transfer payments such as child care benefits to the husband or to the wife makes any difference. Here, the income pooling hypothesis could only be rejected using the estimates from the IV or CS models at the 10% significance level but the SE approach could reject it at the 0.01% significance level. As the income pooling hypothesis has been widely rejected in the literature (Phipps and Burton, 1996), this adds to the support for the SE approach.

Also, Biswal (1999) separated the effects of transfer income from the effects of asset income in the pattern of Schultz (1990) and discovered that the effects are significantly of different signs. The results here re-confirm Biswal's findings, but add to that by separating *"part" asset income*, from *"own" asset income*. The results suggest that it is the *"part" asset income* that has a positive income effect on labour supply, not the *"own" asset income*. Could this be due to spurious correlation caused by the way data on non-labour income is collected? Consider that *"part" asset income*, as it has been defined, comes about through activities such as business, market gardening, roomers and boarders, and while the "labour part" of the income from those activities have been aggregated into total labour income, the "asset part" gets aggregated into non-labour income, causing spurious correlation with the number of hours worked since this income cannot come about without work.

In addition, the SE approach allows for cross equation testing of additional hypotheses. These test if the husband and wife react differently to changes of explanatory variables. Most obviously, the effect of pre-school and elementary school children on the wife and husband's labour supply is significantly (0.1% level) different and of different signs. The effect of education discussed in the preceding section is also significantly different (0.01%). In addition, the effect of job educational requirements, though, is not as significant, lending further support to the arguments put forth earlier.

Table 6: Hypothesis Testing Results (p-value)

Equality of	*w "part" asset y* *w "own" asset y*	*w transfer y* *w asset y*	*h "part" asset y* *h "own" asset y*	*h transfer y* *h asset y*
IV (non-corrected)(2)	0.2820	0.0748	0.7824	0.9372
IV (2-step CS)(4)	0.2901	0.0862	0.7573	0.8730
Sim. Eq. (Wife)(8)	0.3073	0.0275	0.0568	0.0000
Sim. Eq. (Husband)(7)	0.7291	0.0575	0.0009	0.0000
Nash Barg. (Wife)(8')	0.5123	0.0118	0.0817	0.0000
Nash Barg. (Husband)(7')	0.9784	0.0030	0.0014	0.0000
Equality of	*w transfer y* *h transfer y*	*w "own" asset y* *h "own" asset y*	*w "part" asset y* *h "part" asset y*	*income pooling hypothesis*
IV (non-corrected)(2)	0.3050	0.0515	0.1231	0.0622
IV (2-step CS)(4)	0.3475	0.0585	0.1364	0.0803
Sim. Eq. (Wife)(8)	0.0001	0.9585	0.0090	0.0001
Sim. Eq. (Husband)(7)	0.0000	0.3488	0.0004	0.0000
Nash Barg. (Wife)(8')	0.0000	0.7717	0.0212	0.0000
Nash Barg. (Husband)(7')	0.0000	0.2222	0.0009	0.0000
Equality of	*w transfer y*	*w "own" asset y*	*w "part" asset y*	*w y (joint)*
Sim. Eq. (Cross-eq.)(7)-(8)	0.0488	0.8047	0.0163	0.0230
Nash B.(Cross-eq.)(7')-(8')	0.0027	0.5733	0.0349	0.0037
Equality of	*h transfer y*	*h "own" asset y*	*h "part" asset y*	*h y (joint)*
Sim. Eq. (Cross-eq.)(7)-(8)	0.0000	0.1434	0.0000	0.0000
Nash B.(Cross-eq.)(7')-(8')	0.0000	0.1798	0.0001	0.0000
Equality of	*other's labour y*	*k0-5*	*k6-13*	*k14-17*
Sim. Eq. (Cross-eq.)(7)-(8)	0.4778	0.0000	0.0003	0.1996
Nash B.(Cross-eq.)(7')-(8')	0.0162	0.0000	0.0001	0.4455
Equality of	*wage elasticity*	*other's labour ss*	*ed*	*jobedreq*
Sim. Eq. (Cross-eq.)(7)-(8)	0.0000	0.0000	0.0000	0.0243
Nash B.(Cross-eq.)(7')-(8')	0.0000	0.0000	0.0000	0.0693
Equality of	*excessrm*	*hwratio*	*wkgratio*	*eatout*
Sim. Eq. (Cross-eq.)(7)-(8)	0.0258	0.1564	0.0329	0.3607
Nash B.(Cross-eq.)(7')-(8')	0.9683	0.1354	0.0119	0.3049
Equality of	*lnfood*	*childcare*		
Sim. Eq. (Cross-eq.)(7)-(8)	0.0067	0.0106		
Nash B.(Cross-eq.)(7')-(8')	0.2138	0.0162		

9. Nash-Bargaining Game (NB)

There are two key differentiating characteristics of the Nash-bargained game. Firstly, the income pooling hypothesis is rejected and both parties have separate preferences or utility functions. Secondly, distribution within the family is affected by the opportunity cost of marriage of each party. The income pooling hypothesis has already been rejected in the above section on hypothesis testing – the result for NB is the same as that for SE. All that remains is to extend SE to model the effect of the opportunity cost of marriage of each party.

The procedure below primarily implements the divorce-threat model proposed by McElroy and Horney (1981), although it may be possible to adapt it for the separate spheres bargaining framework of Lundberg and Pollak (1993, 1996).

The Nash-bargained solution to the allocation problem of the husband *(m)* and wife *(f)* is that they jointly choose their consumption bundle to maximise the product of their gains from marriage (McElroy, 1990).

$$(13)\ N \equiv [U_m(x) - V_m(p_0, p_1, p_3, I_m ; \alpha_m)][U_f(x) - V_f(p_0, p_2, p_4, I_f ; \alpha_f)]$$

x is a vector of goods $(x_0, x_1, x_2, x_3, x_4)$ where x_0 is a household public good required by both m and f, x_1 and x_2 are the private goods consumed only by m and f respectively, x_3 and x_4 are the leisure time (i.e. total time – working time) of m and f respectively. $(p_0, p_1, p_2, p_3, p_4)$ is the vector of prices for x. U_m and U_f are the utility functions of married m and married f respectively , V_m, V_f , I_m and I_f are the indirect utility functions and incomes of divorced m and divorced f respectively. α_m and α_f are the extra environmental parameters (EEPs) of m and f respectively. The EEPs are any variables that shift the maximum value of utility attainable by the individual outside of the marriage, such as the condition of the remarriage market, or other sources of income from the extended family or government. V_m, V_f , are the opportunity costs of being married, and are the two parties' threat points in the Nash-bargaining game.

McElroy (1990) notes that are two ways of parameterizing income I_m and I_f . In his paper, unlike here, they referred to income pertaining only to the married state and deviations therefrom are actually captured in α_m and α_f, noting that these two methods of parameterization are identical. I have found it is more convenient to take I_m and I_m as including all income regardless of whether it pertains to the married or the divorced state. This has the side effect that the I_m and I_m may depend indirectly on the values of α_m and α_f, i.e. $V_{mi}(p_0, p_1, p_3, I_m|\alpha_m ; \alpha_m)$ and $V_{fi}(p_0, p_2, p_4, I_f|\alpha_f ; \alpha_f)$ may be more accurate expressions of the threat point.

While McElroy (1990) goes on to lay out the algebra of the maximization, it will suffice to say here that the substitution matrix of the Nash hypothesis is obtained by augmenting the neoclassical substitution matrix with the substitution effects in relation to V_m and V_f. V_m and V_f are in turn related to the prices, wages, non-wage incomes, and EEPs. Maximization of the Nash criterion (13) requires that the partial derivatives $dU_m/dV_m > 0$, $dU_f/dV_f > 0$, $dU_m/dV_f < 0$, and $dU_f/dV_m < 0$, assuming that the change in V_m or V_f is caused not by a change in p_0 (which will benefit or hurt both parties threat points unlike other changes that will only affect one party's threat point). This means that an increase in the threat point of an individual, ceteris paribus, increases his/her bargaining power, and results in a reallocation of resources such that his/her utility rises and the utility of the other person falls.

The first step is to do a probit regression of divorced vs. married, i.e. to estimate the probability of being divorced for the full sample of married and divorced persons. This is done separately for the males and the females. Note that husbands and wives share one data observation so 2 variables are used to store the estimated probability of being divorced for married persons. This is actually the "inverse" of the 1st step proposed in McElroy (1990) where the predicted probability of marriage is stored for the purpose of selectivity correction in one of his later steps. The purpose of the probit regression in the following analysis is not selectivity correction.

The procedure here is different from that in McElroy (1990) where it is proposed to estimate V_f and V_m from the sample of divorced persons. Instead of doing this, the results of the probit equation above is used as a proxy measure of V_f and V_m by representing the closeness between the V_f and V_m of a typical divorced person and the V_f and V_m of a particular individual in the married state. Consider that the measure of probability (λ) obtained from the probit equation is a measure of how closely an individual in the sample fits the profile of the "fitted" divorced person, in terms of the independent variables specified. λ can then be used as a measure of the threat points for married persons by making the assumption that an individual who better fits the profile of a divorced person has characteristics that enable him/her to achieve a higher level of utility if divorced. Consider V_{mi} for a particular male individual where Z_m is the set of independent variables, other than the income variables I_m that are in the probit regression. Z_{mi} and I_{mi} are the values of Z_m and I_m for this individual. The female case is identical except for notation and the choice of goods consumed.

$\lambda_{\mathrm{mi}} = Pr(D \mid I_{mi}, Z_{mi}) = \Phi(a_0 + \underline{a_1} I_{mi} + \underline{a_2} Z_{mi})$ is the probit model. Φ is the cumulative standard normal distribution, and D is the event of being divorced. Suppose that $a_0 = f_0(\alpha_m)$, $\underline{a_1} = \underline{f_1}(\alpha_m)$, and $\underline{a_2} = \underline{f_2}(\alpha_m)$ reflects the real world, then $\lambda_{\mathrm{mi}} = Pr(D \mid I_{mi}, Z_{mi}) = g(I_{mi}, Z_{mi}, \alpha_m)$, where f_0, $\underline{f_1}$, $\underline{f_2}$, and g are some functions or vectors of functions.

Let the threat point be affected by the characteristics of the individual and p_0, p_1, p_3 be constant. Then the correct expression of the threat point is $V_{mi}(I_{mi}, Z_{mi}, \alpha_m)$. Assume that $V_{mi}(I_{mi}, Z_{mi}, \alpha_m)$ is a monotonic transformation of $g(I_{mi}, Z_{mi}, \alpha_m) = \lambda_{\mathrm{mi}}$, then λ_{mi} is a valid proxy measure of $V_{mi}(I_{mi}, Z_{mi}, \alpha_m)$.

Using this procedure, information on EEPs need not be estimated if they are not available. The only criterion is that one has to be satisfied that the coefficients of the independent variables chosen for the probit equation are affected by the EEPs. In other words, the state of the environment is reflected in the sample, such that any change in EEPs will change the profile of the "fitted" divorced person implied by the probit regression. If we have more information on EEPs, including them in the regression should improve accuracy. McElroy (1990) recognises the possibility of generating a full range of α_f and α_m from systematic differences in prices and non-wage incomes between married and unmarried states, for example, a woman may receive welfare payments if she is not married but loses them if she is married. In this paper, it will be good but not necessary to identify the EEPs explicitly, as the relationship between these differences in prices and non-wage incomes and the probability of being divorced as identified by the Tobit regression may be all that is needed.

In the currently proposed method, the threat points are not only affected by EEPs that are exogenous to the individual, but may depend also on the characteristics of the individual. This is related to the Lundberg and Pollak (1993) idea where the threat point is internal to the marriage and the non-cooperative equilibrium is Cournot-Nash within the marriage. It might be possible to interpret relative λ_m and λ_f as indicators of which of the multiple equilibria the couple is at, providing a tool to distinguish and classify couples within the married state in empirical work.

Table 7: Estimated Y Elasticities* and Coefficients for Other Variables (Probit: Divorced vs Married)

	labour y	*"own" asset y*	*"part" asset y*	*transfer y*	*wkgratio*	*age*
Male	3.7289(0.000)	.0278(0.824)	.1311(0.009)	.1149(0.058)	-.1987(0.607)	1.170(0.000)
Female	8.6861(0.000)	.2771(0.001)	.1935(0.000)	.3769(0.000)	.3997(0.092)	.7070(0.000)
	age^2	*age^3*	*yneeds*	*ruralurban*	*excessrm*	*ed*
Male	-.0245(0.000)	.00016(0.000)	-.1201(0.000)	.0867(0.040)	-.2905(0.000)	-.1401(0.018)
Female	-.0170(0.000)	.00013(0.000)	-.4663(0.000)	-.0666(0.011)	-.0964(0.043)	.0174(0.754)
	jobedreq	*k0-5*	*k6-13*	*k14-17*	*lnfood*	*hwratio*
Male	.0842(0.172)	-1.141(0.000)	-.4813(0.003)	-.5379(0.041)	-.7624(0.000)	4.9168(0.000)
Female	.0097(0.804)	-.4091(0.009)	-.2136(0.029)	-.4526(0.007)	-1.137(0.000)	2.119(0.000)
	ofum labour y	*ofum non-l y*	*out of lab. force*	*constant*	*n*	*pseudo R^2*
Male	.3859(0.000)	.1182(0.000)	-.7520(0.100)	-12.587(0.000)	3069	0.7841
Female	.8827(0.000)	.1676(0.000)	.2685(0.450)	-1.574(0.468)	2570	0.6819

**Elasticities are calculated at the sample mean value, (p-values in brackets).*

The structural regression equations for the Nash-Bargained labour supply equations are the same as in SE, but with λ_m and λ_f added.

(7’) $ln\ hm_i = a_0 + a_1\ ln\ ym_i + a_2\ ln\ hf_i + \underline{a}_3 Yh_i + \underline{a}_4 Xh_i + a_5\ \lambda_{mi} + a_6\ \lambda_{fi} + e_i$

(8’) $ln\ hf_i = b_0 + b_1\ ln\ yf_i + b_2\ ln\ hm_i + \underline{b}_3 Yf_i + \underline{b}_4 Xf_i + b_5\ \lambda_{mi} + b_6\ \lambda_{fi} + \varepsilon_i$

(9’),(10’),(11’),(12’)= (9),(10),(11),(12)

Table 8: Estimated Wage and Income Elasticities* and Coefficients for Other Variables (NB)

	wage	*other’s labour ss*	*w “own” asset y*	*w “part” asset y*	*w transfer y*	*w labour y*	
Husband(7’)	.2968(0.000)	.1818(0.001)	-.0017(0.169)	-.0015(0.009)	.0047(0.036)	-.0862(0.007)	
Wife(8’)	.8525(0.000)	1.1821(0.000)	-.00007(0.972)	.0014(0.181)	-.0111(0.005)	n.a.	
Husband(11’)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
Wife(11’)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
	λ_m (Husband’s)	λ_f (Wife’s)	*h “own” asset y*	*h “part” asset y*	*h transfer y*	*h labour y*	
Husband(7’)	.0875(0.461)	-.8669(0.000)	-.0016(0.571)	.0052(0.001)	-.0199(0.000)	n.a.	
Wife(8’)	-.1841(0.349)	1.102(0.000)	-.0107(0.034)	-.0090(0.001)	.0204(0.000)	-.3381(0.000)	
Husband(11’)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
Wife(11’)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
	k0-5	*k6-13*	*k14-17*	*excessrm*	*hwratio*	*wkgratio*	
Husband(7’)	.0756(0.000)	.0448(0.003)	-.0136(0.514)	-.0028(0.686)	-.2375(0.000)	.2223(0.000)	
Wife(8’)	-.1718(0.000)	-.0996(0.000)	.0236(0.522)	-.0022(0.856)	-.3682(0.000)	-.1446(0.194)	
Husband(11’)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
Wife(11’)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
	eatout	*lnfood*	*childcare*	*union*	*age*	*age*^{2}	
Husband(7’)	-4.6x10^{-6}(0.662)	-.0093(0.666)	-.00001(0.386)	n.a.	n.a.	n.a.	
Wife(8’)	.00002(0.266)	-.0736(0.060)	.00006(0.007)	n.a.	n.a.	n.a.	
Husband(11’)	n.a.	n.a.	n.a.	.2053(0.000)	-.1636(0.006)	.0045(0.003)	
Wife(11’)	n.a.	n.a.	n.a.	.1746(0.000)	-.0161(0.665)	.00026(0.781)	
	age^3	*exp*	*exp*^{2}	*exp*^{3}	*ed*	*jobedreq*	
Husband(7’)	n.a.	n.a.	n.a.	n.a.	-.0034(0.642)	-.0244(0.000)	
Wife(8’)	n.a.	n.a.	n.a.	n.a.	-.0929(0.000)	-.0486(0.000)	
Husband(11’)	-.00004(0.002)	.0497(0.001)	-.0020(0.007)	.00002(0.034)	.0577(0.000)	.0600(0.000)	
Wife(11’)	-1.7x10^{-6}(0.831)	.0444(0.000)	-.0013(0.040)	.00001(0.376)	.0397(0.000)	.0711(0.000)	
	occ1	*occ2*	*occ3*	*occ4*	*occ5*	*occ6*	
Husband(7’)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
Wife(8’)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
Husband(11’)	3.2219(0.000)	3.2552(0.000)	3.1176(0.000)	3.0520(0.000)	3.2187(0.000)	3.1390(0.000)	
Wife(11’)	.1546(0.518)	.1673(0.485)	-.0062(0.980)	.1062(0.656)	.1503(0.542)	.0896(0.709)	
	occ7	*occ8*	*occ9*	*occ10*	*occ11*	*occ12*	
Husband(7’)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
Wife(8’)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
Husband(11’)	3.1364(0.000)	2.9740(0.000)	2.3405(0.001)	2.6924(0.000)	2.9919(0.000)	4.1056(0.000)	
Wife(11’)	.2719(0.322)	.1381(0.589)	dropped	-.2455(0.424)	-.0636(0.790)	-.1818(0.471)	
					constant	*n*	*“R-sq”*
Husband(7’)					5.8568(0.000)	1303	-0.0826
Wife(8’)					-1.2794(0.255)	1303	-0.7059
Husband(11’)					0 (dropped)	1303	0.4151
Wife(11’)					1.2811(0.011)	1303	0.3435

**Elasticities are calculated at the sample mean, (p-values are in brackets).*

The results in general are comparable to those of SE, but it is important to consider the effects of λ_m and λ_f on the labour supply. There is a little puzzle here. Should not the effect of an increase in λ_m be equivalent to that of a reduction in λ_f? The data doesn't say so. The effect of any change in λ_f is much larger than any corresponding change in λ_m in the reverse direction. Two explanations come to mind. One is that the levels of λ_m and λ_f are different and not strictly comparable. Even if they are numerically the same or if elasticities were used to compare them, they may not really be comparable because they are derived from the cumulative standard normal distribution of separate probit regressions and represent different monotonic transformations of V_m and V_f. Another more likely possibility is that the labour supply of women has a significant positive feedback effect on λ_f, in that *f* working more actually increases her λ_f, causing a multiplicative effect due to bidirectional causation.

In any case, it may be wise to refrain from drawing any premature conclusions here but instead look to differences in the responses of the labour supply of *m* and *f* to opposite direction changes in either λ_m or λ_f. Any change in λ_f affects *f* more than the opposite direction change in λ_f on *m*. The same applies when λ_m is used. For example, an increase in λ_f increases the labour supply of *f* more than the reduction in labour supply of *m*. This provides evidence for the view that policies increasing the relative bargaining power of married women vis-à-vis their husbands increase the overall labour supply of the economy. This does not necessary justify total equality of labour supply by women and men, as some degree of specialisation may be efficient. It might be possible to look at where the trade-off breaks-even by looking at other data sets.

The Nash criterion requires that an increase in the threat point results in an increase in one's own utility. Since λ is positively related to the threat point, the model predicts that an increase in λ will lead to higher utility. Part of this higher utility comes from a substitution of work for leisure or vice-versa. Since *f* increases work significantly more when her λ_f increases, compared to *m* when λ_f decreases, assuming that this is consistent with utility maximisation, it implies that the value of market goods compared to the value of leisure is higher for *f* than for *m*, hence the marginal returns to work for *f* are much greater that the marginal returns to work for *m*.

Consider the opposite case where the Nash criterion requires a reduction of one's utility. Because *m* values market goods less in relation to the value of leisure, when his relative bargaining power reduces (λ_f increases), he will compensate by reducing work more than *f* would if her relative bargaining power is to reduce (λ_f decreases). This implies that *m* works less in marriages that are more equal, even though the overall household supply of labour increases.

The other key question is, "What determines the bargaining power of married men and women?" Even without extensive information on EEPs, a regression of λ_m and λ_f against selected variables followed by hypothesis testing reveals some salient points. The results are in Tables 9 and 10 below.

Firstly, income is generally more important in increasing λ to men than women, although coefficients are positive in both cases. The exception is transfer income, which increases the bargaining power of women more than men. This implies that child support and other measures provided to women in the divorced state increase their bargaining power in the married state. The existence of labour *(ofum labour y)* and non-labour income *(ofum non-l y)* from other family unit members also has a positive effect on λ, as these presumably could become alternative sources of income should one get divorced.

There is significant correlation with the Beale-Ross rural-urban continuum measure (*ruralurban*). The more rural it is (higher values of *ruralurban*), the more bargaining power men have, and the reverse is true for women. Measurements of overall well being (*yneeds* – an income-needs ratio, or *excessroom*) have negative coefficients for both men and women. As these are combined household measures, they may be capturing the amount of household public goods consumed (such as a large house and its associated furnishings or appliances). In other words, the higher the amount of household public goods consumed, the lower the threat point of both individuals as both will have to purchase these separately if divorced. Furthermore, the revealed consumption of these household public goods may imply a higher valuation in terms of utility for them. Being out of the labour force (retired/student/in prison/in institution) reduces λ.

Interestingly, doing housework actually increases λ for men more than for women, although both have positive effects. So as a closing statement, perhaps a good advice for married men is to help out more at home and to work less. The prediction here is that one's utility will increase.

Table 9: Estimated Income Elasticities* and Coefficients for Other Variables (Threat Points)

	labour y	*"own" asset y*	*"part" asset y*	*transfer y*	*wkgratio*	*age*	
Male	1.2225(0.000)	.0715(0.000)	.0406(0.004)	.0385(0.013)	-.0178(0.120)	.0410(0.000)	
Female	.8641(0.000)	.00070(0.909)	.0176(0.002)	.0763(0.000)	-.0830(0.000)	.0208(0.031)	
	age^2	*age*^{3}	*yneeds*	*ruralurban*	*excessrm*	*ed*	
Male	-.00086(0.000)	5.7x10^{-6}(0.000)	-.0042(0.000)	.0025(0.001)	-.0107(0.000)	-.0057(0.000)	
Female	-.00041(0.093)	2.8x10^{-6}(0.163)	-.0062(0.000)	-.0032(0.008)	-.0152(0.000)	.0043(0.077)	
	jobedreq	*k0-5*	*k6-13*	*k14-17*	*lnfood*	*hwratio*	
Male	.0013(0.259)	-.0314(0.000)	-.0190(0.000)	-.0258(0.000)	-.0347(0.000)	.2583(0.000)	
Female	-.0027(0.161)	-.0221(0.001)	-.0093(0.062)	-.0122(0.069)	-.0839(0.000)	.1028(0.000)	
	ofum labour y	*ofum non-l y*	*out of lab. force*	*childcare*	*constant*	*n*	*"R-sq"*
Male	.1515(0.000)	.0983(0.000)	-.0605(0.000)	-2.0x10^{-6}(0.369)	-.2321(0.004)	1800	0.4149
Female	.2007(0.000)	.0199(0.012)	-.0423(0.004)	-3.4x10^{-6}(0.366)	.5167(0.000)	1800	0.3112

**Elasticities are calculated at the sample mean value, (p-values in brackets).*

Table 10: Threat Points Hypothesis Testing Results (p-value)

labour y	*"own" asset y*	*"part" asset y*	*transfer y*	*y (joint)*	*childcare*
0.0000	0.6983	0.0241	0.0000	0.0000	0.7407
yneeds	*ruralurban*	*excessrm*	*ed*	*jobedreq*	*k0-5*
0.0068	0.0000	0.0716	0.0003	0.0753	0.2037
k6-13	*k14-17*	*lnfood*	*hwratio*		
0.0910	0.0760	0.0000	0.0000		
wkgratio	*ofum labour y*	*ofum non-l y*	*out of lab. force*		
0.0035	0.0000	0.0008	0.4098		

10. Conclusion

In the Nash-bargained game, both parties have separate preferences or utility functions. Distribution within the family is also affected by the opportunity cost of marriage for each party. The income pooling hypothesis has been rejected in this paper and the Nash-bargained game empirically modelled with supporting evidence, even without extensive information on EEPs (McElroy, 1990).

Regressions were done using a simultaneous equations approach, extending a set of equations proposed in Lundberg (1988). The main benefit of using the simultaneous equations approach is to accord more flexibility in the modelling and hypothesis testing of household behaviour, by considering the labour supply decisions of both husband and wife simultaneously.

The data on non-labour income was decomposed into three parts: transfer income; asset income derived from rents, interests, dividends, trust funds, alimony, or royalties; and the asset part of income from activities such as business, market gardening, or roomers/boarders. The results suggest that spurious correlation with the number of hours worked due to the decomposition of income from these activities into asset and labour parts may be responsible for wrong signed income effects in regressions using aggregated measures of asset income or non-labour income as regressors.

The results from the simultaneous equations approach were compared to those of an instrumental variables approach in the pattern of Mroz (1987), endogeneity tests were carried out within a framework of over-identifying restrictions, and an attempt was made in adjusting for censored sample selection bias. Problems encountered were evaluated critically, in the context of other work in the literature on the general applicability of Heckman (1976) procedures. The results strongly support the use of the simultaneous equations approach in modelling Nash-bargained household behaviour, and demonstrate that interesting results can be obtained from such an approach.

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Appendix A: Full List of Variables in Dataset

hourlywage, whourlywage	Hourly wages reported by the head and the wife respectively
lnhw, lnww	Natural logarithm of the above
hwkhrs, wwkhrs	Number of hours worked in the year as reported by the head and wife respectively
lnhh, lnwh	Natural logarithm of the above
housewkofum, housewkh, housewkw	Number of hours spent on housework in the year as reported by the head, wife and OFUM
hhwratio, whwratio	Ratio of hours spent doing housework by head or wife to the total hours of housework done for the family unit
housevalue	House value in $'0000 if owned
foodcost	The spending in $ on food in the year
lnfoodcost	Natural logarithm of the above
eatout	The spending in $ on eatout in the year
hlabory, wlabory, ofumly	in '000. The income derived from labour for the head, wife, or OFUM in the year
wkg_nonwkg	The ratio of working persons to total number of persons in the family unit
noofumwkg	Number of OFUM working
noinfu	Number of persons in family unit
sexh	Sex of the head (0=male, 1=female)
ageh, agew	Age of the head and wife
ageh2, agew2	Square of the above
hnotwkg, wnotwkg	Dummy variables indicating that the head or the wife is not in the labour force due to being retired, a student, in prison, or at an institution. There could still be some work or income reported from part-time sources.
humemp, wunemp	Dummy variables indicating that the head or the wife are unemployed and looking for work
hocc1..hocc12, wocc1..wocc12, hind1..hind12, wind1..wind12	Occupation and industry dummies for the head and the wife
hunion, wunion	Union participation dummies for head and wife
hjobedreq, wjobedreq	The level of education required for the job that the head or wife is working in. On a scale of 1 to 8 provided by the PSID.
hjobedreq2, wjobedreq2	Square of the above
hresw, wresw	Reservation wages – apply only to unemployed persons
hwkslooked, wwkslooked	Number of weeks spent looking for a job – apply only to unemployed persons
hplaceslooked, wplaceslooked	Number of places looked for a job – apply only to unemployed persons (5 = 5 or above)
mmorechildwanted, fmorechildwanted	Number of children wanted (more than current number) as provided by male or female person (in the FU) respectively
dmorechildwant	Absolute difference between the m and f measures above
childcaree, childcareb, childcarew, childcareh	Dummy variables indicating if childcare is provided primarily by external person/organization, jointly by both the head and the wife, by the wife, or by the head, respectively.
childcarecost	The spending in $ on childcare in the year
yneeds	The annual household income/needs measure
havhry, wavhry	Average hourly income calculated (and provided by the PSID) by

	dividing annual income by number of hours worked for the head and wife
ruralurban	Beale-Ross rural-urban continuum from 1 to 10. 1 is most urban.
excessrm	An index from 0 to 8 measuring the excess (or shortage) of number of rooms for the size of FU
hed, wed	The level of education of the head or wife is working in. On a scale of 1 to 8 provided by the PSID.
hed2, wed2	Square of the above
expw, exph	Years of working experience for head and wife
expw2, exph2	Square of the above
ftexpw, ftexph	Years of full-time working experience for head and wife
ftexpw2, ftexph2	Square of the above
unemprate	in %. Unemployment rate of the county of residence.
livetogether	A dummy variable indicating that the head is staying together with his/her girlfriend/boyfriend but is otherwise considered not married or cohabiting (information about this other person is not in the data)
divorced	A dummy variable indicating that the head has been divorced
single	A dummy variable indicating that the head has never been married before
widowed	A dummy variable indicating that the head has been widowed
separated	A dummy variable indicating that the head is separated and no longer living with his legal wife
married	A dummy variable indicating that the head is legally married and living with his wife
cohabit	A dummy variable indicating that the head is cohabiting with his "Wife" but not legally married. The PSID considers such long term cohabiting persons equally to legally married wives and collects data similarly.
have2	Either married or cohabit is true. A dummy used to indicate 2 person ("husband-wife") led family units.
divsep	Either divorced or separated. A dummy used to indicate persons divorced or separated (but could be cohabiting with someone else)
weight	A family weight provided by the PSID
kids0_5, kids6_13, kids14_17	Number of children currently staying in the family unit of the respective ages
kids0_5_2, kids6_13_2, kids14_17_2	Square of the above
hnonly, wnonly, ofumnonly	In $'000. Non labor income of head, wife, and OFUM. Consists of the component parts below.
hassety, wassety, ofumassety	In $'000. Asset income of head, wife, and OFUM. Consists of the following 2 component parts.
hpartassety, wpartassety	In $'000. Head and wife's part of asset income from business, market gardening, roomers/boarders.
hownassety, wownassety	In $'000. Head and wife's asset income from rent, interest, dividend, trust fund, alimony and royalties.
htransfery, wtransfery	In $'000. Government and private transfer income.
ofumassety, ofumtransfery	In $'000. Components of OFUM non labour income.
honly, wonly, fnly	In $'000. Sum of non labour income of other than the head, other than the wife, or of the entire family unit respectively.
fly, fnly, fty	In $'000. Family labour, non-labour, and total income respectively
flypp, fnlypp, ftypp	In $'000. Per capita values of above