Labour Supply Estimates for Married Women in Australia

Rosanna Scutella
Melbourne Institute of Applied Economic and Social Research
The University of Melbourne

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Melbourne Institute of Applied Economic and Social Research
The University of Melbourne
Victoria 3010 Australia
***Telephone* (03) 9344 5330**
***Fax* (03) 9344 5630**
***Email* melb.inst@iaesr.unimelb.edu.au**
***WWW Address* http://www.ecom.unimelb.edu.au/iaesrwww/home.html**

Abstract

This analysis uses a sample selection model to estimate the hours of work decision for married women in Australia using unit record data for 1995 and 1996. Hours of work are found to be positively related to the after tax wage rate and negatively related to unearned income (which includes benefits). Other characteristics of married women are also found to have an effect on the labour supply decision. Wage elasticities are calculated from the results of the labour supply estimation. These show considerable heterogeneity in married women's responsiveness to the wage rate between different demographic types.

1. Introduction

The Australian social security system currently offers a diverse range of benefits to individuals in need of financial assistance ranging from unemployment benefits, to assistance to working families, through family allowances and tax rebates. These benefits are subject to individual personal income, family income and assets tests. Many individuals are entitled to receive a range of benefits whilst earning less than some predetermined threshold of income. Certain individuals are also entitled to a number of non-cash benefits such as concessions to pharmaceuticals, energy bills and public transport. Thus, when individuals decide to enter the work force, or increase their hours of work they may be subject to overlapping means tests which combined with the tax system can lead to individuals facing high effective marginal tax rates (EMTR's).[1] These "poverty traps" are commonly seen as a disincentive to either enter the workforce or increase hours of work.

With males being the traditional "bread winner" males tend to be less responsive to changes in taxes and/or benefit structures and work the standard forty-hour week. Women, particularly married women, tend to be more sensitive to policy changes, regularly varying their participation/hours of work decision. For the purposes of policy analysis it is important to know how sensitive the supply of labour is to changes in the tax and social security system. The basis of this is to estimate hours of work as a function of the net wage rate and unearned income.

Early labour supply studies use a standard ordinary least squares regression approach to estimate hours of work. The first published study to do this was in Kosters (1966, 1969) where the approach used was to regress hours of work on an individuals wage, unearned income and a range of variables denoting demographic characteristics. A standard regression approach is however not appropriate as the distribution of hours worked is censored with a spike in the distribution at zero hours of work. A censored regression model or tobit accounts for the censoring. A problem with this approach is that we can not separate out the individual effects of (i) what determines individuals' likelihood of finding themselves in employment and (ii) what

[1] Research at the National Centre for Social and Economic Modelling (NATSEM) shows that in many instances individuals and families face EMTR's close to, and at times, greater than 100%. See for example Harding and Polette (1995), Ingles (1997) and Beer (1998).

determines their hours of work decision. These effects can be separated using a sample selection approach. In this the likelihood of being employed is estimated separately from the hours of work decision where unobserved effects which determine the likelihood of employment may be correlated with the unobserved components of the hours of work decision. An additional complication arises with the possible endogeneity of income variables to the hours of work decision. Data sources used in most labour supply studies do not provide direct information on hourly wage rates. Therefore they must be derived from information on weekly earnings and weekly hours of work information. Thus the wage rate is endogenous with hours. Other income may also be endogenous to the hours of work decision as benefits are reduced or eliminated when individuals work longer hours (as they are receiving higher earnings). Instrumental variables techniques have been used to remedy this problem but choosing a valid set of instruments is not trivial. Alternatively, Smith and Blundell (1986) show that the endogeneity of income variables can be corrected by using the residuals obtained by estimating reduced form wage and unearned income equations as additional regressors in the hours equation.

This paper estimates the hours of work decision for married women in Australia using a sample selection approach. The specification of the model follows that outlined in Duncan (1993). It is important to note that in this analysis demand constraints are ignored. The focus is on the determinants on the supply of labour only. It is therefore assumed that if a person chooses to supply more labour they are able to do so. Endogeneity problems are accounted for, in a final version of the model, using the method proposed by Smith and Blundell (1986). The structure of the paper follows. Section 2 provides a brief overview of the microeconomic theory involved in deriving a theoretical model of labour supply, with Section 3 describing the estimation procedure and issues involved in formulating an applied econometric model of labour supply. A descriptive analysis of the characteristics of married women in Australia is presented in Section 4. Section 5 presents the empirical findings of labour supply decisions for married women in Australia using data from the Income Distribution Survey, ABS (1995, 1996). Concluding comments and policy implications are presented in Section 6.

2. Labour supply theory

The neo-classical approach to consumer theory involves an individual determining optimal labour supply based on maximising a utility function subject to a wealth or budget constraint. This is shown in (2.1) with preferences defined over a bundle of goods (all consumption goods other than leisure) and hours of work. Heterogeneity between individuals is also factored into the general utility function. From this maximisation problem the labour supply function, $h(w, \mu : \xi)$, is derived.

$$\text{Max } U(c, h : \xi) \qquad \text{subject to} \qquad wh + \mu = c \tag{2.1}$$

where:

c = consumption of goods other than leisure,

h = hours of work,

w = after tax wage,

ξ = demographic characteristics,

μ = unearned or virtual income (defined to be the difference between total expenditure and earned income).

The labour supply function can be specified directly. However, in order to examine welfare effects of tax changes it is necessary to derive the indirect utility function, *V(w,μ)*, using an application of Roy's Identity. This imposes a strong constraint on the range of functional forms that can be used. What is required is a flexible functional form allowing for backward bending supply at higher wage rates. Alternative specifications of direct and indirect utility functions and their feasibility are outlined in Stern (1986). This paper uses the specification outlined in Duncan (1993) shown in (2.2).

$$h(w_i, \mu_i, \xi_i) = \alpha \ln w_i + \beta \ln w_i^2 + \gamma(\mu_i / w_i) + \delta + \varepsilon_i \tag{2.2}$$

where:

w_i = after tax wage rate per hour or marginal wage,

μ_i = unearned or virtual income, and

parameters α,β, γ, and δ are allowed to depend on characteristics of individuals (interaction terms).

The above labour supply function displays the required properties of a utility maximising labour supply function. It is upward sloping for lower wages and is flexible enough to allow for the backward bending portion of labour supply at higher wage rates. It is also attractive in that the indirect utility function is explicitly available. An additional requirement for utility maximisation is that the integrability conditions be satisfied. Creedy and Duncan (1999) show that in order for these conditions to be satisfied in the context of labour supply the wage response of the compensated labour supply must be non-negative known as the Slutsky condition, that is

$$\frac{\partial h}{\partial w} - h\frac{\partial h}{\partial \mu} \geq 0 \qquad (2.3)$$

The integrability condition defined is straightforward to check once the hours of work equation has been specified and estimated.

3. Estimation method

As mentioned earlier, a standard regression approach is not appropriate when estimating an hours of work function. The distribution of hours worked exhibits censoring at zero hours of work. Thus an alternative approach needs to be used. A censored regression model or tobit is one alternative. However the determinants of whether an individual decides to work may be different from those affecting the hours of work decision. A selection model accounts for these differences.

Certain individuals may leave the labour force due to the presence of search costs or they may simply be discouraged from looking for work as they feel that the probability of finding a job is very small. Duncan (1993) accounts for discouraged workers by estimating an hours of work equation which models the desire to enter the labour force and the employment probability separately from the hours of work decision. However, the data source used here does not identify discouraged workers; therefore this decision cannot be modelled. Therefore the following analysis only accounts for the probability of employment, conditional on being in the labour force.

Using the sample selection approach to model the hours of work equation, the probability of individuals finding themselves in employment is estimated separately from the hours of work decision. Thus hours of work can be estimated for the selected sample of those employed. The probability of being employed or selection equation may be estimated using a probit specification with the dependent variable, y_i, a discrete choice variable. The specification of the selection equation is outlined in (3.1) where x_i refers to a vector of individual and regional characteristics.

$$y_i^* = x_i\theta + \psi_i \qquad with\ \psi_i \sim N(0,\sigma_\psi^2) \tag{3.1}$$

Where:

$$\begin{aligned} y_i &= 1 \quad if\ y_i^* > 0 \\ &= 0 \quad if\ y_i^* \leq 0 \end{aligned} \tag{3.2}$$

The log-likelihood function, assuming normality, is thus specified as,

$$\begin{aligned} \ln(L_i) &= \sum_{i=1}^{N}\{(1-y_i)\ln[\Pr(h_i^* \leq 0)] + y_i \ln[\Pr(h_i^* > 0)]\} \\ &= \sum_{i=1}^{N}[y_i \ln(\Phi_i) + (1-y_i)\ln(1-\Phi_i)] \end{aligned} \tag{3.3}$$

Now that the selection equation has been defined the next step is to outline how to estimate the hours of work equation conditional on being employed. Expected hours of work conditional on being employed are,

$$\begin{aligned} E[h_i|h_i > 0] &= E[h_i|y_i = 1] \\ &= E[h_i|\psi_i > -\theta' x_i] \\ &= \alpha \ln w_i + \beta \ln w_i^2 + \gamma(\mu_i / w_i) + \delta + E[\varepsilon_i|\psi_i > -\theta' x_i] \\ &= \alpha \ln w_i + \beta \ln w_i^2 + \gamma(\mu_i / w_i) + \delta + \beta_\lambda \lambda_i(\theta' x_i) \end{aligned} \tag{3.4}$$

where $\quad \lambda_i(\theta' x_i) = \dfrac{\phi(h_i - \theta' x_i)}{\Phi(\theta' x_i)}$ and $\beta_\lambda = \rho\sigma_\varepsilon$

In (3.4) and (3.5) it can be seen that unobserved information determining the probability of being employed enters the conditional hours equation in the form of an extra regressor, $\lambda_i(\theta' x_i)$. This regressor is known as the “Inverse Mills Ratio”. Thus, estimating hours of work on the selection of solely those employed without this additional information may lead to biased estimates. The resulting hours of work specification is presented in (3.5).

$$h_i | y_i = 1 = \alpha \ln w_i + \beta \ln w_i^2 + \gamma(\mu_i / w_i) + \delta + \beta_\lambda \lambda_i(\theta' x_i) + v_i \qquad (3.5)$$

Estimates of the above parameters can be easily obtained using the two-step procedure outlined by Heckman (1979). This consists of first estimating a probit equation using maximum likelihood methods to obtain estimates of θ. For each observation in the selected sample compute the inverse mills ratio as shown in (3.6).

$$\hat{\lambda}_i = \frac{\phi(\hat{\theta}' x_i)}{\Phi(\hat{\theta}' x_i)} \qquad (3.6)$$

The second step consists of finding $\hat{\alpha}, \hat{\beta}, \hat{\gamma}, \hat{\delta}\, and\, \hat{\beta}_\lambda$ by ordinary regression methods.

This procedure yields consistent parameter estimates however they are not efficient, as the error term of (3.5) is heteroskedastic. The appropriate covariance matrix, derived in Greene (1981), is shown in (3.7).

$$\text{Var}\left(\beta_*\right) = \hat{\sigma}_v^2 [X_*' X_*]^{-1} \left[X_*'\left(I - \hat{\rho}^2 \Delta\right) X_* + Q\right][X_*' X_*]^{-1}, \qquad (3.7)$$

where X_* is the matrix of variables $[w_i, \mu_i, \xi_i, \lambda_i]$ with associated coefficients β_*, $\left(I - \hat{\rho}^2 \Delta\right)$ is a diagonal matrix with $\left(1 - \hat{\rho}^2 \delta_i\right)$ on the diagonal and $Q = \hat{\rho}^2 \left(X_*' W\right) V \left(W' X_*\right)$ where $\hat{}$ is the estimated asymptotic covariance matrix of θ.

As noted above there is also a possible endogeneity problem between the income variables (wage rates and unearned income) and hours of work. To test for possible endogeneity and correct for it, the methodology derived by Smith and Blundell (1986) is used. This entails including the residuals from reduced form wage and unearned income equations respectively as additional regressors in the hours equation.

4. Data

Data used in this analysis are taken from the 1995 and 1996 Survey of Income and Housing Costs available from ABS (1995) and (1996). This survey collects information on the sources and amounts of income received by persons residing in private dwellings throughout Australia. It provides detailed information on the characteristics of income units and persons surveyed. The survey is continuous with around 650 households interviewed every month during the 1995-96 and 1996-97 financial years. With over seven thousands households surveyed in each respective year, the pooled data set consists of over 28,000 individuals over the age of 15.

Households are surveyed each month. In order to derive real wage rates, average weekly earnings data provided by ABS (1999) are used to deflate/inflate wage rates. The result is a measure of real wages based on August 1995. Weekly tax paid on wage income is imputed assuming weekly wage income is constant throughout the financial year and applying the current marginal tax rates associated with the personal income tax system. The resulting estimate of weekly tax paid on earnings is subtracted from total weekly tax paid, provided in the data source, to provide an estimate of tax paid on unearned income. Tax paid on earned and unearned income is then subtracted from the gross weekly values to generate a rough estimate of after-tax wages and unearned income. Note that unearned income refers to after-tax household income including all social security benefits, investment and asset income, and partners earned income. This is not quite the same as virtual income, which is defined to be the difference between total expenditure and earned income. However as the data source does not contain information on expenditure, it is the closest proxy of virtual income available.

Individuals not in the labour force are removed, as are the self-employed. As mentioned earlier, ideally discouraged workers would be included in the estimation to capture changes in participation rates but this information is not provided in this data source.

A sample of married women is taken from the pooled data set. Difficulties arise where the partner/husband is unemployed, as benefits for the partner start tapering out when the woman begins earning a wage. As this results in more variation in women’s wage rates I further condition the sample to include only married women where the partner/husband is employed. Outliers were deleted with individuals having wage rates greater than $100 per hour and/or unearned income greater than $2000 a week omitted.

The result is a total sample size of 3,178 married females where 2,953 are employed and 225 unemployed.

Table 1 provides some descriptive statistics on hours of work per week and the hourly wage rate. Average weekly hours for married women are just over thirty hours per week. Average wages are nearly twelve dollars an hour with the average married woman's unearned income (including partner income) reaching close to $596 per week. Average weekly working hours of married women by individual characteristics are presented in Appendix 1. The distribution of weekly hours of work is shown in Figure 1. From this we can see that married women have a varied pattern of hours worked with some bunching at the standard forty-hour week. This implies that they may be sensitive to changes in the structure of taxes and/or benefits. Figure 2 shows the distribution of the logarithm of the net wage rate.

Table 1: Descriptive statistics on hours and income for employed married women

	Mean	Standard error of the mean	Standard deviation	Skewness	Kurtosis
Hours of work	31.5	0.2	12.1	-0.5	-0.7
Net hourly wage rate	11.9	0.1	5.1	4.4	39.8
Log net hourly wage rate	2.4	0.006	0.3	0.0	5.2
Net unearned weekly income	595.6	4.2	225.7	0.8	19.2

Figure 1: Hours distribution of workers

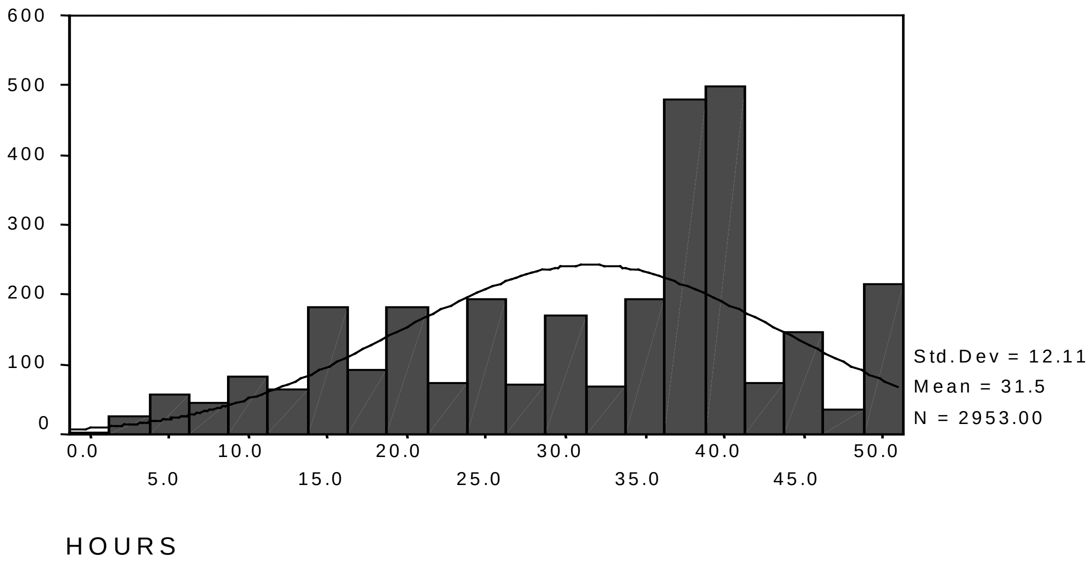
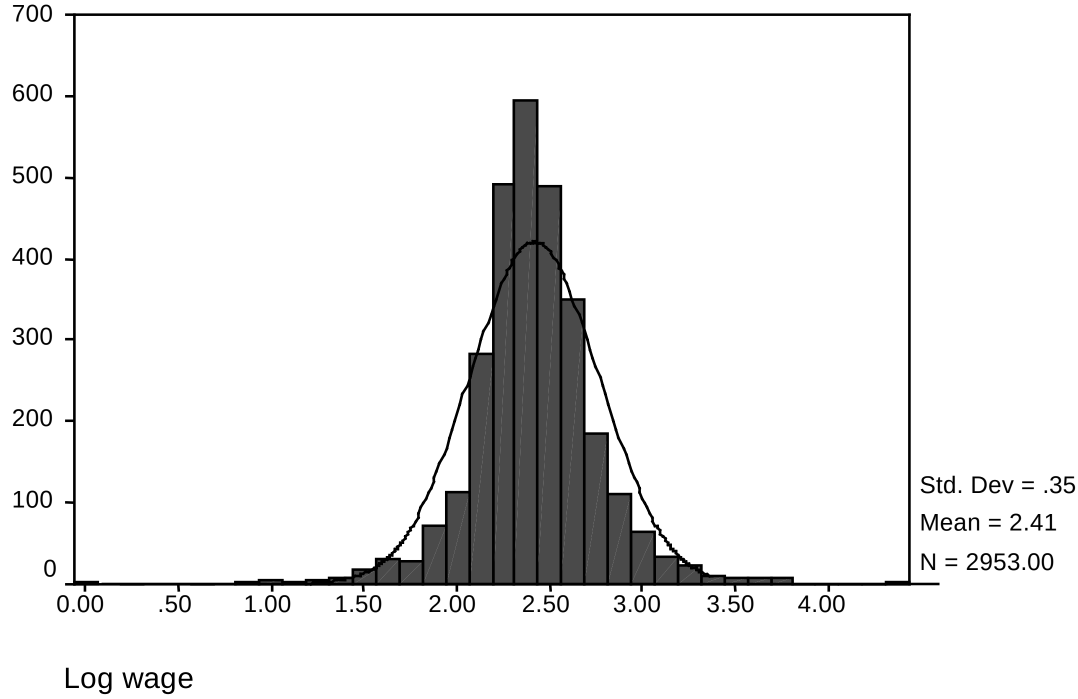


Figure 2: Earnings distribution of workers, log hourly wage based on August 1995 wages



5. Results

This section applies the econometric methods outlined in Section 3 to the data outlined in Section 4 to estimate an hours of work equation for Australian married women. Table 2 presents the results of the selection equation determining the probability of a married woman being found in employment. Married women aged younger than 25 years are more likely to be employed than those aged 25 to 29 (reference age group) while those women born in Europe or Asia are less likely to be employed. Education is a factor with a tertiary qualification (either postgraduate or undergraduate) raising the probability of finding employment. Women residing in Western Australia are statistically less likely to be in employment than women in other States while living in a capital city increases the chance of employment. Looking after a young family decreases the probability of employment. Women living in households that are renting or in other tenure are also less likely to be in work. The probability of being in employment is positively related to partners hours of work.

Table 2: Participation decision for married women

	Coefficients	t-statistics
Constant	1.569044	6.261
Age less than 25 years	-0.37558	-1.815
Age 30 to 34 years	0.001922	0.01
Age 35 to 39 years	0.172412	0.848
Age 40 to 44 years	-0.07301	-0.383
Age 45 to 49 years	-0.06516	-0.328
Age 50 years plus	-0.28291	-1.413
Europe or middle east	-0.22059	-2.32
Asia	-0.40107	-2.846
America/Africa	0.258383	0.921
Postgraduate	0.508798	1.714
Undergraduate	0.530995	1.929
Diploma	-0.56684	-1.172
Vocational	-0.63153	-1.315
Other income (not including benefits)/1000	0.075059	0.566
Victoria	-0.11807	-1.084
Queensland	-0.12753	-1.103
South Australia	-0.07582	-0.557
Western Australia	-0.23732	-1.968
Tasmania	-0.04864	-0.295
ACT/NT	0.02971	0.199
Capital City	0.173522	2.103
Number of dependent children	-0.04277	-0.842
Youngest child aged 0 to 2 years	-0.37327	-2.54
Youngest child aged 3 to 4 years	-0.51018	-3.019
Youngest child aged 5 to 9 years	-0.53691	-3.595
Youngest child aged 10 to 15 years	-0.29561	-2.053
Renting	-0.26402	-2.829
Other tenure	-0.38642	-1.826
Partner postgraduate	-0.40232	-2.809
Partner undergraduate	-0.03082	-0.255
Partners hours of work	0.00869	1.847
“Older” than partner	-0.52193	-1.689
“Younger” than partner	-0.0994	-0.889
Age 25 to 29*university	-0.70441	-1.905
Age 30 to 34*university	-0.52168	-1.444
Age 35 to 39*university	-0.21331	-0.59
Age 40 to 44*university	-0.40773	-1.214

	Coefficients	t-statistics
Age 50 to 54*university	-0.26169	-0.585
Age 55 to 59*university	0.99551	1.789
Age 25 to 29*vocational	0.244377	0.467
Age 30 to 34*vocational	0.320373	0.629
Age 35 to 39*vocational	0.276036	0.538
Age 40 to 44*vocational	0.706488	1.37
Age 45 to 49*vocational	0.705471	1.339
Age 50 to 54*vocational	0.948722	1.762
Age 55 to 59*vocational	0.143699	0.256

* Note: shaded area denotes significance at 10%.

The determinants of hours of work estimated using the sample selection approach outlined earlier are presented in Table 3. The second and third columns assume that the hourly wage and unearned income are exogenous. The last two columns show the results when we correct for endogeneity problems using the methods discussed in Smith and Blundell (1988). The estimated reduced form wage and unearned income equations are presented in Appendix 2. From these results it can be seen that the wage rate is lower for married women aged less than 25 years and greater than 50 years. Occupation and educational qualification are important determinants of wages with professionals and postgraduates paid the highest wage rates. Married women born overseas face lower wage rates than the Australian born. Women residing in capital cities receive higher wage rates while married women living in Victoria, Queensland or Western Australia receive lower wage rates than women in NSW. Unearned income increases with the number of dependent children. Married women with a diploma have higher levels of unearned income with unearned income positively related to their partner’s educational qualification.

Table 3 shows that the wage rate and unearned income are endogenously determined with hours worked, as the residuals from the reduced form wage and unearned income equations are significantly different from zero. Therefore the focus will be on the results which correct for the endogeneity.

Hours worked increase with the number of dependent children however the more children aged between 0 and 2 years a woman has the more likely they are to work fewer hours than other women. Married women born overseas have a tendency to supply more labour than the Australian born, particularly those born in Asia. Overall, hours of work for married women rise with the wage rate. However the negative effect of the squared hourly wage indicates this effect is decreasing (raising the possibility of backward bending labour supply at higher wage rates). As hourly wages increase, mothers with larger families tend to supply less labour. Hours worked by professionals, paraprofessionals and clerical workers or salespersons are positively related to the hourly wage rate. Unearned income as a proportion of the wage rate has a negative effect on hours worked. With a significant and negative inverse mills ratio coefficient, unobserved characteristics of married women that effect the likelihood of employment are inversely related to the hours of work decision. The integrability conditions outlined in equation (2.3) are satisfied in 99.6 per cent of cases for the estimates correcting for any endogeneity.

It is convenient to express the responsiveness of hours of work to wages as elasticities. Wage elasticities can be decomposed into substitution and income effects. The substitution effects are normally referred to as compensated (for income effects) wage elasticities. Table 4 presents the wage and income elasticities evaluated at observation means across various demographic groups.[2] Negative income elasticities indicate that leisure is a normal good, that is an increase in income leads to an increase in the consumption of leisure (or a decrease in hours worked). Substitution effects (or compensated wage elasticities) are positive which are required by the theory. Large substitution effects outweigh the income effects leading to positive average uncompensated wage elasticities across all groups.

As family size increases hours of work become less responsive to wage changes, with income effects increasing and substitution effects decreasing with the number of dependent children. Married women with children under 2 years old are the most responsive to wage changes with an uncompensated wage elasticity of over 0.36. Those with undergraduate tertiary qualifications are the least likely to increase their hours of work when offered higher wages with relatively small substitution and income effects.

The estimates found in this paper are largely consistent with international studies. Killingsworth (1983) documents estimates of wage elasticities from the "second generation" studies of the 1976-1983 period. Wage and income elasticities in this analysis are slightly smaller in magnitude than those found for married women in these other studies. However comparing the results from

[2] Table A4 in Appendix 3 presents the average wage and income elasticities for various groups of married women.

this study to that of Duncan (1993) married women in Australia are on average more responsive to changes in the after-tax wage rate than in the United Kingdom.

Table 3: Estimation results for hours of work

	Exogenous wage and unearned income		Correcting for endogeneity of wage and unearned income	
	Coefficient	t-statistic	Coefficient	t-statistic
Constant	41.29264	6.689	4.607685	0.323
Number of dependent children	6.931203	1.996	7.063268	1.986
Number of children aged 0 to 2 years* youngest child aged 0 to 2 years	-6.79745	-2.534	-7.79868	-2.858
Number of children aged 3 to 4 years* youngest child aged 3 to 4 years	3.048734	1.604	2.423054	1.249
Number of children aged 5 to 9 years *youngest child aged 5 to 9 years	0.212469	0.241	-0.20359	-0.223
Number of children aged 10 to 15 years* youngest child aged 0 to 2 years	-1.04391	-1.395	-0.88011	-1.171
Europe or Middle Eastern	0.516956	0.841	0.992402	1.742
Asia	1.960084	1.877	3.514578	3.422
America or Africa	1.750484	1.277	2.5395	2.059
ln(hourly wage)	7.444241	1.637	22.4471	2.985
ln(hourly wage)*postgraduate	1.362172	1.802	0.59617	0.76
ln(hourly wage) *undergraduate	-0.21791	-0.443	-0.92947	-1.741
ln(hourly wage)*diploma	0.072143	0.137	-0.28996	-0.543
ln(hourly wage)*vocational	0.487674	1.188	0.357826	0.872
ln(hourly wage)*number of dependent children	-5.14812	-1.871	-4.98128	-1.769
ln(hourly wage)*professional	4.638392	16.036	2.871767	5.901
ln(hourly wage)*paraprofessional	3.806795	11.796	2.51961	5.843
ln(hourly wage)*clerical/salesperson	1.828605	8.511	1.099505	4.031
ln(hourly wage)*manufacturing	1.504995	2.396	0.373455	0.543
ln(hourly wage)*construction	0.969305	1.188	-0.4339	-0.496
ln(hourly wage)*utility	1.519364	1.349	-0.89493	-0.709
ln(hourly wage)*retail/wholesale sales	-1.4505	-2.379	-2.54031	-3.797
ln(hourly wage)*transport	0.805922	1.045	-1.11954	-1.253
ln(hourly wage)*communication	0.902739	1.062	-1.60058	-1.561
ln(hourly wage)*financial services	-0.37726	-0.613	-2.06296	-2.797
ln(hourly wage)*other services	-1.28437	-2.171	-2.58687	-3.823
$(\ln(\text{hourly wage}))^2$	-3.80924	-4.134	-2.18618	-2.166
$(\ln(\text{hourly wage}))^2$* Number of children aged 0 to 2 years	0.204974	0.642	0.333541	1.029

	Exogenous wage and unearned income		Correcting for endogeneity of wage and unearned income	
	Coefficient	t-statistic	Coefficient	t-statistic
$(\ln(\text{hourly wage}))^2$* Number of children aged 3 to 4 years	-0.54313	-3.429	-0.48863	-3.04
$(\ln(\text{hourly wage}))^2$* Number of children aged 5 to 10 years	-0.29166	-2.481	-0.24765	-2.081
$(\ln(\text{hourly wage}))^2$* Number of children aged 10 to 15 years	-0.10535	-0.988	-0.09609	-0.905
$(\ln(\text{hourly wage}))^2$*number of dependent children	0.928758	1.642	0.852591	1.48
$(\ln(\text{hourly wage}))^2$*age less than 25 years	-0.43035	-1.317	-0.16123	-0.487
$(\ln(\text{hourly wage}))^2$*age 30 to 34 years	0.0985	0.459	-0.06297	-0.287
$(\ln(\text{hourly wage}))^2$*age 35 to 39 years	-0.2525	-1.166	-0.39538	-1.838
$(\ln(\text{hourly wage}))^2$*age 40 to 44 years	-0.05043	-0.235	-0.05272	-0.25
$(\ln(\text{hourly wage}))^2$*age 45 to 49 years	-0.32111	-1.47	-0.33552	-1.594
$(\ln(\text{hourly wage}))^2$*age 50 years plus	-0.6301	-2.965	-0.54617	-2.635
$(\ln(\text{hourly wage}))^2$*partners hours of work	-0.0113	-2.092	-0.01381	-2.527
(Unearned income/wage)	-0.13776	-3.764	-0.20925	-4.981
(Unearned income/wage)*partners hours of work	0.003375	5.475	0.003867	6.045
(Unearned income/wage)*youngest child aged 0 to 2 years	-0.00226	-0.091	-0.00176	-0.071
(Unearned income/wage)*youngest child aged 3 to 4 years	-0.05943	-1.929	-0.05984	-1.899
(Unearned income/wage)*youngest child aged 5 to 10 years	-0.02402	-1.46	-0.02162	-1.295
(Unearned income/wage)*youngest child aged 10 to 15 years	-0.00495	-0.301	-0.00762	-0.475
(Unearned income/wage)*age less than 25 years	0.021954	0.672	0.03268	0.981
(Unearned income/wage)*age 30 to 34 years	-0.04621	-1.965	-0.05658	-2.363
(Unearned income/wage)*age 35 to 39 years	-0.04484	-1.964	-0.05333	-2.343
(Unearned income/wage)*age 40 to 44 years	-0.06459	-2.996	-0.05856	-2.72
(Unearned income/wage)*age 45 to 49 years	-0.0505	-2.276	-0.04762	-2.198
(Unearned income/wage)*age 50 years plus	-0.02215	-1.027	-0.01339	-0.63
(Unearned income/wage)*postgraduate	0.038907	1.157	0.002854	0.084
(Unearned income/wage)*undergraduate	0.047976	2.333	0.022841	1.111

	Exogenous wage and unearned income		Correcting for endogeneity of wage and unearned income	
	Coefficient	t-statistic	Coefficient	t-statistic
(Unearned income/wage)*diploma	0.011377	0.569	0.000389	0.019
(Unearned income/wage)*vocational	-0.00872	-0.568	-0.01127	-0.721
Inverse Mills Ratio	-14.3894	-4.085	-23.2535	-4.463
Residuals from reduced form wage equation			0.006665	3.577
Residuals from reduced form unearned income equation			-7.71829	-2.209
Number of observations	2953		2953	

* Note: shaded area denotes significance at 10%.

Table 4: Wage and income elasticities evaluated at observation means

Mean	Uncompensated	Compensated	Income	Number of observations
Total	0.304	0.394	-0.089	2953
Age				
Age less than 25 years	0.251	0.268	-0.017	193
Age 25 to 34 years	0.314	0.400	-0.085	829
Age 35 to 44 years	0.331	0.445	-0.114	1024
Age 45 years plus	0.285	0.366	-0.081	907
Number of dependent children				
No children	0.297	0.336	-0.069	1306
1 child	0.340	0.434	-0.094	565
2 children	0.320	0.429	-0.108	754
3 children	0.273	0.385	-0.112	275
4 children plus	0.247	0.361	-0.114	53
Age of youngest child				
0 to 2 years	0.363	0.439	-0.077	342
3 to 4 years	0.259	0.439	-0.150	185
5 to 9 years	0.309	0.426	-0.117	414
10 to 15 years	0.348	0.452	-0.104	420
Educational qualification				
Postgraduate	0.270	0.368	-0.098	164
Undergraduate	0.228	0.297	-0.069	380
Diploma	0.293	0.387	-0.094	303
Vocational	0.333	0.431	-0.098	561
No qualification	0.325	0.414	-0.089	1545

6. Concluding comment

Estimating labour supply for married women using a sample selection approach this analysis suggests that married women's hours of work decision are sensitive to changes in the structure of the Australian Tax and Social Security System. The positive relationship between the wage rate and the hours of work decision suggest that cuts in income taxes (through higher after tax wage rates) would offer a positive incentive to increase married women's hours of work. This is reinforced by a positive wage elasticity for married women. As family size increases, although the estimation shows that married women tend to work longer hours, the income effects of a change in wages increase, leading to women with larger families responding less to changes in after-tax wages. Women with children younger than 2 years of age are the most responsive to changes in wages.

The analysis also shows that changes in the benefit structure would affect work incentives. Generally, an increase in the value of benefits decreases the supply of labour by married women. Thus, if social security payments were more generous, married women would significantly reduce their hours of work. Alternatively, a tightening of benefits would increase the supply of labour by married women. Also indicated from this analysis is that the wage rate and unearned income are indeed endogenous with the hours of work decision. Thus, not accounting for this endogeneity will lead to biased estimates.

Appendix 1

Table A1: Average weekly working hours of married women

Characteristics	Hours per week
Age	
20 to 24 years	27.2
25 to 29 years	27.3
30 to 34 years	26.8
35 to 39 years	27.0
40 to 44 years	30.1
45 to 49 years	28.6
50 to 54 years	33.9
55 to 59 years	*
Educational qualification	
Postgraduate	33.3
Undergraduate	29.6
Diploma	28.5
Vocational	27.0
No qualification	27.0
Occupation	
Professional	31.4
Paraprofessional	29.1
Clerical/Sales	26.3
Tradesperson/Labourer	26.8
Industry	
Agriculture/Forestry	27.7
Mining	*
Manufacturing	33.6
Construction	32.2
Utilities	31.4
Retail/Wholesale Sales	24.2
Transport	29.7
Communications	30.3
Financial or business services	28.3
Other services	27.5
Country of birth	
Australia	27.5
Europe or middle east	28.2
Asia	31.0

Characteristics	Hours per week
America or Africa	32.9
Number of dependent children	
One	30.2
Two	27.4
Three	26.2
Four	27.9
Five or more	29.4
Age of youngest child	
0 to 2 years	25.2
3 to 4 years	27.6
5 to 9 years	28.7
10 to 15 years	29.5

* Less than 5 observations in category.

Appendix 2

Table A2: Results from estimation of reduced form wage equation

	Parameter estimates	t-statistic
Constant	2.162972	23.963
Age less than 25 years	-0.10874	-3.508
Age 30 to 34 years	0.075905	2.438
Age 35 to 39 years	0.052455	1.753
Age 40 to 44 years	-0.0144	-0.492
Age 45 to 49 years	0.005554	0.187
Age 50 years plus	-0.05007	-1.659
Professional	0.18472	7.711
Paraprofessional	0.130315	4.995
Clerical/Salesperson	0.068011	3.994
Manufacturing	0.103351	1.173
Construction	0.12518	1.304
Utility	0.254012	2.182
Retail/Wholesale Sales	0.102412	1.187
Transport	0.190889	2.031
Communications	0.254107	2.575
Financial or business services	0.162896	1.885
Other services	0.12499	1.468
Europe or middle east	-0.03749	-2.053
Asia	-0.10707	-3.283
America/Africa	-0.04384	-1.141
Postgraduate	0.202716	4.871
Undergraduate	0.168198	4.773
Diploma	0.073108	2.007
Vocational	0.014374	0.442
Victoria	-0.03992	-2.146
Queensland	-0.04657	-2.311
South Australia	0.020435	0.913
Western Australia	-0.05229	-2.361
Tasmania	-0.01431	-0.513
ACT/NT	0.03719	1.393
Capital City	0.044209	2.849
Age 25 to 29*university	-0.04921	-0.887
Age 30 to 34*university	-0.07863	-1.469
Age 40 to 44*university	0.006205	0.125

	Parameter estimates	t-statistic
Age 45 to 49*university	0.019681	0.39
Age 50 to 54*university	0.003464	0.056
Age 30 to 34*vocational	-0.00783	-0.162
Age 35 to 39*vocational	0.021587	0.455
Age 40 to 44*vocational	0.008273	0.179
Age 45 to 49*vocational	-0.00933	-0.2
Age 50 to 54*vocational	0.006919	0.138
Age 55 to 59*vocational	0.052767	0.639
Inverse mills ratio	-0.03118	-0.308

* Note: shaded area denotes significance at 10%.

Table A3: Results from estimation of reduced form unearned income equation

	Parameter estimates	t-statistic
Constant	561.2311	15.896
Age less than 25 years	-29.2876	-0.756
Age 30 to 34 years	10.54215	0.341
Age 35 to 39 years	-23.4597	-0.708
Age 40 to 44 years	26.12587	0.814
Age 45 to 49 years	26.28067	0.825
Age 50 years plus	27.68521	0.851
Renting	23.81353	0.955
Other tenure	50.14942	0.854
Europe or middle east	5.05	0.212
Asia	-2.36979	-0.058
America/Africa	-51.3126	-1.012
Postgraduate	23.76275	0.613
Undergraduate	-5.95981	-0.22
Diploma	46.35173	1.689
Vocational	26.66197	1.223
Victoria	-12.4746	-0.517
Queensland	23.2178	0.895
South Australia	-11.5171	-0.396
Western Australia	55.93116	1.944
Tasmania	-6.86134	-0.191
ACT/NT	29.37665	0.863
Capital City	-5.46701	-0.278
Number of dependent children	46.22994	3.794
Youngest child aged 0 to 2 years	22.01785	0.596
Youngest child aged 3 to 4 years	34.31506	0.765
Youngest child aged 5 to 9 years	50.63894	1.295
Youngest child aged 10 to 15 years	29.85335	0.92
Partner postgraduate	254.1872	6.853
Partner undergraduate	147.2761	5.521
Partner diploma	82.81698	6.048
Partner vocational	27.7914	2.795
Inverse mills ratio	-836.025	-5.312

* Note: shaded area denotes significance at 10%.

Appendix 3

Table A4: Average wage and income elasticities

Mean	Uncompensated	Compensated	Income	Number of observations
Total	0.441	0.530	-0.088	2953
Age				
Age less than 25 years	0.289	0.307	-0.017	193
Age 25 to 34 years	0.442	0.525	-0.084	829
Age 35 to 44 years	0.487	0.600	-0.113	1024
Age 45 years plus	0.422	0.503	-0.080	907
Number of dependent children				
No children	0.379	0.448	-0.069	1306
1 child	0.492	0.586	-0.094	565
2 children	0.500	0.607	-0.107	754
3 children	0.479	0.591	-0.113	275
4 children plus	0.411	0.522	-0.111	53
Age of youngest child				
0 to 2 years	0.644	0.721	-0.077	342
3 to 4 years	0.407	0.555	-0.149	185
5 to 9 years	0.434	0.552	-0.117	414
10 to 15 years	0.491	0.594	-0.103	420
Educational qualification				
Postgraduate	0.330	0.426	-0.096	164
Undergraduate	0.306	0.375	-0.069	380
Diploma	0.425	0.518	-0.093	303
Vocational	0.495	0.592	-0.098	561
No qualification	0.470	0.559	-0.088	1545

References

Australian Bureau of Statistics (1999), *Average Weekly Earnings: Australia*, Catalogue No. 6301.0, Table 1, AGPS, Canberra.

Australian Bureau of Statistics (1995), *Income and Housing Costs Survey: Confidentialised Unit Record File,* Catalogue No. 6541.0.15.001, AGPS, Canberra.

Australian Bureau of Statistics (1996), *Income and Housing Costs Survey: Confidentialised Unit Record File,* Catalogue No. 6541.0.15.001, AGPS, Canberra.

Beer, G. (1998): "The State of Play of Effective Marginal Tax Rates in Australia in 1997", *Australian Economic Review*, 3rd quarter, pp. 263-270.

Creedy, J. and A. Duncan (1999): "Welfare, Non-Linear Budget Constraints and Behavioural Microsimulation", MIAESR Working Paper No. 10/99.

Duncan, A. (1993): " Labour Supply Decisions and Non-Convex Budget Sets", in *Empirical Approaches to Fiscal Policy Modelling*, ed. by A. Heimler, and D. Muelders, pp. 137-162. London: Chapman Hall.

Greene, W. (1981); Sample Selection Bias as a Specification Error: Comment, *Econometrica*, vol. 49, pp. 795-798.

Harding, A. and J. Pollette (1995): "The Price of Means-Tested Transfers: Effective Marginal Tax Rates in Australia in 1994", *Australian Economic Review*, 3rd quarter, pp. 100-106.

Heckman, J. J. (1979): "Sample Selection Bias as a Specification Error," *Econometrica*, 47, pp. 153-161.

Ingles, D. (1997): "Low Income Traps for Working Families", Discussion Paper no. 363, Centre for Economic Policy Research, Australian National University.

Killingsworth, M. (1983), "*Labour Supply*", Cambridge, MA: Cambridge University Press.

Smith, R. J. and R.W. Blundell (1986): “An Exogeneity Test for a Simultaneous Equation Tobit Model with an Application to Labour Supply”, *Econometrica*, Vol. 54, No. 3, pp. 679-685.

Stern (1986): “On the Specification of Labour Supply Functions”, in *Unemployment, Search and Labour Supply*, ed. by R. Blundell and I. Walker, pp. 143-189, Cambridge University Press.