The Australian National University

Centre for Economic Policy Research

DISCUSSION PAPER

Improving the Modeling of Couples' Labour Supply

Robert Breunig*, Deborah A. Cobb-Clark and Xiaodong Gong

DISCUSSION PAPER NO. 499
September 2005

ISSN: 1442-8636
ISBN: 0 7315 3569 3

---

*Corresponding Author: Robert Breunig, Economics Program, Research School of Social Sciences, Building 9, Australian National University, Canberra, ACT 0200 Australia
Email: Robert.Breunig@anu.edu.au.

Acknowledgements
We would like to thank Guyonne Kalb and Patricia Apps for their comments, which have led to an improved paper.

ABSTRACT

We study the work hours of Australian couples, using a neoclassical labour-supply model in which couples choose from a small, realistic set of possible wife-husband working hour combinations. We introduce three improvements to this standard model. First, we allow partners' preferences about non-market time to be correlated. We also correct the estimates to accunt for the fact that we estimate the non-observable wage rates of individuals who do not work. Lastly, we allow each individual's preferences for non-market time to be correlated with her or his wage rate. These changes, which substantially enhance the realism of the standard, discretized labour-supply model, also have an important impact on the results. We estimate the model using HILDA data and find wage elasticities of labour supply - 0.26 for men and 0.50 for women - that are twice as large as those found without these three innovations. Using simulation methods, we then analyze the expected impact of the 2005/06 Australian tax reform. As a result of the tax cuts, we expect working hours to increase by 1.7 per cent for both men and women and household after-tax incomes to increase by approximately $60 per week on average. For families with two wage earners, each earning between $25,000 and $55,000 per year, our model predicts an after-tax increase in income of $38 after accounting for these labour supply effects - much larger than the Australian Government's own prediction of $12, which does not allow for labour supply effects.

JEL Codes: C51,D10,J22

Keywords: Family Labour Supply, Australia, Simulated Maximum Likelihood, Discretized Structural Model

1 Introduction

The objective of this paper is to estimate a structural labour-supply model for Australian couples. We improve upon existing models by making several extensions which better capture the complexity of couple behaviour. Since individuals choose to take up a job at a particular wage, it seems intuitively correct that their reservation wage should be affected by their personal trade-off between having more money and having more free time. Moreover, partners are not randomly assigned to one another, but instead choose to be together on the basis of compatibility over a whole set of issues. Thus it also seems plausible that spouses' preferences about the relative value of working and non-working time should be related to one another. Our specification allows for both of these possibilities–and we find that both matter. We also make an improvement of a more technical nature (which also matters considerably for our estimates). Specifically, we account for the fact that wage rates for non-working individuals are *estimated* within our model. They are not treated as fixed constants, as has been done in previous work.

Having better labour-supply estimates for Australian couples is important given concerns about the economic and social consequences of population ageing. The Australian Government predicts, for example, that over the next 40 years the proportion of the population over the age of 65 will almost double, while the growth in the size of the workforce-age population will slow to zero (Australian Treasurer (2004)).[1] The ensuing increase in demand for old-age pensions and health care spending – in the face of a more or less constant tax base – implies that these demographic trends are expected to exert substantial fiscal pressure on the national budget. Policymakers have responded by considering a range of policy options targeted towards raising productivity and increasing labour force participation.

In particular, the Australian tax and transfer system is being reformed in order to improve the incentives for market work (see Australian Treasurer (2004)). The extent

[1] See McDonald and Kippen (1999) who discuss Australia's ageing population in depth.

to which these reforms are successful in increasing participation, however, is likely to depend on the labour-supply responses of key groups in society – in particular married women and lone parents – who appear to be particularly sensitive to the financial return to market work (see for example, Apps (1991); Eissa and Hoynes (2004); Blundell and Hoynes (2004); Blundell et al. (2000); Doiron and Kalb (2002); Doiron and Kalb (2005); Creedy et al. (2003)). Apps (1991) argues, for example, that understanding shifts in the labour supply of married women is particularly important in predicting the fiscal effects of demographic change. To the extent that increasing female labour supply results in an expansion of the tax base, the expected budget deficits arising from the increased demand for old-age pensions and health care spending due to population ageing become less problematic.[2]

Consequently, it is important to understand how different segments of the population are expected to respond to specific changes in the relative return to market work. To this end, a small Australian literature has assessed lone parents' labour-supply responses to the 1987 reform of family payments (Doiron (2004)), the 2000 reform of the tax system (Duncan and Harris (2002)), and reductions in the means-tested taper rates (Kalb et al. (2002), Kalb and Kew (2002), and Creedy et al. (2003)). Somewhat more is known about the labour-supply responses of married women. Jones and Savage (1996) estimate a labour-supply model to address the effects of income splitting for taxation purposes and Scutella (2001) provides wage elasticities for married women.[3] The structural model of Kalb (2002)[4] is similar to ours in approach and has been used to study the effect of changes to the tax and transfer system on married women's labour supply (Creedy et al. (2003), Kalb (1999), Kalb (2000), Kalb et al. (2002), and Kalb and Kew (2002)) and

[2]In fact, Apps (1991) argues that in the face of increasing female labour force participation, changes to the tax-benefit system may be unnecessary and could induce counter-productive labour-supply responses by imposing higher effective marginal tax rates on the earnings of married women.

[3]These papers do not model the joint labour supply of the household, but instead focus on the wife's behaviour keeping the husband's hours and wages fixed.

[4]The estimation of this model is described in this and two other papers, Kalb (1999) and Kalb (2000). These papers also provide estimates of married women's labour supply.

the effects of the 2000 tax reform on the population (Kalb et al. (2005)).

We use data from the Household Income and Labour Dynamics in Australia (HILDA) Survey to estimate a structural model of family labour-supply model along the lines of Van Soest (1995) but – unlike the previous literature in Australia– we estimate wage and labour-supply equations jointly and, more importantly, take the correlation between the error terms of the wage equations and unobserved preferences in the labour-supply equation into account both for individuals and couples.

These estimates are used to simulate the effects of the 2005/06 tax reform package introduced by the Australian Government in 2005. We find that the effect of the tax cut is to increase working hours by approximately 1.7 per cent for both men and women, while after-tax, household income is expected to increase by $60 per week on average. The estimated labour-supply elasticities and, subsequently the expected effects of the tax cut, are twice as large as those found when employing a more restricted structural model of household behaviour similar to that found in other Australian studies. In section 5.2.4 we examine these differences in more detail, demonstrating that it is our modelling improvements, not some unusual feature of the data, that drive these differences.

The rest of the paper is organized as follows. In Section 2 we describe the importance of the tax and income support system in understanding the budget constraint faced by Australian families and discuss how we incorporate this into our estimation procedure. In Section 3, we outline the data. Section 4 discusses the model and the estimation procedure. The results, including a comparison with other Australian studies which use a structural labour supply model and an evaluation of the differences which arise from our approach, are discussed in Section 5. Our conclusions follow in Section 6.

2 The Income Support System and the Family Budget Constraint

Families are assumed to maximize their direct utility over a budget constraint. The Australian tax and welfare system is complicated, however, which makes the family budget constraint nonlinear and nonconvex. Specifically, Australian income tax is individual-based and progressive with the highest marginal tax rate set at 47 per cent. Low income individuals are entitled to several rebates, the most common of which is the "low income rebate". Moreover, individuals and families may be entitled to several of the thirty-two different income support payments, allowances or pensions described in Centrelink (2005).

As discussed below, for each possible combination of husband-wife working hours, we construct the budget constraint using a household-specific calculation of the amount of income the couple would have at that working hour combination taking taxes and transfers into account. Specifically, we account for four payments from the income support system–New Start Allowance (including Partner Allowance), Parenting Payment Partnered, and Family Tax Benefit Parts A and B–in constructing this budget constraint. Centrelink records indicate that 83 per cent of partnered Centrelink customers between the ages of 25 and 59 are receiving one or more of these four payments and no other payment[5]. Given the unimportance of other payments for this age group and for simplicity, we do not consider payments such as Disability Pensions, Youth Allowance, and Austudy Payments. However, we do include all rebates including the various low income rebates. We briefly describe below the payments included in the budget calculation.

New Start Allowance (NSA) is an unemployment benefit, rather than an unemployment insurance scheme. Benefits do not depend upon previous employment histories, however, recipients are subject to income and asset tests and must also undertake job

[5]This information was provided by Centrelink in an email correspondence and is based upon the population in the administrative database on 15 July 2005.

search activity or participate in some other voluntary or work-for-the-dole program. Partner Allowance provides payments at the same level as NSA, but without the job search requirement. Parenting Payment Partnered (PPP) is an income-support payment for partnered individuals with dependent children. PPP is also subject to asset and income tests and payments become taxable income, further complicating the calculation of the budget constraint. As income increases, PPP and NSA phase out at different rates. Families with children are also entitled to Family Tax Benefit (FTB). FTB Part A payments are subject to an income test exclusively on the basis of family income. FTB Part B is paid when one member of the couple earns below \$21,000[6] per year. FTB Part A is not subject to an asset test and payments phase out as family income increases ending completely at rather high income levels. As of July 1, 2005, the maximum income at which FTB Part A was paid was \$92,139 for a family with one child under age 18 and \$101,495 for a family with 2 children under age 18.[7] A further complication is that while payments are given to individuals, the income tests are applied to the individual's income and the partner's income (although using different rules for each) or to total household income.

Figure 1 shows the budget constraint for a typical family.[8] The budget surface has two major areas of nonconvexity: at low working hours, when income-support payments are paid and phased out and at rather high income levels, where FTB is phased out. Moreover, the surface tilts at several places reflecting the very different marginal tax rates induced by the tax and transfer system.

These important nonconvexities make continuous structural models inappropriate for analyzing couples' labour-supply behaviour. Consequently, we follow Van Soest

[6]This is the earnings threshold for couples with a child under 5. The allowable earnings threshold is lower when the youngest child is over the age of 5. All dollar amounts in the paper are in Australian dollars.

[7]These are the current thresholds. However, in our estimates, we use the payment rates and program rules that were in force at the time the survey data were gathered.

[8]In particular, we consider a family just starting out, with hourly wages just below our sample means, \$23 (husband) and \$20 (wife), and small amounts of non-labour income, \$123 and \$0 respectively. We assume the family has one 6-year old child.

(1995) in replacing the actual budget set with a finite number of points and approximate the utility maximization problem by finding the best point in this finite set. Treating the budget constraint as a set of discrete points (rather than as continuous) avoids the requirement that the tax and benefits system is piecewise linear or convex and allows us to incorporate fixed costs of working, unobserved wages for non-workers, and nonparticipation into the model.

3 The Household Income and Labour Dynamics in Australia Survey

We use data from the second wave of the Household, Income and Labour Dynamics in Australia (HILDA) survey to estimate our model. HILDA is a nationally representative panel survey which provides extensive data on labour market status and working hours, labour market histories, income of all types, welfare participation, family background, family formation, and life satisfaction. Approximately 8000 Australian households were surveyed and our focus is on 3,951 couple-headed families who live in single-family households in which there are no extended family members or other non-related individuals present. We have excluded couples in which either partner is disabled or a student. We have included the self-employed.

We make several other sample restrictions. We drop 1,639 families in which one member of the couple was over 59 years old or younger than 25 in 2002. We drop another 899 observations for which key variables (not including the wage) are missing. Our estimation sample therefore consists of 1,413 couple-headed households.

The distributions of hours worked by husbands and wives are presented in Figure 2.[9] Approximately 11 per cent of husbands and 31 per cent of wives reported not working at wave 2. Most non-working men were unemployed, while most non-working women

[9] This sample includes both legally married and de facto couples. Consequently we use the term "husband" to refer to the male partner and "wife" to refer to the female partner.

were non-participants. Amongst workers, husbands worked on average about 45.6 hours, while wives worked on average 30.7 hours per week. (See Table 1.)

Hourly wage rates for employed individuals were constructed from the annual gross income from wages and reported working hours from the previous week. Average hourly wage rates for those who are working and who reported both wage income and working hours were approximately \$23.70 and \$21.30 for men and women respectively.[10] The distribution of log wage rates are uni-modal and roughly symmetric for both men and women–see Figure 3.

On average, the husbands in our sample are about 42 years of age and their partners are about two years younger. The proportion of men and women receiving higher education is about the same, though more men than women have completed vocational education. Approximately, 23 per cent of individuals are foreign-born, and approximately 8 to 9 per cent speak a language other than English at home. Couples are generally healthy — only 1.6 per cent of husbands and 1.4 per cent of wives report that their health is poor. The vast majority of couples are in registered marriages, with less than 12 per cent living in de facto relationships. The average couple has 1.4 dependent children under age 21.

4 The Model

We use as our basic framework the discrete, static, neoclassical, structural labour-supply model developed by Van Soest (1995) in which the family is assumed to maximize utility over a finite budget set. As discussed in Van Soest (1995) and elsewhere (for example, Callan and Van Soest (1996); Euwals and Van Soest (1999); Gong and Van Soest (2002); and Van Soest et al. (2002)), this approach has several advantages in comparison

[10] In addition to estimating the wages of the 150 men and the 440 women who did not work simultaneously with our labour-supply model (see Section 4), we also estimate wages for the 205 male and 137 female workers who reported positive working hours but who did not report their earnings from wages.

to models which impose a continuous budget constraint. In particular, by eliminating the requirement that the budget set and preferences be convex, this approach makes it computationally feasible to simultaneously incorporate multiple, nonstandard budget restrictions such as fixed costs of working, demand-side hours constraints, nonlinear taxation, unemployment benefits, and other income sources such as tax rebates. As discussed above, this is an important advantage given the complexity of the Australian tax and transfer system and the concomitant non-convexity of the budget constraint. Furthermore, the model can incorporate many different types of utility specifications including those typically referred to in the literature as 'flexible functional forms.' Thirdly, a rich, stochastic specification can be accommodated. We use this third strength to improve on previous research by allowing the unobserved components of the preference for non-market time between members of a couple to be correlated and accounting for correlation between the unobserved heterogeneity in an individual's hourly wage and his or her preferences for non-market time. This allows for correlation in unobserved factors which influence both an individual's productivity and her or his preferences.

4.1 Model Specification

To be specific, the family chooses the husband's non-market time (n_m), the wife's non-market time (n_f), and hence the net income (y), (which is composed of after-tax labour income from both spouses and the family's nonlabour income) to maximize utility. Utility is given by the direct translog specification, which is a second-order polynomial in its arguments:

$$U(\boldsymbol{v}) = \boldsymbol{v}'\boldsymbol{A}\boldsymbol{v} + \boldsymbol{b}'\boldsymbol{v} \tag{1}$$

where $\boldsymbol{v} = (\ln y, \ln n_m, \ln n_f)'$. $\boldsymbol{A}$ is a symmetric 3×3 matrix with entries A_{ij}, $(i, j = 1, 2, 3)$ and $\boldsymbol{b} = (b_y, b_{n_m}, b_{n_f})'$ is a vector of parameters to be estimated. This specification can also be viewed as an approximation of the 'true' preference over $\boldsymbol{v}$. Provided standard smoothness and compactness assumptions hold, one can approximate any function of $\boldsymbol{v}$ to any arbitrary degree of accuracy by choosing the appropriate order of the polynomial.

We set non-market time equal to $TE - h$, where h is working hours per week and TE is the time endowment, which we set equal to 80 hours per week. Following the majority of the literature, agents in our model choose between market time and non-market time, but make no distinction between non-market time for leisure and non-market time for home production. We adopt this simplification for comparability with other discretized structural models of labour supply which have been estimated for couples in Australia.[11]

Variation in preferences across families (as well as across individuals within families) with different observed and unobserved characteristics is incorporated through the parameters b_{n_m} and b_{n_f}:[12]

$$b_{n_s} = \sum_{k=1}^{K} \beta_k^{n_s} x_k^s + \epsilon^{sr}, \;\; s = m, f \tag{2}$$

where $x^s = (x_1^s, \ldots, x_K^s)'$ is a vector of exogenous characteristics including age and family composition. Following the typical strategy of Hausman type models, the additive error terms ϵ^{sr} are interpreted as random preferences arising from unobserved characteristics. These errors are assumed to be normally distributed with mean zero and independent of x, but they are allowed to be correlated with each other and with the error terms in each individual's wage equation. The correlation in partners' preferences may be due to unobserved common factors which shift family preferences.

Note that we impose no a priori structure on the correlation allowing marital partners to be positively sorted on their preferences over non-market time and income. Alterna-

[11] Apps and Rees (1999), Apps and Rees (2002), and Apps and Rees (2004) show how excluding home production can affect conclusions about household labour supply. Incorporating home production into the discretized labour-supply model is an important area of future research.

[12] Theoretically, all other parameters in the utility function may vary with individuals' characteristics as well. However, in practice, the effects would be hard to identify without extraordinarily large samples.

tively, it may be the case that 'opposites attract' and individuals who have a (relative) aversion to work chose a partner who prefers working relatively more. Our specification permits either result.

The utility function is required to be increasing in y for the model to be coherent with its theoretical foundation, implying that each household will choose a point on the frontier of the household budget set. This modeling approach does not allow this requirement to be imposed directly. The standard fix in the literature if this requirement is not met is to make an adjustment in the likelihood function to ensure that each household is on the budget frontier. In all of our estimates, as noted below, the requirement is met and we therefore do not need to make any such adjustments.

As in most of the literature, the individual's before tax wage rate w is assumed not to depend on hours worked. Thus, once n_m and n_f are chosen, after-tax income y is determined by w_m and w_f: so that $y = y(n_m, n_f, w_m, w_f)$.

In the standard continuous model, the family is assumed to solve the following problem:

$$\text{Max } U(y, n_m, n_f) \text{ s.t. } y \leq y(n_m, n_f, w_m, w_f), n_m \leq TE, \text{ and } n_f \leq TE. \tag{3}$$

The econometrician solves this problem using Lagrangian techniques, which are complicated when the budget set becomes non-convex or kinked. Following Van Soest (1995), however, we replace the budget frontier by a discrete set. In other words, individuals may choose from only some of the points along the continuous budget set. The optimization problem then becomes:

$$\text{Max } U(y, n_m, n_f) \text{ s.t. } (y, n_m, n_f) \in CS(w_m, w_f) \tag{4}$$

where the choice set (CS) is given by

$$
\begin{aligned}
CS(w_m, w_f) &= \{(y, n_m, n_f); y = y(n_m, n_f, w_m, w_f); \\
n_m, n_f &\in TE - \{0, IL, \ldots, (g-1)IL\}\}
\end{aligned} \qquad (5)
$$

IL is a fixed interval length which determines the set of possible working hours while g determines the number of elements in this set. The choice set for both partners with $G = g^2$ elements is denoted by $\{(y_{00}, n_{m0}, n_{f0}), (y_{10}, n_{m1}, n_{f0})..., (y_{g-1,g-1}, n_{m,g-1}, n_{f,g-1})\}$. We set IL to 8 hours and g to 9 so that there will be 81 alternatives for each family.

Random disturbances are added to the utilities of all the alternatives in the choice set as in the multinomial logit model Maddala (1983):

$$U_j = U(y_j, n_{mj}, n_{fj}) + \epsilon_j \ (j = 0, ..., G) \qquad (6)$$

where the ϵ_j are *i.i.d.* with a type I extreme value distribution, and are independent of the other error terms in the model and of x. We cannot interpret ϵ_j as random preferences, which are already represented by ϵ^{sr} in (2). Instead, ϵ_j can be seen as the nonsystematic part of the utility associated with alternative j, which could reflect optimization errors made by the family or might capture demand-side factors – such as search costs or other job characteristics – which make alternative j unattractive.

We also allow for unobserved fixed costs of working. Following Euwals and Van Soest (1999), the fixed costs of working are incorporated into the model as a fixed savings from not working (FR) for the sake of computational convenience. Thus, for those couples j where either $h_{mj} = 0$ or $h_{fj} = 0$, $U(y_j, n_{mj}, n_{fj})$ is replaced by

$$U(y_0 + 1(h_{mj} = 0) * FR_m + 1(h_{fj} = 0) * FR_f, n_{mj}, n_{fj}). \qquad (7)$$

FR_s is specified as follows:

$$FR_s = \boldsymbol{\delta}_s' \boldsymbol{t}_s, \ \ s = m, f \tag{8}$$

where $\boldsymbol{t}_s$ is a vector of exogenous variables and $\boldsymbol{\delta}_s$ a vector of parameters which we estimate. Positive fixed savings increase the probability of not working by increasing the utility of nonparticipation (since utility increases with income). The fixed savings are fully incorporated into the structural model. An increase in wages will increase the utility of working while leaving the utility of not working unchanged. (Since the utility of not working is calculated as the utility at zero hours of work, the wage can have no effect on this quantity.) Thus, an increase in wages has an unambiguous positive effect on the participation rate. Of course, an increase in wages for those who are working has both an income and substitution effect resulting in an ambiguous effect on working hours which may either increase or decrease. The income and substitution effects can not be derived algebraically from the model because of its discrete nature. But they can be easily simulated once parameter values have been estimated (see the discussion below).[13] Consequently, the effects of wage, tax, or benefit changes on participation and working hours can be easily analyzed in this framework.

The family chooses alternative j if U_j is larger than all the other U_i for $i \neq j$. Conditional on ϵ^{sr}, x^s, w_m, and w_f the probability that j is chosen is

$$Pr[U_j \geq U_i \text{ for all } i] = \frac{exp(U(y_j, n_{mj}, n_{fj}))}{\sum_{i=0}^{G} exp(U(y_i, n_{mi}, n_{fi}))} \tag{9}$$

Before-tax wage rates of nonworkers and some workers are not observed (see footnote 10) and hence wages must be predicted for these individuals. The fact that these wage rates are predicted has to be taken into account in both the estimation and the inference. To be specific, we form predicted wages for non-workers using both the systematic and

[13] That the model produces an appropriately signed income effect can be seen from the fourth column of Table 5 where we simulate the effects of an increase in non-labour income on hours.

the stochastic parts of the wage equation. Following Gong and Van Soest (2002) and Van Soest et al. (2002), the wage equation is estimated jointly with the labour-supply equation in order to account for the selectivity.[14] The wage equation is also needed to allow for correlation between wage rates and random preferences (ϵ^{sr}). Consequently, wages are given by

$$\ln w_s = \boldsymbol{\pi}^{s'} \boldsymbol{z}^s + \epsilon^{ws},\ s = m, f \tag{10}$$

where z^s are vectors of individual characteristics (such as education), π^s are vectors of parameters, ϵ^{ws} are error terms that are assumed to be normally distributed with mean zero and independent of z^s and x^s. We allow ϵ^{ws} to be correlated with the random preference term ϵ^{sr} in (2). The motivation for including this correlation is that those individuals with high productivity might also have stronger preferences for working, i.e. a lower marginal utility of non-market time, in which case one would expect a negative correlation between ϵ^{ws} and ϵ^{sr}. Alternatively, individuals with higher productivity might have higher marginal utility of non-market time leading to a positive correlation. Moreover, measurement errors in wage rates also tend to cause a negative correlation between wages and hours and this term will incorporate that measurement error.

4.2 Estimation

In the absence of random preferences and unobserved wage rates, the likelihood contribution of each household would be given by equation (9). In our case, when wages are observed, we account for random preferences by averaging over the distribution of preferences conditional on observed wage rates. Thus the likelihood contribution for a couple observed to work (h_m^o, h_f^o) hours with observed gross wage rate w_m^o, w_f^o (which

[14]This is akin to the full maximum likelihood approach of implementing the Heckman (1979) selection correction rather than a two-step procedure.

may contain measurement errors) would be given by

$$L = \iint Pr[h_m^o, h_f^o \mid w_m^o, w_f^o, \epsilon^{mr}, \epsilon^{fr}] f_1(\epsilon^{mr}, \epsilon^{fr} \mid w_m^o, w_f^o) \phi_m(w_m^o) \phi_f(w_f^o) \mathrm{d}\epsilon^{mr} \mathrm{d}\epsilon^{fr}, \qquad (11)$$

where f_1 is the joint conditional density of ϵ^{sr} given observed wages w_s^o, ϕ_m and ϕ_f are the densities of male and female wage rates, and in general

$$Pr[h_{mj}, h_{fj} \mid w_m, w_f, \epsilon^{mr}, \epsilon^{fr}] \quad (j = 1, ..., G), \qquad (12)$$

is the probability of the jth couple working (h_{mj}, h_{fj}) hours conditional on ϵ^{sr} and the wage rate w_s, $(s = m, f)$.[15] For any given w_m, w_f, ϵ^{mr}, and ϵ^{fr}, (12) can be calculated directly from (9) using (1) and (2) to obtain the values of $U(y_i, n_{mi}, n_{fi})$.

The likelihood in the case where we do not observe wage rates for either member of the couple is

$$L = \iiiint Pr[h_m^o, h_f^o \mid w_m, w_f, \epsilon^{mr}, \epsilon^{fr}] f(\epsilon^{mr}, \epsilon^{fr}, \epsilon^{wm}, \epsilon^{wf}) \mathrm{d}w_m \mathrm{d}w_f \mathrm{d}\epsilon^{mr} \mathrm{d}\epsilon^{fr}. \qquad (13)$$

$f(\epsilon^{mr}, \epsilon^{fr}, \epsilon^{wm}, \epsilon^{wf})$ is the joint density of random preferences and wage rates. The complete likelihood function will be made up of expressions like (11) and (13) and the intermediate cases where wages are only observed for one member of the household.

To minimize the complexities in solving a four-dimensional integral, we estimate the model by simulated maximum likelihood. We allow the random preference of each individual to be correlated with the error component in his or her own wage rate and to be correlated with his or her spouse's random preference. However, we impose zero correlation between the error terms of partners' wage rates and zero correlation between an individual's random preferences and his or her partner's error in the wage equation.

[15] Throughout, we condition on the family's non-labour income and other exogenous explanatory variables $\boldsymbol{x}^s$ and $\boldsymbol{z}^s$. These variables are suppressed in our notation.

This implies that the correlation structure is

$$\boldsymbol{\epsilon} \equiv (\epsilon^{mr}, \epsilon^{fr}, \epsilon^{wm}, \epsilon^{wf})' \sim N(\mathbf{0}, \boldsymbol{\Sigma}) \tag{14}$$

where

$$\boldsymbol{\Sigma} = \begin{pmatrix} \sigma^2_{rm} & \sigma^r_{mf} & \sigma^{rw}_m & 0 \\ \sigma^r_{mf} & \sigma^2_{rf} & 0 & \sigma^{rw}_f \\ \sigma^{rw}_m & 0 & \sigma^2_{wm} & 0 \\ 0 & \sigma^{rw}_f & 0 & \sigma^2_{wf} \end{pmatrix} \tag{15}$$

To solve the numerical integration problem, the integrals in the likelihood function are approximated by a simulated multi-variate mean. In other words, for each individual we take Q independent draws from the distribution of the error terms ($\boldsymbol{\epsilon}$) and compute the average of the likelihood values conditional on the simulation draw. The integral (13) can thus be approximated by

$$L = \frac{1}{Q}\sum_{q=1}^{Q} Pr[h^o_m, h^o_f \mid \epsilon^{wm}_q, \epsilon^{wf}_q, \epsilon^{mr}_q, \epsilon^{fr}_q] \tag{16}$$

where $q = 1, ..., Q$ indexes the draw from ($\boldsymbol{\epsilon}$). Similarly, (11) can be replaced by

$$L = \frac{1}{Q}\sum_{q=1}^{Q} Pr[h^o_m, h^o_f \mid w^0_m, w^0_f, \epsilon^{mr}_q, \epsilon^{fr}_q]\, \phi_m(w^o_m)\phi_f(w^o_f), \tag{17}$$

where ϵ^{fr}_q and ϵ^{mr}_q are based upon independent draws from their joint distribution.[16] The resulting estimator is consistent if Q increases sufficiently fast with respect to the number of sample observations, n. Specifically, if $n^{1/2}\frac{1}{Q} \rightarrow 0$ and the draws from $\boldsymbol{\epsilon}$ are independent across observations, this method is asymptotically equivalent to maximum likelihood. See Lee (1992), Gourieroux and Monfort (2002), or Hajivassiliou and Ruud (1994) for examples.

[16] Similarly for the intermediate cases.

5 The Determinants of Couples' Labour Supply

5.1 Estimation Results

Estimation results for the labour-supply model are presented in Table 2, while those from the wage equation are provided in Table 3. These simulated maximum likelihood estimates are based upon Q = 20 draws per individual. The estimated utility function is increasing in income for all observations so we did not need to make any adjustments to the model in order to produce theoretically consistent results.

5.1.1 Determinants of Labour Supply

Due to the complex structure of the model, interpretation of the coefficients is not straightforward. Nevertheless, the sign and significance of each parameter are informative about the direction of the effect and the precision with which it is estimated. For example, the estimated determinants of the utility function (see the top panel of Table 2) describe the way in which specific characteristics affect preferences for non-market time. A positive coefficient implies a positive effect of that variable on the marginal utility of non-market time, and a subsequent negative effect on labour supply. Meanwhile, a positive coefficient (δ_s) in the fixed saving from nonwork equation (8) implies that the factor has a positive effect on the fixed costs of working, decreasing labour force participation.

Consistent with the literature, we find that family structure plays an important role in determining preferences for non-market time through the utility function. The presence of children causes men to prefer working more, whereas it increases women's preferences for non-market time, see top panel, Table 2. Similarly, estimates of equation (8) tell us about the fixed costs of working, which, in addition to preferences, will also affect labour supply. We find that the presence of children decreases the benefit of not working which will act to increase the labour supply of both spouses. We note that the effect is significant for women and marginally insignificant for men. One interpretation is that having more mouths to feed increases the (fixed) utility cost of not-working. Together these results suggest that the presence of children has unambiguous effects for men (increasing labour supply) but contradictory effects for women. In order to determine the overall effect of the presence of children on husbands' and wives' labour supply, we need to account for both of these effects.

To do this, we plot labour supply curves (wages against hours for husbands and wives separately) in Figure 4 for two benchmark families. The two families are identical except that in one family there is one child aged between 6 and 12, while in the other there are two. The addition of the second child causes the father to work a bit more, while the addition of the second child has a large negative overall effect on the wife's labour supply. Overall, we consistently find that an increase in the number of children causes wives to decrease their labour supply indicative of the stronger effect of children through the utility function, (1), relative to the effect through the fixed savings of non-working equation, (8). It is also worth noting that the effect of younger children on women's preferences is larger than the effect of older children, consistent with the evidence that women choose to provide care at home to pre-school age children. The availability of public schooling for children over the age of five means that school-age children have less effect on women's decision to participate in the labour market. The effect of younger and older children is roughly the same for husbands. From Figure 4, we also observe that the effect of children on both parents' labour supply is larger the higher are wives' wages. This is also consistent with what others have found in Australia.

Once we control for speaking English in the home, we do not find any effect of being born outside of Australia on husbands' labour supply. For wives, however, we find that, being foreign-born has a positive effect on labour supply. Furthermore, this effect is stronger for more recent immigrants. It may be that immigrants choose to work harder when they first arrive in order to establish themselves in Australia. It may also be the result of Australia's selective immigration policy which is based upon health, age, education, and occupation type.

We also find that unobserved heterogeneity plays a significant role in determining labour supply. The standard deviation of the unobserved heterogeneity terms are significant for both men and women. However, the correlation between spouses' preferences (ρ^r_{mf}) is not significant (see Table 2) suggesting an absence of correlation in the unobserved factors. There is still a complementarity in spousal non-market time through the utility function, however, as A_{23} is positive and significant.

On the other hand, individuals' random preferences are highly positively correlated with the error terms in the wage equations, which may be due to higher productivity individuals having higher preference for non-market time, to measurement errors in wage rates, or some combination of the two. Gong and Van Soest (2002) find similar results for Mexico.

The complex structure of the model also makes the parameters A_{ij} hard to interpret. They are important, however, as they determine the shape of the indifference curves and hence capture the sensitivity of labour supply to changes in wages, taxes, and benefits. For example, they determine the shape of the curves in Figure 4. It is interesting that when the husband's wage is low, the wife's working hours tend to increase with her partner's wage (see Figure 4a), but when the husband's wage exceeds about \$10 per hour, the working hours of the wife begin to decrease with further increases in her husband's wage. Comparing the husband's response in Figure 4a to the wife's response in Figure 4b, we see that husbands are less responsive to own wages, which is also reflected in the results from the simulations (see Section 5.2).

5.1.2 Determinants of Wages

The estimated wage equations are presented in Table 3 and our findings are consistent with those standard in the literature. Age has a nonlinear effect on men's wages, although age is not significantly related to the wage rate for women. There are positive wage returns for native-born women and for foreign-born women who have lived longer in Australia. English language ability, though not quite significant at standard levels, matters in the way one would expect–i.e. those who speak a language other than English at home earn less. We do not find significant differences for fluency in English after controlling for speaking a different language at home, but this could be due to the self-reported nature of the information. The return to education is higher for women than for men. Significantly, women with a higher education earn 31 per cent more than women who are Year 12 graduates while the analogous figure for men is 25 per cent.

5.2 Simulating Wage and Income Elasticities and the Effects of Tax Reform

In this section we simulate the sensitivity of working hours to changes in wage rates and non-labour income in order to shed light on our estimates. These simulations reflect the "expected hours" for each individual computed as a probability weighted sum of hours levels. From these, we compute average hours of work measures across the whole sample. Wage and income elasticities are derived by increasing all wage rates or incomes by one per cent and then calculating the percentage change in average hours. The model provides a flexible method of examining a wide variety of policy changes and the resulting change in hours worked is an outcome of interest to policy makers.

5.2.1 Goodness of fit

Table 4 presents the means of reported and simulated hours for men and women. These numbers are point estimates. Standard errors (numbers in the parentheses) are obtained by repeating the simulations for a large number of draws from the estimated asymptotic distribution of the parameter estimates. The model predicts average hours of work very well for both men and women. The model also predicts the frequencies of most hour categories very precisely, though it overpredicts the frequency of the 56-hour category at the expense of the 40-hour category for both men and women.

5.2.2 The Elasticity of Labour Supply

Estimated wage and income elasticities are reported in Table 5. The second row shows the labour force participation elasticities, while the third through the fifth rows are the hours of work elasticities for the whole sample and for two sub-samples split by level of educational attainment. It is important to note several things. First, the elasticities of both men and women with respect to their partner's wage and to family non-labour income are negative and very small, although some are statistically significant. The cross wage elasticities for wives are larger than those for husbands. In other words, women respond more to their husband's wage changes than the other way around. This can also be seen from Figure 4. For example, in Figure 4b the labour-supply schedule for men is nearly vertical, indicating that as the wife's wage changes, her husband does not change his labour-supply behaviour. The schedules for women in Figure 4a are much flatter at low wages. This indicates that women do respond to their husbands' wage changes, particularly in the low wage range.

Own wage elasticities are positive for both men and women with women responding more to their own wage changes than men. For example, for each one per cent increase in his wage, a man will increase his working hours by 0.26 per cent, while women increase working hours by 0.50 percent in response to a one per cent increase in own wages.

Response to wage changes varies by demographic group. Those who are relatively educated are less responsive to changes in their own wages than are those with low educational attainment.[17] For example, for every one per cent increase in his own wage a relatively educated man will increases his labour supply by 0.17 per cent, while the

[17]This finding is consistent with Kalb (1999) and Kalb (2000) who finds that wage elasticities are larger in low income families. It is due in part to the fact that these individuals are already working, on average, a large number of hours.

labour supply of a man with relatively little education will increase by 0.30 per cent. Highly-educated women react to a one per cent increase in their own wages by increasing their labour supply by 0.39 per cent, while women with low education increase their labour supply by 0.55 per cent.

The weekly family income in the first row of Table 5 represents the model's prediction of the new level of average family income after a ten per cent increase in the indicated income source (wages or non-labour income.) Family income before any changes is predicted to be $1,197. For example, if every husband's wage is increased by ten per cent, family after-tax income would be $1258, an average increase of $61. An increase in non-labour income by the same proportion would bring a much smaller increase ($6) to the family in after-tax income.[18]

5.2.3 The Effects of the 2005-2006 tax reforms

From the 2005-2006 and 2006-2007 financial years, the Australian Government introduced a tax reform package in which the marginal tax rate for income between $6,000 and $21,600 is lowered from 17 to 15 per cent and the threshold for higher tax rates are increased. Notably, from 2006-2007, the income threshold for the highest tax rate (47 per cent) – which was $65,000 in 2001– will be $125,000.[19] In the last column of Table 5, we present our prediction of the effects of these tax reforms based upon simulations from our estimated model. These calculations assume that everything about the Australian population which is included in our model (particularly family structure and age distribution) remains as in 2001, only the tax rates are allowed to change. For predicting short-term impacts of these tax reforms, this ceteris paribus assumption is reasonable. Long-term predictions, on the other hand, would involve incorporating estimates of changing population structures into the simulation of the model.

[18]This last result partly stems from the fact that many households have little or no non-labour income.

[19]For details of the tax reform package, see Commonwealth of Australia (2005).

We find that the tax cuts are expected to increase the working hours of both husbands and wives by 1.7 per cent on average. Husbands will increase participation by 0.82 percentage points and wives by 0.98 percentage points. Husbands' hours respond more than wives' hours to the tax reform resulting in the same overall change in labour supply (1.7 per cent increase) for both. Of course, the distribution of these effects is not uniform across the population. Amongst men, the response of hours is stronger for those with less education (1.77 per cent) and thus a large part of the overall increase in male working hours is being driven by those in the lower education groups. The results also show that the average weekly family income is expected to increase by approximately $60 as a result of the tax cuts. For families with two wage earners, each making between $25,000 and $55,000 per year, our model predicts an average after-tax increase in income of $38–much larger than the Australian Government's own prediction of $12, which does not include labour supply effects (see ABC News Online (2005)).

5.2.4 Comparison with other studies

Scutella (2001) estimates a single-equation labour-supply model for women, correcting for sample selection but holding men's hours and income constant, and finds small labour-supply elasticities for women–around 0.11. Likewise holding men's behaviour constant, Jones and Savage (1996) estimate female labour supply in the context of a demand system approach with a continuous budget constraint. They find a large average wage elasticity of female labour market participants but they do not report any average wage elasticities which would be comparable with the combined effect from participants and non-participants reported in other papers.[20]

Kalb (2002) and Creedy and Kalb (2005) use a discretized family labour-suppply

[20] For married women already working, they report a compensated wage elasticity of 1.125. All of the other papers, and our paper, report uncompensated wage elasticities, and this further complicates direct comparison.

model in an approach similar to ours.[21]. Creedy and Kalb (2005) report labour supply elasticities quite similar to ours (0.25 for husbands and 0.54 for wives) for the subset of married couples. Furthermore they find that a one per cent wage increase leads to a 0.14 percentage point increase in husband's participation rate and a 0.19 percentage point increase in wife's participation rate. We find somewhat larger responses in the participation rate, with a one per cent increase in own wage leading to a 0.18 percentage point increase in participation for men and a 0.35 percentage point increase in participation for women. We hesitate to draw any conclusion from direct comparison of these figures as these elasticities are not calculated in the same way.[22]

Using the estimates of Kalb (2002), Buddelmeyer et al. (2005) simulate the effect of the 2005-2006 tax reforms. It is even more difficult to compare this paper to our results, as they do not provide an estimate of the effect of the tax reforms on post-reform family incomes which includes labour-supply effects.[23] The one directly comparable estimate from their study is the expected change in total average hours worked per week due to the labour supply effects of the tax reform. They estimate, for the subset of individuals in married couples who are already working, that husbands will work 0.14 hours more and wives 0.11 hours more. We estimate much larger responses–0.78 additional hours for husbands and 0.52 additional hours for wives–but our estimates include the hours response of those who take up work after the change. Buddelmeyer et al. (2005) appear to use the estimates from Kalb (2002) and Creedy and Kalb (2005), and the authors report very similar labour-supply elasticities to ours. However, these estimates result in very different changes in average hours, albeit measured differently, when applied to the

[21]These models are estimated using 1994-1998 data from the Australian Bureau of Statistics Survey of Income and Housing Costs. The models are also described in Kalb (1999) and Kalb (2000), although only estimated on one year of data in those papers. The model is applied to analyze the effect of various policy changes in Creedy et al. (2003), Kalb and Kew (2002), Kalb et al. (2002), and Kalb et al. (2002). The general approach and main features of all of these papers are similar.

[22]We calculate the elasticity of the average. Thus, we calculate the average over all individuals (for hours or participation) before and after the change and we report the change in this average. Kalb (2002) instead calculates the elasticity for each individual and reports the average across individuals.

[23]They do analyze the impact on the government's budget after accounting for labour-supply effects.

tax reform.

This further highlights the difficulty of direct comparison between our paper and the Australian literature using discretized labour-supply models which are all based upon Kalb (2002). In addition to the difference in the method of calculating the elasticities (see footnote(22)), there are a number of differences which might affect the results. Specifically, the models are estimated on different data at different points in time.[24] Moreover, the utility functions are specified differently and include a different set of variables. Finally, the permissible labour supply points (specified by $CS(w_m, w_f)$) differ between their model and our own and the fixed cost of working is specified differently.

Thus, comparison of our model with these does not lead to a direct evaluation of the contribution made by the three methodological innovations which we have introduced in this paper. All of these improvements extend the models described above. In the next section, we undertake this direct evaluation.

5.3 Evaluating the improvements to the model

We have made three substantive specification changes to the standard, discretized structural labour-supply model. The first is to incorporate correlation in husbands' and wives' preferences for non-market time. This is captured by the term σ^r_{mf} in equation (15). The second is to allow for correlation between the unobservables, for each individual, in the wage equation and the equation which captures preferences about the income/non-market time tradeoff. This is captured by the terms σ^{rw}_m (for men) and σ^{rw}_f (for women) in equation (15). The third extension is to predict wages from equation (10) using the linear predictor based upon the coefficient estimates <u>and</u> random draws from the distribution of ϵ^{wm} and ϵ^{wf}.[25] We find that the quantitative effect of these improvements is substantial.

[24] A minor difference may also arise from our using de facto and married couples together. It is not clear if Kalb (2002) includes de facto couples.

[25] We correct for selection as indicated in equation (10) and footnote 14.

In order to undertake this evaluation, we re-estimate our model, "turning off" the three new features of our model. We also adopt the standard estimation strategy of separately estimating the wage equation in a two-step Heckman (1979) procedure and using the predicted wage from that procedure as if it were the true wage (ignoring the stochastic component).[26] For the sake of conciseness, we do not present the estimation results in the paper but they are available on request. Rather, we present simulated wage and income elasticities and the predicted effect of the tax reform in Table 6. It is clear that the wage elasticities are now less than half the size of those from our preferred model (see Table 5).

We conclude that there are substantial differences which arise from our specification improvements. Given that our correlation term between husbands' and wives' preferences is not significant, we believe that there are two things driving the differences in results. The first is the correlation between wages and preferences. The other is the unobserved measurement errors, which appear to be exacerbated if we ignore the noise in estimating non-workers' wages.

6 Conclusions

The objective of this paper has been to estimate a structural labour-supply model for Australian couples. To this end, we develop a model which extends previous models by allowing for random preferences for leisure for each spouse, correlation between these preferences within a couple, and individual-specific correlation in the unobservable factors determining wages and preferences for leisure. These extensions produce a more realistic model of labour-supply behaviour and have a significant impact on the resulting

[26] We make one adaptation of the approach taken in Kalb (2002) and the related papers, in which the conditional predictor (i.e., including the inverse Mills-ratio in the predicted wage) is used. Including the inverse Mills-ratio in the predicted wage will result in inconsistent predictions. The inverse Mills-ratio is included in OLS estimation to produce consistent estimates of the coefficients in the linear predictor term. Once these consistent coefficients are obtained, prediction should be based unconditionally on the estimated linear predictor.

estimates of labour-supply elasticities.

Our results indicate that women are more responsive to both their own wage changes and their husbands' wage changes than are their partners. Specifically, elasticities with respect to own wages are on average 0.26 and 0.50, for men and women respectively. We also find that more highly educated individuals are less responsive to their own wage changes than are individuals with less education. Neither husbands nor wives are particularly responsive to changes in nonlabour income or partner's wages, although most of the estimated elasticities are significantly different to zero.

In order to assess the quantitative impact of our modelling improvements, we estimate a restricted version of the model that does not account for the unobservability of non-workers' wages, the correlation between wages and preferences for individuals and within couples. The results suggest that ignoring these issues generates a downward bias in the estimates of labour-supply elasticities. Specifically, the estimates implied by the restricted model are half those of our preferred model.

Finally, we use the results of our labour-supply model to make predictions about the likely labour-supply effects of the changes to the Australian tax system which came into effect on 1 July 2005. We find that the tax cuts introduced by the government are expected to increase both men's and women's labour supply by about 1.7 per cent and to generate an extra $60 in family weekly income for the average Australian family. Families with two wage earners each earning between $25,000 and $55,000 per year are expected to see after-tax family income increase by $38 per week. This compares to the government's own prediction of an increase of $12 per week, which appears not to include the effect of any labour-supply responses. This disparity demonstrate the importance of accounting for individuals' labour-supply reactions to government policy in understanding the effects of policy changes. In particular, changes to the tax and transfer system can induce strong labour-supply responses and a realistic assessment of these responses is crucial to understanding and evaluating alternative policies. The model of this paper provides an improvement of existing methods of doing this.

References

ABC News Online (2005). Costello slashes taxes, revamps welfare. Tuesday, May 10, 2005. Available at `http://www.abc.net.au/news/newsitems/200505/s1362926.htm`.

Apps, P. (1991). Tax reform, population ageing, and the changing labour supply behaviour of married women. *Journal of Population Economics*, 4:201–216.

Apps, P. and Rees, R. (1999). On the taxation of trade within and between households. *Journal of Public Economics*, 73:241–263.

Apps, P. and Rees, R. (2002). Household production, full consumption and the costs of children. *Labour Economics*, 8:621–648.

Apps, P. and Rees, R. (2004). Taxation and saving over the life cycle. *Ifo Economic Studies*, 50:479–502.

Australian Treasurer (2004). Australia's demographic challenges. Treasury Discussion Paper, Commonwealth of Australia 2004.

Blundell, R., Duncan, A., McCrae, J., and Meghir, C. (2000). The labour market impact of the working families tax credit. *Fiscal Studies*, 21(1):75–104.

Blundell, R. and Hoynes, H. (2004). Has "in-work" benefit reform helped the labour market? In Blundell, R., Card, D., and Freeman, R., editors, *Seeking a Premier League Economy*, pages 411–460. University of Chicago Press.

Buddelmeyer, H., Freebairn, J., and Kalb, G. (2005). The melbourne institute analysis of the 2005 federal budget. *Mercer - Melbourne Institute Quarterly Bulletin of Economic Trends*, pages 1–3.

Callan, T. and Van Soest, A. (1996). Family labour supply and taxes in Ireland. ESRI Working Paper No. 78.

Centrelink (2005). A guide to Australian Government payments. Centrelink Publication, Commonwealth of Australia 2005. Available at: `http://www.centrelink.gov.au/internet/internet.nsf/filestores/co029_0507/$file/co029_0507en.pdf`.

Commonwealth of Australia (2005). Budget 2005-2006 overview. Technical report, Commonwealth of Australia 2005. Available at: `http://www.budget.gov.au/2005-06/overview/html/index.htm`.

Creedy, J. and Kalb, G. (2005). Behavioural microsimulation modelling for tax policy analysis in Australia: Experience and prospects. *Australian Journal of Labour Economics*, 8(1):73–110.

Creedy, J., Kalb, G., and Kew, H. (2003). Flattening the effective marginal tax rate structure in Australia: Policy simulations using the melbourne institute tax and transfer simulator. *The Australian Economic Review*, 36(2):156–172.

Doiron, D. (2004). Welfare reform and the labour supply of lone parents in Australia: A natural experiment approach. *The Economic Record*, 80(249):157–176.

Doiron, D. and Kalb, G. (2002). Demand for childcare services and labour supply in Australian families. *The Australian Economic Review*, 35(2):204–213.

Doiron, D. and Kalb, G. (2005). Demands for childcare and household labour supply in Australia. *Economic Record*. forthcoming.

Duncan, A. and Harris, M. (2002). Simulating the behavioural effects of welfare reforms among sole parents in Australia. *The Economc Record*, 78:264–276.

Eissa, N. and Hoynes, H. (2004). Taxes and the labor market participation of married couples: The earned income tax credit". *Journal of Public Economics*, 88(9-10):1931–1958.

Euwals, R. and Van Soest, A. (1999). Desired and actual labour supply of unmarried men and women in the Netherlands. *Labour Economics*, 6:95–118.

Gong, X. and Van Soest, A. (2002). Female labour supply and family structure in Mexico City. *Journal of Human Resources*, 37(1):163–191.

Gourieroux, C. and Monfort, A. (2002). Simulation based inference: A survey with special reference to panel data. *Journal of Econometrics*, 59(1-2):5–34.

Hajivassiliou, V. A. and Ruud, P. A. (1994). Classical estimation methods for LDV models using simulation. In Engle, R. F. and McFadden, D. L., editors, *Handbook of Econometrics, Volume IV*, pages 2384–2443. New York: North-Holland.

Heckman, J. J. (1979). Sample selection bias as a specification error. *Econometrica*, 47(1):153–161.

Jones, G. and Savage, E. (1996). An evaluation of income splitting with variable female labour supply. *The Economic Record*, 28(218):224–235.

Kalb, G. and Kew, H. (2002). The effect of a reduced allowance and pension taper rate: Policy simulations using the Melbourne Institute Tax and Transfer Simulator. Melbourne Institute Working Paper No. 25/02.

Kalb, G., Kew, H., and Scutella, R. (2002). The effect of a reduced family payment taper rate: Policy simulations using the Melbourne Institute Tax and Transfer Simulator. Melbourne Institute Working Paper No. 26/02.

Kalb, G., Kew, H., and Scutella, R. (2005). Effects of the Australian new tax system on income tax and benefits: With and without labour supply responses. *Australian Economic Review*, 38(2).

Kalb, G. R. (1999). Labour supply and welfare participation in Australian two-adult households: Comparing 1986/87 with 1994/95. Working Paper BP-34, Centre of Policy Studies and the Impact Project.

Kalb, G. R. (2000). Labour supply and welfare participation in Australian two-adult households: Accounting for involuntary unemployment and the "cost" of part-time work. Working Paper BP-35, Centre of Policy Studies and the Impact Project.

Kalb, G. R. (2002). Estimation of labour supply models for four separate groups in the Australian population. Melbourne Institute Working Paper No. 24/02. Available at `http://melbourneinstitute.com/wp/wp2002n24.pdf`.

Lee, L.-F. (1992). On efficiency of methods of simulated moments and maximum simulated likelihood estimation of discrete response models. *Econometric Theory*, 8:518–552.

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

McDonald, P. and Kippen, R. (1999). Ageing: the social and demographic dimensions. In *Policy Implications of the Ageing of Australia's Population*. Productivity Commission.

Scutella, R. (2001). Labour supply estimates for married women in Australia. *Australian Journal of Labour Economics*, pages 152–172.

Van Soest, A. (1995). Structural models of family labour supply–a discrete choice approach. *The Journal of Human Resources*, 30:63–88.

Van Soest, A., Das, M., and Gong, X. (2002). A structural labour supply model with flexible preferences. *Journal of Econometrics*, 107:345–374.

Tables

Table 1. Means and Standard Deviations by Gender

	Husbands		Wives	
Individual Variables	Mean	St. Dev.	Mean	St. Dev.
Hours of Work	45.64	12.59	30.67	14.40
Wage	23.72	15.24	21.34	14.69
Non Labour Income ($1000 AUD)	6.200	20.79	4.592	23.97
Higher Education	0.256		0.244	
Vocational Education	0.450		0.347	
Completed Year 12	0.074		0.113	
Less than Year 12	0.219		0.295	
Age	42.3	8.7	40.1	8.5
Australian-born	0.771		0.787	
English Speaking Background	0.125		0.099	
Non-English Speaking Background	0.103		0.114	
Years Since Arrival	5.3	11.7	4.5	10.8
Language other than English	0.080		0.092	
Fluent English Speaker	0.073		0.082	
Poor Health	0.016		0.014	
Health Improved in Last Year	0.130		0.179	
Health Worsened in Last Year	0.093		0.099	

Household Variables	Mean	St. Dev.
Married	0.878	
Kids Aged 0 - 5	0.468	0.77
Kids Aged 6 - 12	0.541	0.83
Kids Aged 13 - 15	0.230	0.49
Kids Aged 16 - 17	0.121	0.34
Kids Aged 18 - 20	0.043	0.31
Joint Credit Cards	0.360	
Observations	1413	

Source: Wave 2 HILDA
All variables are measured in percents except age (years), hours of work, non-labour income (1000s of Australian dollars), number of kids, and years since arrival.

Table 2. The Determinants of Couples's Hours of Work
(Simulated Maximum Likelihood Coefficients and t-values)

	Household			
	Coefficient	**t-value**		
Utility Function **(Equation 1):**				
A_{11}	-0.718	(-3.31)		
A_{12}	-0.379	(-3.00)		
A_{13}	-0.562	(-3.06)		
A_{22}	-2.831	(-14.22)		
A_{33}	-2.428	(-9.45)		
A_{23}	0.515	(5.28)		
b_{11}	22.238	(5.46)		
	Husband		**Wife**	
	Coefficient	**t-value**	**Coefficient**	**t-value**
Preferences β_k^s **(Equation 2):**				
Constant	21.310	(6.16)	21.548	(4.73)
Kids 0 - 5	-0.353	(-2.92)	1.752	(8.71)
Kids 6 - 12	-0.354	(-3.22)	0.661	(3.83)
Kids 13 - 15	-0.280	(-1.54)	0.450	(1.76)
Kids 16 - 20	-0.567	(-3.52)	0.069	(0.29)
Health Improved	0.378	(1.82)	0.236	(1.01)
Health Worsened	0.230	(1.09)	0.450	(1.54)
Poor Health	3.598	(5.82)	4.189	(2.28)
Age	0.654	(0.61)	0.513	(0.33)
Age Squared	-0.066	(-0.52)	0.001	(0.00)
Australian-born	-0.632	(-1.58)	0.629	(1.09)
Years Since Arrval	-0.150	(-1.01)	0.240	(1.12)
σ_r	1.338	(5.00)	1.225	(7.11)
ρ_{mf}^r	0.332	(1.25)	0.332	(1.25)
ρ^{rw}	0.586	(4.14)	0.912	(14.65)
Fixed Saving from Not Working δ_j **(Equation 8):**				
Constant	0.887	(1.10)	1.737	(3.17)
Kids 0 - 5	-0.069	(-1.26)	-0.056	(-1.83)
Kids 6 - 12	-0.006	(-0.12)	-0.073	(-2.67)
Kids 13 - 15	-0.139	(-1.73)	-0.080	(-1.86)
Kids 16 - 20	0.087	(1.21)	-0.035	(-0.84)
Age	-0.355	(-0.95)	-0.586	(-2.21)
Age Squared	0.062	(1.43)	0.075	(2.31)
Australian-born	0.207	(1.43)	-0.137	(-1.40)
Years Since Arrival	0.050	(0.96)	-0.050	(-1.35)
lnSL^*	-6688			

* ln SL: simulated log likelihood.
t-values are in parentheses.

Table 3. The Determinants of Wages
(Simulated Maximum Likelihood Coefficients and t-values)

Equation 10	**Husband**		**Wife**	
	Coefficient	**t-value**	**Coefficient**	**t-value**
Constant	2.509	(7.07)	2.218	(5.66)
Age	0.282	(1.72)	0.243	(1.33)
Age Squared	-0.030	(-1.59)	-0.022	(-1.03)
Australian-born	0.054	(0.83)	0.184	(2.41)
Years Since Arrival	0.009	(0.43)	0.048	(1.81)
NSW	-0.225	(-4.65)	-0.062	(-1.25)
Melbourne	-0.046	(-1.05)	-0.009	(-0.18)
VIC	-0.307	(-5.39)	-0.102	(-1.80)
Brisbane	-0.170	(-2.91)	-0.068	(-1.20)
QLD	-0.263	(-4.93)	-0.141	(-2.60)
Adelaide	-0.207	-2.94)	-0.120	(-1.49)
SA	-0.340	(-3.87)	-0.154	(-1.97)
Perth	-0.176	(-2.83)	-0.148	(-2.50)
WA	-0.222	(-2.56)	-0.156	(-1.69)
Tas	-0.292	(-3.34)	-0.159	(-1.39)
NT	0.206	(1.11)	-0.168	(-1.15)
ACT	0.016	(0.17)	-0.017	(-0.17)
Higher Education	0.252	(3.95)	0.310	(6.11)
Vocational Education	-0.054	(-0.86)	-0.045	(-0.93)
Less than Year 12	-0.109	(-1.61)	-0.176	(-3.47)
Language other than English	-0.396	(-1.49)	-0.384	(-1.49)
Fluent English Speaker	0.166	(0.62)	0.348	(1.35)
σ^w	0.425	(55.73)	0.387	(57.35)

t-values are in parentheses.

Table 4. Simulated Working hours
(Comparison of sample means to implied means from model)

	Husband		Wife	
	Sample	**Simulated**	**Sample**	**Simulated**
Average hours	40.849	40.699(0.60)	21.509	22.340(0.59)
0 hours(%)	10.7	10.656(1.0)	32.1	30.459(1.3)
8 hours(%)	1.0	01.284(0.2)	6.1	7.0(0.5)
16 hours(%)	1.1	02.152(0.2)	8.4	9.4(0.4)
24 hours(%)	2.5	05.025(0.3)	13.4	11.7(0.4)
32 hours(%)	5.4	09.884(0.4)	11.0	13.2(0.4)
40 hours(%)	31.4	16.985(0.4)	18.7	12.6(0.5)
48 hours(%)	27.5	23.581(0.6)	6.4	9.7(0.5)
56 hours(%)	6.6	21.929(0.7)	1.8	5.0(0.4)
64 hours(%)	13.7	08.700(0.6)	2.2	1.3(0.3)

Numbers are percentages of individuals in each discrete hour category.
Percentages in parentheses are bootstrap standard errors.

Table 5. Simulated labour-supply and income elasticities from preferred model

	Own Wage	**Cross Wage**	**Own Income**	**Cross Income**	**Tax reform**
Husband					
Family income	1256.68(10.65)		1203.02(10.11)		1257.49(11.03)
Participation	0.1759(0.021)	-0.0184(0.007)	-0.0004(0.001)	-0.0003(0.001)	0.819(0.10)
Hours:					
Whole sample	0.2634(0.032)	-0.0165(0.011)	-0.0029(0.001)	-0.0010(0.001)	1.698(0.21)
High educated	0.1664(0.021)	-0.0122(0.009)	-0.0043(0.001)	-0.0029(0.001)	1.554(0.19)
Low educated	0.2999(0.037)	-0.0273(0.012)	-0.0024(0.002)	-0.0003(0.001)	1.752(0.22)
Wife					
Family income	1236.93(10.91)		1201.73(10.11)		
Participation	0.3500(0.039)	-0.0028(0.023)	-0.0012(0.001)	-0.0007(0.002)	0.983(0.22)
Hours:					
Whole sample	0.5025(0.060)	-0.0348(0.035)	-0.0050(0.002)	-0.0033(0.003)	1.731(0.40)
High educated	0.3872(0.046)	-0.0894(0.031)	-0.0055(0.002)	-0.0054(0.003)	1.853(0.44)
Low educated	0.5484(0.068)	-0.0131(0.037)	-0.0048(0.002)	-0.0025(0.003)	1.683(0.39)

The average family income predicted by the model before any changes is $1197.24(10.12)

The rows correspond to changes in family income, participation and working hours, which result from the change indicated in the column headings.

Changes in participation are measured in percentage points while changes in hours are measured as a percentage of hours. The family income values are the average levels after the simulated change.

We simulate one per cent changes in wage and non-labour income for columns two, three, and five.

The tax reform column provides the simulated results from the tax cuts only (see subsection (5.2.3)).

The new *levels* of family income in the column labelled 'own income' are the result of increasing non-labour income by *ten* per cent. The changes in the participation rate and hours in that column are those resulting from a one per cent change in non-labour income.

Table 6. Simulated labour-supply elasticities (restricted model without improvements)

	Own Wage	Cross Wage	Own Income	Cross income	Tax reform
Husband					
Family income	1235.20(9.53)		1189.97(9.02)		1232.70(9.81)
Participation	0.098(0.026)	0.009 (0.014)	-0.001(0.004)	-0.001(0.002)	0.404(0.047)
Hours:					
Whole sample	0.111(0.043)	-0.013(0.023)	-0.007(0.005)	-0.004(0.003)	0.587(0.101)
High educated	0.071(0.026)	-0.027(0.021)	-0.008(0.005)	-0.006(0.003)	0.588(0.097)
Low educated	0.126(0.050)	-0.008(0.024)	-0.006(0.005)	-0.004(0.003)	0.586(0.104)
Wife					
Family income	1214.50(9.76)		1188.81(9.01)		
Participation	0.189(0.051)	-0.001(0.050)	-0.001(0.003)	-0.001(0.005)	0.495(0.116)
Hours:					
Whole sample	0.239(0.082)	-0.079(0.085)	-0.007(0.005)	-0.008(0.007)	0.387(0.234)
High educated	0.198(0.072)	-0.114(0.086)	-0.007(0.004)	-0.010(0.007)	0.356(0.278)
Low educated	0.254(0.086)	-0.066(0.086)	-0.006(0.005)	-0.007(0.007)	0.398(0.219)

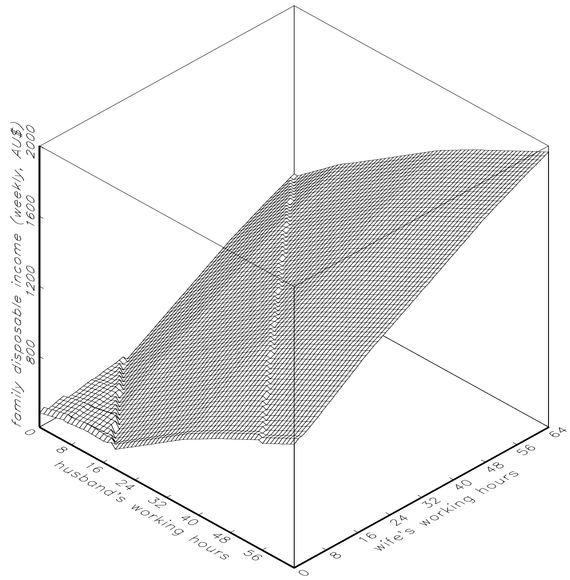
The average family income predicted by the model before any changes is $1184.37(9.00)

Table entries are defined as in Table 5.

Percentages in parentheses are standard errors

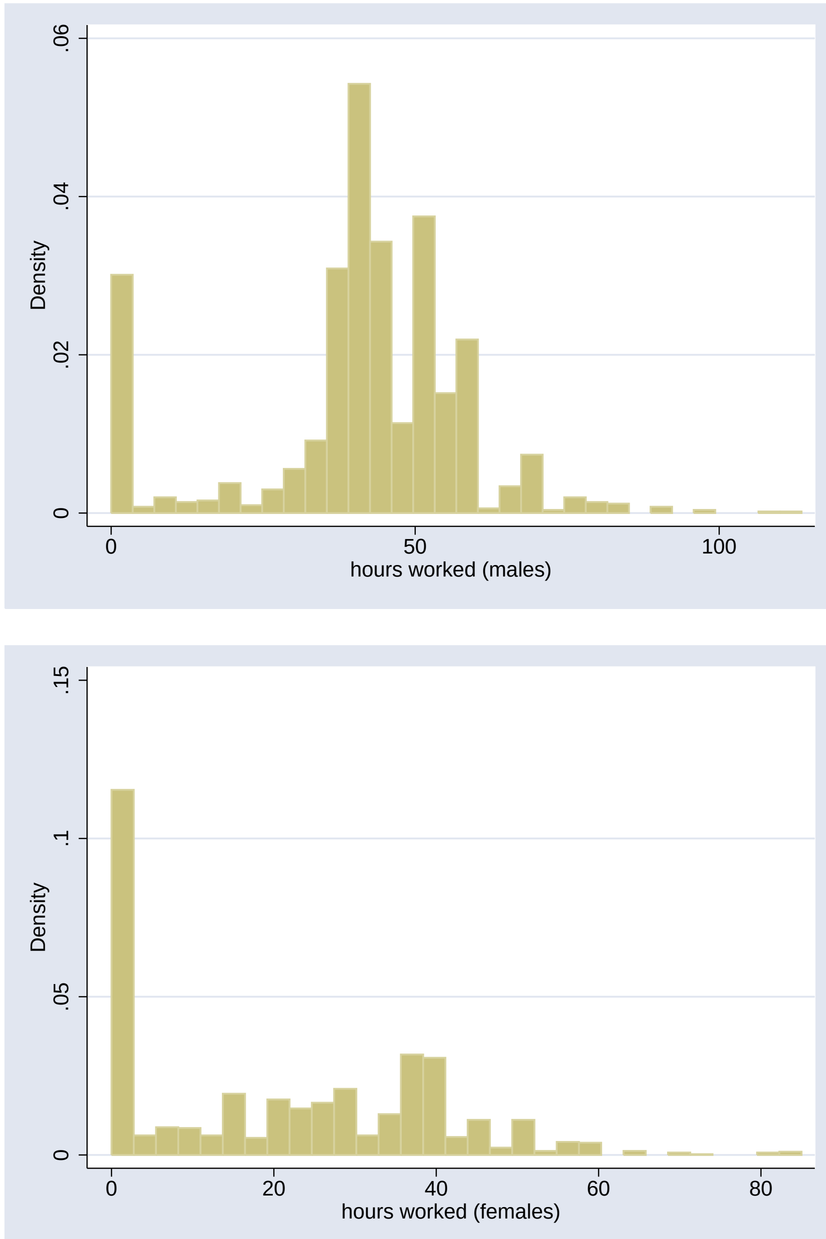
Figures

Figure 1. Budget surface of a typical Australian family



This is the budget set for a family with one 6 year-old child, husband's hourly wage \$23, wife's hourly wage \$20, husband's non-labour income of \$123 and wife's non-labour income of \$0.

Figure 2. Distribution of working hours (husbands and wives)



Source: Wave 2 HILDA

Figure 3. Distribution of hourly wage (husbands and wives)

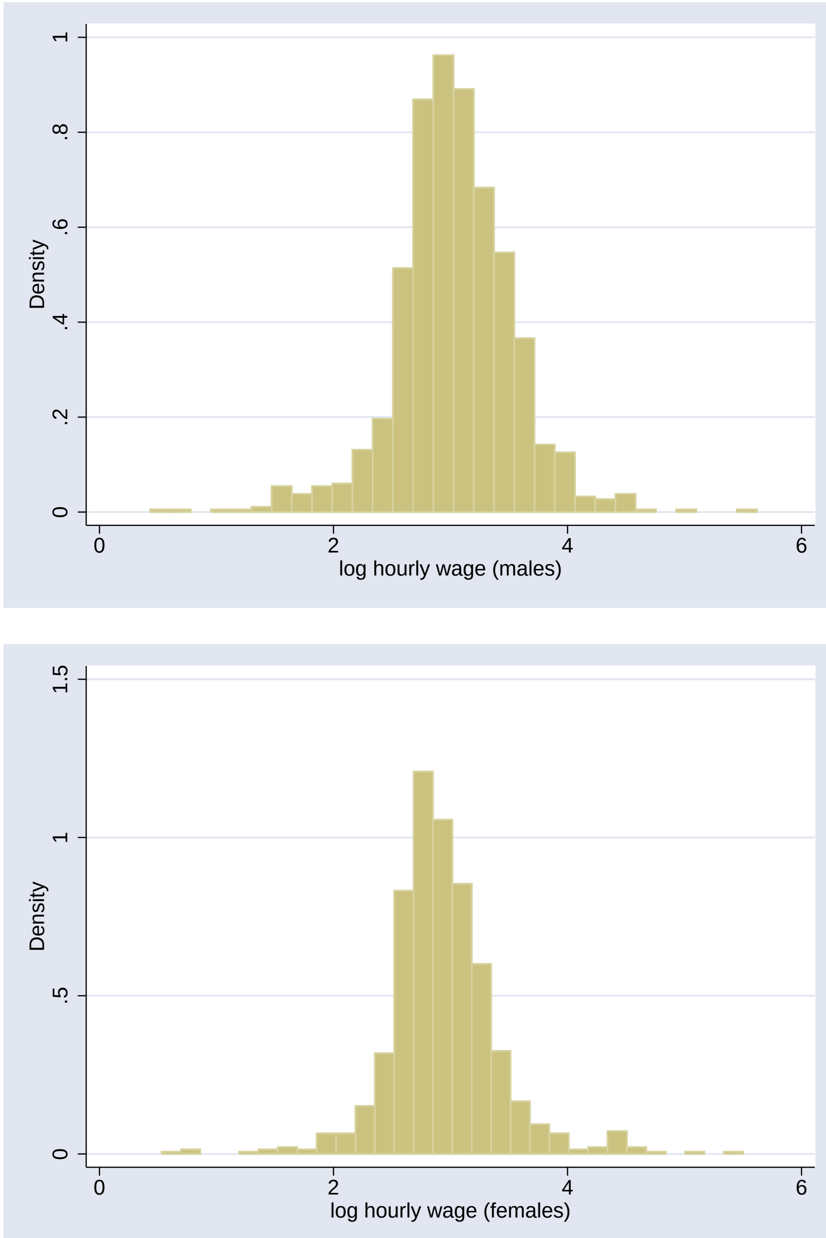
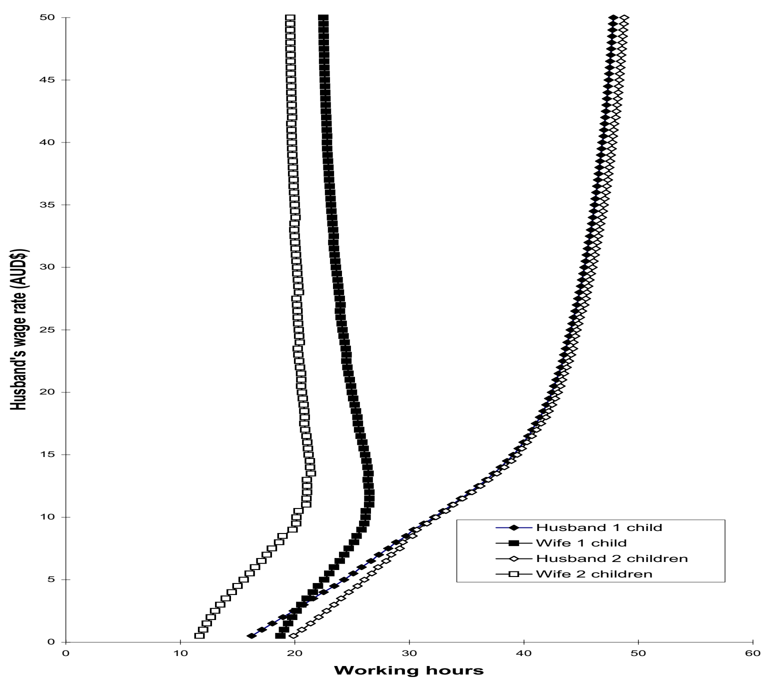
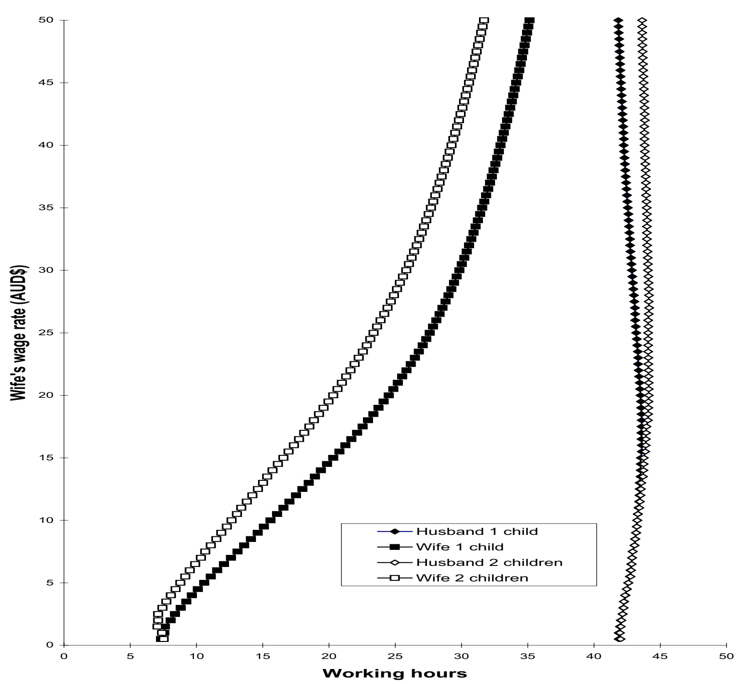


Figure 4. Labour Supply (by husband's and wife's wages)





Appendices

Table A. Variable Definitions

Variable	Definition
Kids Aged 0 - 5	Number of children under 6
Kids Aged 6 - 12	Number of children between 6 and 12
Kids Aged 13 - 15	Number of children between 13 and 15
Kids Aged 16 - 17	Number of children between 16 and 17
Kids Aged 18 - 20	Number of children between 18 and 20
Age	age in years
Married	dummy, 1 if married, 0 defacto
Higher Education	dummy, 1 if received higher education
Vocational Education	dummy, 1 if received vocational education
Completed Year 12	dummy, 1 if completed year 12
Less than Year 12	dummy, 1 if did not finish year 12
Language other than English	dummy, 1 if speak at home a language other than English
Fluent English Speaker	dummy, 1 if fluent in English
rent	dummy, 1 if renting home
mortgage	dummy, 1 if paying mortgage for home
Poor Health	dummy, 1 if poor health
Health Improved	dummy, 1 if health improved
Health Worsened	dummy, 1 if health worsened
Australian-born	dummy, 1 if born in Australia
Years since arrival	years lived in Australia
Sydney	dummy, 1 if Sydney
NSW	dummy, 1 if New South Wales (except Sydney)
Melbourne	dummy, 1 if Melbourne
VIC	dummy, 1 if Victoria (except Melbourne)
Brisbane	dummy, 1 if Brisbane
QLD	dummy, 1 if Queensland (except Brisbane)
Adelaide	dummy, 1 if Adelaide
SA	dummy, 1 if South Australia (except Adelaide)
Perth	dummy, 1 if Perth
WA	dummy, 1 if Western Australia
Tas	dummy, 1 if Tasmania
NT	dummy, 1 if Northern Teritory
ACT	dummy, 1 if Australian Capital Territory
Hours of work	hours worked per week
Wage	hourly wage rate
Non-labour income	non-labour income in $1000