Estimation of Wage Equations in Australia: Allowing for censored observation of labour supply

Guyonne Kalb and Rosanna Scutella*
Melbourne Institute of Applied Economic and Social Research
University of Melbourne

February 2002

Final report prepared for the Department of
Family and Community Services

Abstract:
This paper presents results for five separately estimated sets of participation and wage equations. The Australian working-age population is divided into sole parents, single men, single women, married men and married women. People expected to behave differently from the average working-age person, such as full-time students and disabled people, are excluded from the estimation. In addition, self-employed people are excluded since their work decision cannot be seen as the choice of working an additional hour against a known wage rate. The approach in this paper takes the censoring of labour supply observations over 50 hours per week into account.
The results are as expected with education, work experience and age increasing the expected wage.

* We would like to thank John Creedy and Mark Harris for helpful discussions and suggestions.

1 Introduction

This paper reports estimates of wage functions for a number of demographic groups in Australia, using pooled information from the 1994/95, 1995/96, 1996/97 and 1997/98 Surveys of Income and Housing Costs (SIHC). This is an extension from a previous report using 1995 and 1996 SIHC data (Creedy et al., 2001). In addition to the extra years of data, the model used in this paper accounts for the censoring of labour supply information at 50 hours. As in the previous report, the estimation procedure corrects for the sample selection bias that would arise from the fact that only the wage rates of those currently working are observed using the standard Heckman procedures (Heckman, 1979).

Wage functions provide useful descriptive information on the characteristics of individuals that are associated with relatively high or low wage rates. Earlier Australian wage functions were discussed by Miller and Rummery (1991) and Creedy et al. (2001).

The main aim of the paper is to estimate and document updated wage functions that can be used to impute wage rates for those who are not currently working. The imputed wage rates are needed as input in the construction of a behavioural microsimulation model for Australia, the Melbourne Institute Tax and Transfer Simulator (MITTS). These wage rates are required in the simulation of labour supply behaviour, in particular, so that changes in behaviour as a result of changes in taxes and transfers can be simulated.

Many tax policies are specially designed in an attempt to stimulate an increase in labour supply. There would therefore be little value in restricting analyses to those currently working, thereby excluding non-participants whose participation decision may be influenced by taxes and transfers. Labour supply analyses require an individual-specific budget constraint, so a wage rate must be assigned to non-workers. The imputation of wage rates is complicated by the fact that wage equations should ideally contain variables, such as industry and occupation, which are not observed for non-workers (for the same reason that wage rates are not available). These variables are major determining factors of wage rates. This paper therefore follows the same approach as the previous paper on this topic (Creedy et al., 2001).

The standard selection model is described briefly in section 2. The data are described in section 3. Estimates of selection and wage equations are reported in section 4. The problem of assigning wage rates to non-workers and the prediction of wage rates for some hypothetical individuals are discussed in section 5. Brief conclusions are in section 6.

2 The Statistical Model

The estimation of wage equations involves a system of two correlated equations, the first of which determines selection (employment) using a probit equation, while the second determines wage rates, conditional on employment. The correlation between the two equations accounts for the possible selection into work of those with higher wage rates. The wages of workers may therefore not represent the wages of non-workers. However, the inclusion of an additional term in the wage equation indicating the tendency to participate can correct for this.

Each individual's observed employment outcome is regarded as being the result of an unobservable index of tendency to participate in the labour force and employability, E_i^*, which varies with observed personal characteristics, z_i. The variables included in z may include both supply and demand side variables. Hence:

$$E_i^* = z_i'\gamma + u_i \qquad (1)$$

where u_i is assumed to be independently distributed as N(0, 1)[1]. The realisation of E_i^* determines whether the individual is employed ($E_i = 1$), or unemployed or out of the labour force ($E_i = 0$), such that:

$$E_i = \begin{cases} 1 \text{ if } E_i^* > 0 \text{ with prob. } \Phi\left(z_i'\gamma\right) \\ 0 \text{ if } E_i^* \le 0 \text{ with prob. } 1\text{-}\Phi\left(z_i'\gamma\right) \end{cases} \qquad (2)$$

where $\Phi\left(z_i'\gamma\right)$ is the standard normal distribution function evaluated at $z_i'\gamma$. The associated normal density function is denoted $\varphi\left(z_i'\gamma\right)$. The parameters of (2) can be consistently

[1] As there is no information about the scale of E_i the variance of u cannot be identified and is therefore set equal to unity.

estimated by a standard probit model; see Maddala (1983). Having estimated (2), an estimate, $\hat{\lambda}_i$, of the inverse Mills ratio for a working individual i is obtained using:

$$\hat{\lambda}_i = \frac{\varphi\left(z_i'\hat{\gamma}\right)}{\Phi\left(z_i'\hat{\gamma}\right)} \tag{3}$$

Let w_i denote the logarithm of the wage rate and x_i a vector of characteristics of individual i. The regression model is written as:

$$w_i\Big|_{E_i=1} = x_i'\beta + \varepsilon_i \tag{4}$$

The u_i from equation (1) and ε_i are assumed to be jointly normally distributed as N(0, 0, 1, σ_ε^2, ρ)[2]. In order to avoid selectivity bias, a correction term is added to (4):

$$w_i\Big|_{E_i=1} = x_i'\beta + \rho\sigma_\varepsilon\hat{\lambda} + \upsilon_i \tag{5}$$

Equation (5) takes into account the correlation between u_i and ε_i. It can be seen that the variance of υ_i, σ_i^2, is heteroscedastic, since:

$$\sigma_i^2 = \sigma_\varepsilon^2\left(1 - \rho^2\delta_i\right) \tag{6}$$

where:

$$\delta_i = \lambda_i\left(\lambda_i + z_i'\gamma\right) \tag{7}$$

Efficient estimation of this model is carried out using the procedure described in, for example, Greene (1981).

For individuals working more than 50 hours per week, the exact hours worked are not observed. In these cases only the maximum possible value is known of the dependent variable w_i, that is, the wage rate has to be smaller than the total income from wages and salaries divided by 50. Given that people are extremely unlikely to work more than 100

[2] The covariance between u_i and ε_i is thus $\rho\sigma_\varepsilon$.

hours per week, the total income from wages and salaries divided by 100 is used as a lower boundary for the wage rate. Instead of the usual contribution of an observation to the likelihood function of:

$$\ln L_i = \ln \Pr(\upsilon_i = w_i - x_i'\beta - \rho\sigma_\varepsilon\hat{\lambda}) = -0.5\ln(2\pi) - \ln\sigma_i - \frac{(w_i - x_i'\beta - \rho\sigma_\varepsilon\hat{\lambda})^2}{2\sigma_i^2} \qquad (8)$$

The contribution, when only the range of the wage is known, is:

$$\ln L_i = \ln \Pr(w_{i,min} - x_i'\beta - \rho\sigma_\varepsilon\hat{\lambda} \le \upsilon_i \le w_{i,max} - x_i'\beta - \rho\sigma_\varepsilon\hat{\lambda}) =$$
$$\ln\left[\int_{w_{i,min}-x_i'\beta-\rho\sigma_\varepsilon\hat{\lambda}}^{w_{i,max}-x_i'\beta-\rho\sigma_\varepsilon\hat{\lambda}} \frac{1}{\sigma_i\sqrt{2\pi}}\exp\left(-\frac{(t)^2}{2\sigma_i^2}\right)dt\right] \qquad (9)$$

where

$w_{i,max}$ is the maximum possible value for the wage rate, and

$w_{i,min}$ is the minimum possible value for the wage rate.

By using interval regression in these cases (and including a range rather than one value for the dependent variable), overestimation of the wage rate is avoided and the uncertainty associated with the wage rate for people working more than 49 hours is included in the estimation.

3 The Data

The data used in this analysis are taken from the 1994/95, 1995/96, 1996/97 and 1997/98 Surveys of Income and Housing Costs, available from the ABS in the form of confidential unit record files (CURFs). The survey collects information on the sources and amounts of income received by persons resident in private dwellings throughout Australia, along with data on a range of characteristics of income units and individuals. The survey is continuous with around 650 households interviewed every month during the financial year. In the surveys from 1994/95 to 1997/98, information is available respectively for 13827, 14017, 14595 and 13931 individuals over the age of 15.

Earlier Surveys of Income and Housing Costs (or Income Distribution Surveys as they were called then) were carried out, but the 1994/95 survey is the first to provide published data on the precise hours worked (up to 50 hours per week) by each individual worker in the sample; earlier surveys contain only grouped information on labour supply, divided into

broad hours groups. The details of hours worked are required for the calculation of wage rates, obtained for each individual as the ratio of total earnings to hours worked. Hence the following analysis ignores the possibility that individuals may obtain overtime premia, or may work in more than one job. Where individuals worked more than 50 hours[3], the exact wage rate is unknown. It is only known that the wage must be lower or equal to the total earnings divided by 50. The estimation procedure takes this into account by using an interval regression when the recorded hours worked equals 50. In this interval regression, we assume that the maximum number of hours of labour supply is 100 per week. As a result the wage must be higher than the total earnings divided by 100.

The majority of the data used as explanatory variables were recoded as zero-one dummy variables. To keep the variables to scale all of the non-wage income variables were divided by 1000 and age was divided by 10. Any individuals with inconsistent observations on income from wages and salaries and hours worked, that is positive earnings for zero hours or zero earnings for positive hours are excluded from the wage equation (as sensible wage rates cannot be calculated for them). However these observations do remain in the participation equation assuming that we correctly observe whether or not they are in the work force. In view of the emphasis of the analysis on obtaining results that are useful in the labour supply analysis for people of working age, people over 65 are excluded from the sample. Furthermore, groups such as the disabled and those in full-time education are excluded, because they are unlikely to participate and the factors determining their participation decision would be quite different from other people of working age. Finally, the self employed were omitted from the sample, because their decision to work an additional hour cannot be linked to the wage rate for that additional hour, which is crucial in the labour supply estimation for the wage and salary earners[4].

[3] Table A.1 shows the proportion of people in the different demographic groups, who work 50 hours or more. Except for sole parents, a substantial number of people fall into this category.

[4] In the four surveys used, there were 1035 people either at school or studying full-time. There were 18 unpaid voluntary workers and 283 individuals permanently unavailable for work. Also, there were 8141 individuals over the age of sixty-five. There were 4978 self-employed persons.

The four surveys were pooled[5] and the sample was divided into five demographic groups. These are: sole parents; single females without dependents; single males without dependents; married females; and married males. Summary tables of sample characteristics are provided for each demographic group in the Appendix. It was not possible to estimate separate equations for sole mothers and sole fathers, given the small number of sole fathers in the sample[6].

Table 1 presents the average real wage rates across the four years for the five demographic groups. Here it can be seen that, once average wage inflation has been accounted for, average wages do not seem to change systematically between the various survey years. In estimation, we include year dummies in the wage equation to check more formally for systematic differences.

Table 1: Average real wage rates for 1994/95 to 1997/98, inflated to May 1998 level

	1994/95	1995/96	1996/97	1997/98
Sole parents	14.79	15.56	16.51	15.66
Single females	14.08	13.76	14.04	14.42
Single males	14.64	14.69	15.03	15.10
Married females	15.96	16.00	15.82	15.95
Married males	18.70	18.76	19.02	18.94

Examples of distributions of the logarithms of observed hourly wage rates for the five demographic groups are shown in Figures 1 to 5. These are based on May 1998 wages and the censoring of labour supply over 50 hours per week is not taken into account. The histograms suggest that these distributions are approximately lognormal, although they are slightly more peaked than the corresponding normal distributions with the same mean and variance. Individuals reporting wage rates lower than $4 an hour or greater than $100 an hour are considered outliers and are omitted from the wage equation. These observations remain in the participation equation. As expected, the graphs show that the modal wage rate is higher for men than for women.

[5] All wage rates are uprated to 1998 using indices derived from average weekly earnings for males and females respectively and all income from other sources is inflated with the appropriate consumer price index to obtain the value it would have had in 1998.
[6] There were 194 male sole parents, compared with 1593 females.

Figure 1: Log hourly wage rates for sole parents, May 1998 wages

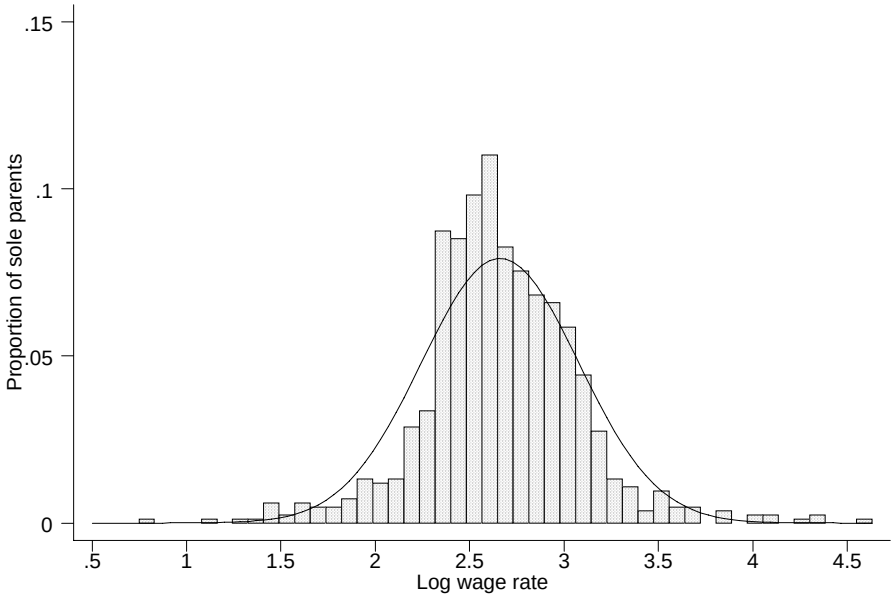


Figure 2: Log hourly wage rates for single females without dependents, May 1998 wages

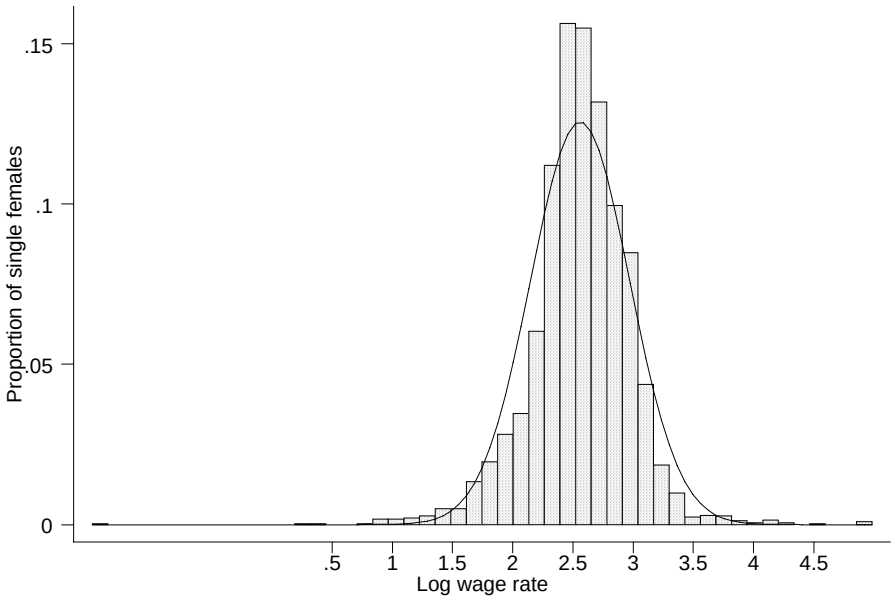


Figure 3: Log hourly wage rates for single males without dependents, May 1998 wages

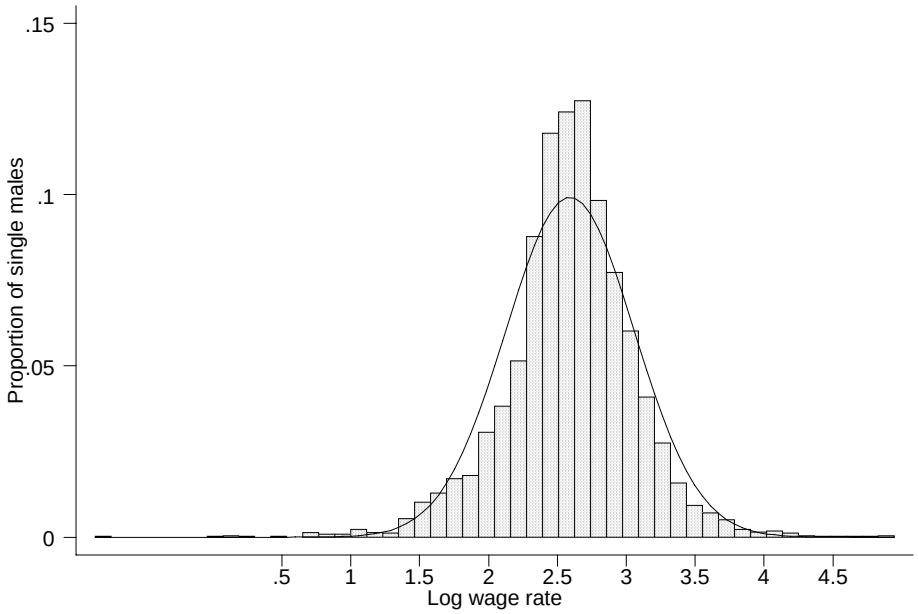


Figure 4: Log hourly wage rates for married females, May 1998 wages

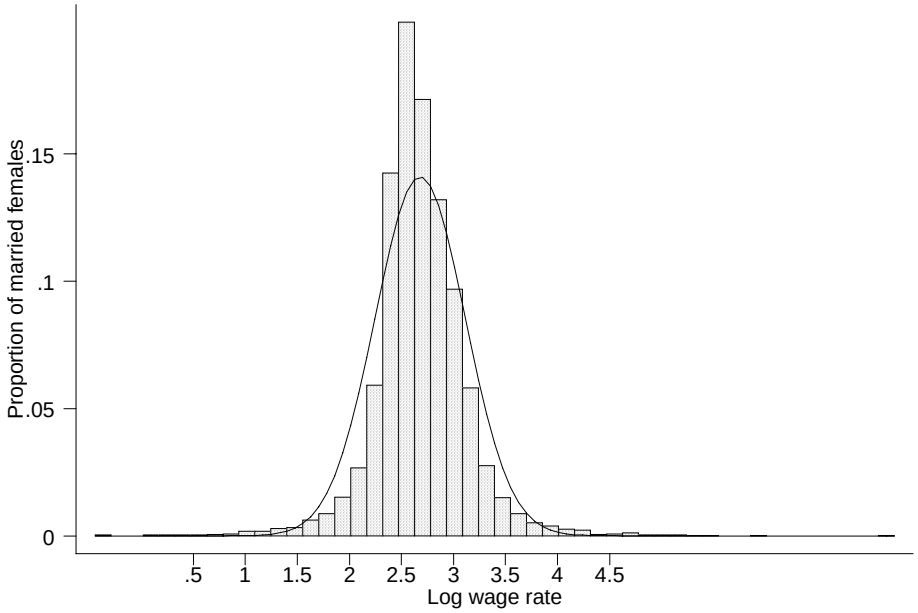
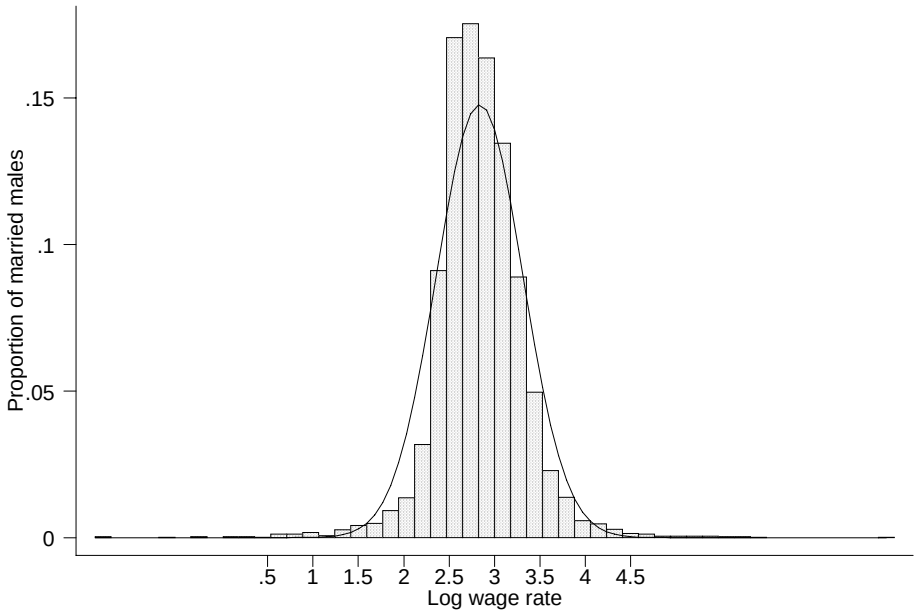


Figure 5: Log hourly wage rates for married males, May 1998 wages



4 Empirical Results

This section presents the main empirical results. The selection equations, along with specification tests and `hit and miss' tables, are reported in subsection 4.1. The wage equations and associated specification tests are reported in subsection 4.2.

4.1 Selection Equations

The selection equations for each demographic group are based on sample sizes, for married women, married men, single women, single men and sole parents of respectively 13354, 11240, 4628, 5682 and 1787 individuals. Tables 3, 4 and 5 present the marginal effects on the probability of being employed, evaluated at sample means of variables and changing the relevant variable by one unit (in most cases these marginal effects are the effects of a discrete change from 0 to 1 in the dummy variable). The majority of coefficients are significantly different from zero and the coefficients' signs appear to accord with expectations[7].

[7] Direct comparisons with results in Miller and Rummery (1991) are not possible because the latter distinguish only two demographic groups (males and females) and include a much smaller set of variables than is used here. The results from the participation equation in Creedy et al. (2001) cannot be directly compared because their sample does only include non-participants who are looking for work.

Before discussing the estimation results, a `hit and miss' table of actual versus predicted values can be constructed to evaluate how well the selection model predicts (see Table 2). The models generally tend to overpredict the empirically most frequently chosen outcome. Indeed, this is true of the present models, with the employed being somewhat overpredicted for each demographic group, except for sole parents where the non-working category is largest. Such a result stems from the fact that the random elements of the model are explicitly ignored in its evaluation.

Table 2: Predicted versus actual probabilities

	Actual		
Predicted	**Not working**	**Working**	**Total**
Married women			
Not working	5151	527	5678
Working	600	7076	7676
Total	5751	7603	13354
Married men			
Not working	1008	208	1216
Working	493	9531	10024
Total	1501	9739	11240
Single females			
Not working	908	166	1074
Working	270	3284	3554
Total	1178	3450	4628
Single males			
Not working	644	217	861
Working	510	4311	4821
Total	1154	4528	5682
Sole parents			
Not working	863	120	983
Working	76	728	804
Total	939	848	1787

Considering the results in Tables 3 to 5, we find that age affects the probability of labour force participation with the exception of sole parents, where the effect of age is insignificant. Using the underlying coefficients for age and age squared, we find that age has a positive effect on labour force participation for single women, married men and women up to an age of around 30 years. After this age, a further increase in age means a decrease in the probability of labour force participation. For single men, the maximum probability seems to occur at a much younger age (around 20 years). Employment status is unaffected by the number of children, apart from having a slight negative effect on the

probability of married men being in work. Although the number of dependent children has no significant effect on the participation decision, the age of the youngest child is an important factor in the participation probability of married women and sole parents, while there is hardly an effect for married men. As expected, women with younger families (particularly those with children under 5 years old) are less likely to participate. The effects seem somewhat larger for sole parents than for married women. Sole parents receiving child support are less likely to participate, whereas receipt of child support does not affect the participation of married women significantly.

In the case of married women the probability of employment is higher for those with a tertiary qualification than for those without any qualification, whereas a similar but smaller effect is observed for married men. The size of the effects for singles without dependents is in between those for married men and married women, with similar effects for males and females. The probability of employment is higher for sole parents with a vocational qualification than for those without any qualification, whereas the effects of the other qualifications are of a similar size but insignificant. Surprisingly, the effect of a postgraduate qualification was insignificant and small. The number of sole parents with a postgraduate qualification is small, therefore we have included them in the reference group.

Previous work experience (as measured by the number of months in work of the last seven months and whether there was any income from wages and salaries in the last financial year) has a positive effect on participation probabilities. This effect is largest for married women and sole parents and lowest for married men. The effect for singles is in between these two effects with the effect for single men and women being similar in size.

Other income in the income unit (that is income for the income unit that is not derived from benefits or from wages and salaries of the relevant individual) has a negative effect on the participation of singles, which is largest for single women. There is hardly any effect on participation for members of a couple. Individuals whose partner is employed are significantly more likely to be in employment than couples where the partner is out of work. This is particularly true for women. The other partner variables do not seem to have much effect on the probability of employment. Other income seems to have a positive effect on the participation probability of sole parents. However, it should be noted that only

a small group of sole parents receive other income. Single men who have been married, but are now separated or a widower, are slightly more likely to be employed than single men who have never been married.

Table 3: Selection Equations: Married Women and Men

	Women		Men	
participation	Marginal effect	Std. Err.	Marginal effect	Std. Err.
Age	0.021	0.006**	0.006	0.002**
Age squared	0.000	0.000**	0.000	0.000**
# months worked in last 7	0.141	0.003**	0.029	0.001**
Work exp (last financial year)	0.424	0.016**	0.195	0.017**
Australia (reference)				
Europe/Middle East	-0.005	0.019	-0.005	0.005
Asia	-0.009	0.032	-0.004	0.010
America/Africa	0.051	0.046	0.001	0.015
No qualifications (reference)				
postgraduate	0.123	0.036**	0.036	0.005**
undergraduate	0.101	0.024**	0.027	0.005**
diploma	0.049	0.025**	0.019	0.005**
vocational	0.037	0.019*	0.005	0.005
Other income in income unit/1000	0.002	0.013	-0.012	0.006*
Child support	0.341	0.728		
NSW (reference)				
Victoria	-0.030	0.022	0.000	0.006
Queensland	-0.030	0.023	0.010	0.006*
South Australia	-0.070	0.027**	-0.009	0.008
Western Australia	-0.051	0.025**	0.011	0.006
Tasmania	0.005	0.031	0.001	0.009
ACT/Northern Territory	0.030	0.033	0.012	0.008
Capital city	-0.006	0.016	-0.004	0.005
Number of children	-0.014	0.010	-0.006	0.003**
Youngest child: 0 to 2	-0.287	0.027**	-0.017	0.010*
Youngest child: 3 to 4	-0.181	0.036**	-0.007	0.012
Youngest child: 5 to 9	-0.101	0.032**	-0.001	0.009
Youngest child: 10 to 15	-0.048	0.030*	-0.002	0.009
Owned (reference)				
mortgage	0.030	0.018*	0.027	0.005**
rented	0.102	0.021**	0.012	0.005**
Other tenure	0.001	0.045	0.020	0.008**
Partner is employed	0.163	0.022**	0.040	0.006**
Partner postgraduate	-0.042	0.033	0.008	0.012
Partner undergraduate	0.019	0.025	-0.003	0.009
Older than partner	0.019	0.063	0.008	0.006
Younger than partner	-0.009	0.022	-0.030	0.023
observed probability	0.569		0.866	
predicted probability (at the mean of all x)	0.608		0.956	
Number of observations	13354		11240	

Notes: ** coefficient is significant at the 5 per cent level, * coefficient is significant at the 10 per cent level.

Table 4: Selection Terms, Single Men and Women

	Single females		Single males	
participation	**Marginal effect**	**Std. Err.**	**Marginal effect**	**Std. Err.**
Age	0.013	0.003**	0.003	0.002
Age squared	0.000	0.000**	0.000	0.000**
# months worked in last 7	0.068	0.003**	0.053	0.002**
Work exp (last financial year)	0.208	0.025**	0.218	0.020**
Separated/widowed	-0.012	0.024	0.028	0.014**
Australia (reference)				
Europe/Middle East	-0.051	0.025**	-0.022	0.017
Asia	0.016	0.031	-0.069	0.034**
Americas/Africa	-0.045	0.058	0.015	0.036
No qualifications (reference)				
postgraduate	0.047	0.030	0.074	0.018**
undergraduate	0.071	0.016**	0.091	0.010**
diploma	0.050	0.019**	0.061	0.013**
vocational	-0.004	0.017	0.008	0.011
Other income in income unit/1000	-0.226	0.085**	-0.138	0.067**
NSW (reference)				
Victoria	0.008	0.019	-0.033	0.016**
Queensland	-0.005	0.020	-0.012	0.016
South Australia	-0.074	0.029**	-0.038	0.020**
Western Australia	0.024	0.021	0.006	0.016
Tasmania	-0.009	0.029	-0.054	0.026**
ACT/Northern Territory	0.012	0.029	0.013	0.021
Capital city	0.023	0.015	0.008	0.011
Owned (reference)				
mortgage	0.086	0.019**	0.042	0.019**
rented	0.011	0.024	0.032	0.020*
Other tenure	-0.095	0.034**	-0.019	0.023
Observed probability	0.745		0.797	
Predicted probability (at the mean of all x)	0.869		0.884	
Number of observations	4628		5682	

Notes: ** coefficient is significant at the 5 per cent level, * coefficient is significant at the 10 per cent level.

Table 5: Selection Terms: Sole Parents

participation	Marginal effect	Standard Error
female	-0.125	0.061*
Age	0.004	0.017
Age squared	0.000	0.000
# months worked in last 7	0.169	0.009**
Work exp (last financial year)	0.302	0.039**
Separated/widowed	0.071	0.048
Australia (reference)		
Europe/Middle East	-0.086	0.059
Asia	-0.234	0.082**
America/Africa	0.073	0.123
No qualifications (reference)		
undergraduate	0.094	0.083
diploma	0.116	0.070
vocational	0.084	0.047*
Other income in income unit/1000	0.415	0.341**
Child support	-0.656	0.321*
NSW (reference)		
Victoria	0.080	0.058
Queensland	0.106	0.059*
South Australia	0.048	0.068
Western Australia	0.133	0.064**
Tasmania	0.158	0.074**
ACT/Northern Territory	0.105	0.084
Capital city	-0.014	0.041
Number of Children	-0.032	0.025
Youngest child: 0 to 2	-0.315	0.082**
Youngest child: 3 to 4	-0.219	0.086**
Youngest child: 5 to 9	-0.121	0.079
Youngest child: 10 to 15	-0.109	0.072
Owned (reference)		
mortgage	0.040	0.072
rented	0.138	0.066**
Other tenure	0.044	0.106
Observed probability	0.475	
Predicted probability	0.501(at the mean of all x)	
Number of observations 1787		

Notes: ** coefficient is significant at the 5 per cent level, * coefficient is significant at the 10 per cent level.

In addition to the variables relating to age, education, work experience and household composition, it is found that all groups are more likely to be employed if their homes are either rented or if they have a mortgage (as opposed to owning their home outright). However this effect is not always significant. There is no clear pattern in the effect of the state of residence on employment patterns, and living in a capital city is not significant for any of the demographic groups.

Finally, although the group of sole parents cannot be subdivided into a male and a female group, because of the small number of male sole parents, a variable indicating the gender of the sole parent is estimated. Female sole parents are less likely to participate, but the coefficient is only significant at the 10 per cent level.

Maximum likelihood estimation of discrete choice models, such as the selection model used here, is based upon a specified distribution of the unobserved elements of the underlying economic model. However, unlike the traditional linear regression model, if the distributional assumptions in such non-linear models are invalid, parameter estimates are both biased and inconsistent. For this reason, diagnostic testing procedures in a discrete choice framework have been suggested; see for example Pagan and Vella (1989).

Thus, the first stage in checking model specification is to test the specification of these selection equations. Following Pagan and Vella (1989), tests for both normality and heteroscedasticity were undertaken. The results are reported in Table 6. These results show that the assumption of homoscedasticity appears invalid for all the demographic groups (high p-values indicate that the null hypothesis cannot be rejected). In addition, the assumption of normality is rejected (at the 5% level) for all the demographic groups.

Table 6: Specification tests for selection equation (P-values)

	Null hypothesis of:	
Demographic group	**Normality**	**Homoscedasticity**
Sole parents	0.0000	0.0002
Single females	0.0000	0.0000
Single males	0.0000	0.0000
Married females	0.0000	0.0000
Married males	0.0000	0.0000

Although the standard approach to estimate wage equations is to estimate a homoscedastic probit model and use correction terms derived from this probit model, these results indicate that a heteroscedastic probit model might be a better specification[8]. Few papers estimating

[8] The term heteroscedastic probit model is used here, but in practice a heteroscedastic probit model cannot be distinguished from a probit model where some of the explanatory variables enter in a non-linear way. Thus the misspecification may lie in an incorrect functional specification of the model as well as in ignoring heteroscedasticity. However, for ease of notation we continue referring to the alternative as a heteroscedastic specification in this paper.

wage equations appear to test for normality or heteroscedasticity, so we do not know whether these tests would fail in other studies as well. Creedy et al. (2001) found that for sole parents the above normality test failed as well. Kalb (1998) found that homoscedasticity was rejected, but she did not test for normality. She compared a homoscedastic probit specification with a heteroscedastic probit specification and found it did not have a large effect on the predicted probabilities of participation. An adapted correction term[9] was constructed using the results from the heteroscedastic probit and included in the wage equation. Compared to the homoscedastic specification, the constant in the wage equation shifted upwards while the other parameters shifted downwards, not changing the relative importance of the different parameters. The predicted wages in the two specifications were quite similar.

For the moment we continue to use the standard approach in the literature. However, at a later stage we will explore the implications of using a heteroscedastic probit specification.

4.2 Wage Equations

The estimated wage equations, conditional on being in employment, are reported for each demographic group in Tables 7, 8 and 9. The results here look quite similar to the results in Creedy et al. (2001). The main difference between the two models is that, in the version presented here, some additional explanatory variables on recent work experience are included. The sample sizes are, for married women, married men, single women, single men and sole parents respectively 7434, 9513, 3398, 4459 and 836. The inverse Mills ratio has the expected sign for married women and sole parents only, that is for these two groups the parameter is significant and positive. The inverse Mills ratio is insignificant for married men and single women and significantly negative for single men. The interpretation of negative inverse Mills ratios in this context was discussed by Ermisch and Wright (1994)[10]. The results on this coefficient are not comparable to the results in the previous paper since a different selection equation was estimated.

[9] Assuming that the heteroscedasticity in the participation probit was caused by heteroscedasticity in the error term of the underlying reservation wage equation.

[10] Miller and Rummery (1991) found a positive value for women and a negative value for men. They also review results found in previous Australian studies. They do not distinguish between single and married men and women.

Here all models are presented with the Mills ratio included. However to impute wages for non-workers, the equations for married men and singles are re-estimated using the interval regression specification without the selection correction.

Table 7: Wage Equations: Married Women and Men

	Women		Men	
	coefficients	**s.e.'s**	**coefficients**	**s.e.'s**
constant	1.662	0.088**	1.755	0.086**
Age/10	0.207	0.033**	0.206	0.031**
Age squared/100	-0.025	0.004**	-0.022	0.004**
# months worked in last 7	0.020	0.005**	0.005	0.004
Work exp (last financial year)	0.169	0.028**	0.151	0.029**
Tradesperson/labourer (reference)				
Professional	0.284	0.017**	0.125	0.011**
Paraprofessional	0.216	0.018**	0.111	0.014**
Clerical/sales	0.112	0.012**	0.056	0.012**
Agriculture/forestry (reference)				
Mining	0.268	0.064**	0.613	0.034**
Manufacturing	0.121	0.034**	0.281	0.025**
Construction	0.267	0.045**	0.228	0.027**
Utilities	0.259	0.070**	0.413	0.035**
Trade	0.067	0.033**	0.129	0.025**
Transport	0.188	0.043**	0.266	0.027**
Communication	0.195	0.048**	0.355	0.032**
Financial/bus	0.146	0.034**	0.264	0.026**
Services	0.098	0.032**	0.240	0.025**
Australia (reference)				
Europe/Middle East	-0.014	0.012	-0.019	0.010*
Asia	-0.060	0.020**	-0.102	0.018**
America/Africa	-0.037	0.027	-0.079	0.027**
No qualifications (reference)				
postgraduate	0.128	0.054**	0.112	0.051**
undergraduate	0.087	0.049*	0.052	0.048
diploma	0.092	0.015**	0.132	0.013**
vocational	0.025	0.011**	0.057	0.010**
NSW (reference)				
Victoria	-0.039	0.013**	-0.057	0.012**
Queensland	-0.061	0.013**	-0.039	0.012**
South Australia	-0.052	0.015**	-0.077	0.014**
Western Australia	-0.061	0.015**	-0.034	0.013**
Tasmania	-0.045	0.019**	-0.031	0.017*
ACT/Northern Territory	0.068	0.018**	0.071	0.017**
Capital city	0.054	0.010**	0.058	0.009**
Age * university degree	0.021	0.012*	0.042	0.011**
Mills ratio	0.127	0.031**	0.011	0.044
σ_ε	0.356		0.373	
Number of observations	7434		9513	

Notes: ** coefficient is significant at the 5 per cent level, * coefficient is significant at the 10 per cent level.

Table 8: Wage Equations, Single Women and Men

	Women		Men	
	coefficients	**s.e.'s**	**coefficients**	**s.e.'s**
constant	1.177	0.091**	1.012	0.087**
Age/10	0.590	0.031**	0.657	0.030**
Age squared/100	-0.068	0.004**	-0.075	0.004**
# months worked in last 7	-0.010	0.005**	-0.014	0.005**
Work exp (last financial year)	0.137	0.029**	0.101	0.031**
Tradesperson/labourer (reference)				
Professional	0.185	0.021**	0.176	0.018**
Paraprofessional	0.178	0.023**	0.123	0.021**
Clerical/sales	0.084	0.016**	0.080	0.015**
Agriculture/forestry (reference)				
Mining	0.497	0.115**	0.587	0.053**
Manufacturing	0.039	0.053	0.237	0.029**
Construction	0.065	0.069	0.253	0.031**
Utilities	0.211	0.110*	0.436	0.052**
Trade	0.016	0.052	0.130	0.029**
Transport	0.205	0.059**	0.314	0.034**
Communication	0.178	0.067**	0.343	0.041**
Financial/bus	0.085	0.052	0.251	0.031**
Services	0.060	0.051	0.210	0.029**
Australia (reference)				
Europe/Middle East	-0.008	0.018	0.005	0.018
Asia	-0.031	0.027	-0.033	0.030
America/Africa	-0.043	0.045	0.039	0.044
No qualifications (reference)				
postgraduate	0.114	0.049**	0.104	0.068
undergraduate	0.067	0.042	0.078	0.055
diploma	0.083	0.018**	0.066	0.020**
vocational	0.069	0.014**	0.101	0.013**
NSW (reference)				
Victoria	-0.017	0.015	0.008	0.015
Queensland	-0.050	0.016**	-0.005	0.016
South Australia	-0.001	0.019	-0.030	0.019
Western Australia	-0.048	0.018**	0.008	0.017
Tasmania	-0.017	0.023	-0.019	0.024
ACT/Northern Territory	0.091	0.025**	0.033	0.024
Capital city	0.040	0.012**	0.026	0.013**
Age * university degree	0.027	0.012**	0.012	0.016
Mills ratio	-0.068	0.044	-0.113	0.058**
σ_ε	0.292		0.342	
Number of observations	3398		4459	

Notes: ** coefficient is significant at the 5 per cent level, * coefficient is significant at the 10 per cent level.

Table 9: Wage Equation: Sole Parents

	coefficient	Standard error
Constant	2.316	0.293**
Female	-0.132	0.039**
Age/10	-0.101	0.119
Age squared/100	0.011	0.015
# months worked in last 7	0.048	0.015**
Work exp (last financial year)	0.078	0.057
Tradesperson/labourer (reference)		
Professional	0.268	0.046**
Paraprofessional	0.215	0.054**
Clerical/sales	0.099	0.034**
Agriculture/forestry (reference)		
Mining	1.034	0.219**
Manufacturing	0.053	0.089
Construction	0.032	0.130
Utilities	0.444	0.203**
Trade	0.055	0.089
Transport	0.228	0.109**
Communication	0.238	0.113**
Financial/bus	0.117	0.090
Services	0.093	0.085
Australia (reference)		
Europe/Middle East	-0.019	0.039
Asia	-0.139	0.072*
America/Africa	-0.004	0.075
No qualifications (reference)		
postgraduate	0.268	0.067**
undergraduate	0.205	0.052**
diploma	0.097	0.047**
vocational	-0.019	0.033
NSW (reference)		
Victoria	-0.058	0.041
Queensland	-0.045	0.044
South Australia	-0.055	0.048
Western Australia	-0.026	0.046
Tasmania	0.035	0.053
ACT/Northern Territory	0.108	0.054**
Capital city	0.057	0.030*
Mills ratio	0.220	0.084**
σ_ε	0.371	
Number of observations	830	

Notes: ** coefficient is significant at the 5 per cent level, * coefficient is significant at the 10 per cent level.

To ensure that the changes over time in the proportion of people in unemployment and out of the labour force combined, and those in employment[11] did not affect the estimated

[11] See Table A.1 for the proportion of respondents in the different labour market states in each of the survey years.

results, a wage equation including year dummies for each of the survey years has been estimated. These dummies turned out to be insignificant, indicating that after taking into account the changes in average wage rates for men and women separately, wages do not appear to differ significantly over the years.

The coefficients more or less display the expected variation of wage with age, that is wage rates generally increase with age up to people's early forties, after which they decline again with age. The exception is the sole parents group, where no effect from age is found. The age effect is more important for singles than for couples.

There is a considerable amount of difference in wage rates between occupations and educational qualifications. Wage rates of professionals, paraprofessionals, and clerical or salespersons are significantly higher than for trades persons or labourers across all groups. As expected, the wage level is highest for professionals, followed by paraprofessionals and then clerical or salespersons. Wage rates also tend to increase with the level of educational qualification across all groups. Generally, people educated at university level have the highest wages, although for single men a vocational education seems just as beneficial. Sole parents with a diploma receive considerably lower wages compared to sole parents with a postgraduate or undergraduate degree, followed by sole parents with a vocational qualification. The significance of the interaction term between age and education level (distinguishing between university level or less) indicates that the effects of age and education are not completely independent of each other. For single women and married couples the coefficient indicates that people with a university degree, have wages that increase more with age than people without a university degree. This might indicate that work experience results in more wage growth for people with a higher education level.

Work experience in the previous financial year has a positive effect on the current wage level. However, the number of months in employment out of the last seven has little, and sometimes even a negative, effect; only for married women and sole parents is the effect positive and significant. The latter group, in particular, has a wage premium for recent work experience, but on the other hand, the effect of work experience in the last financial year is smaller than for other groups (and insignificant).

Couples living in NSW experience higher wage rates than those living in the other states, with the exception of those residing in the Territories who receive even higher wages; residents of the ACT form the larger part of this category. People living in capital cities are paid higher wage rates than their counterparts living in other areas of the country. Wage rates of married women and married or single men are higher in all industries compared with the agriculture/forestry industry (the reference industry). For single women and sole parents only the wage rates in mining, utilities, transport and communication are significantly higher. People in the mining and utilities industries generally have the highest wages, for men and sole parents the difference between these and other industries is particularly high. The differences in wage rates between industries is smallest for married women.

There seems to be little effect on wages depending on the country of origin. Only immigrants from Asia earn significantly lower wages if they are in the groups of sole parents or married men or women. Married men from America and Africa earn less than those born in Australia. The effects for singles are insignificant and smaller in size. This perhaps reflects a difference in the effect of being an immigrant between younger (who are more likely to be single) and older age groups.

Female sole parents earn significantly less than male sole parents. Comparing the size of the coefficient with the difference in the constant terms in the wage equations for married men and women and in the equations for single men and women, it appears that the gender difference in wages for sole parents is similar to the gender difference for the other groups.

Finally, the estimated standard error (σ_ε) has a similar size over all the demographic groups. It is largest for married men, indicating that for this group a larger proportion of the differences in wage rates has not been explained by the variables included in the equation. The standard error is smallest for single women, however, the differences between groups are rather small.

The specification of the present model is based on the joint normality of both the selection and regression equations. If the selection equation is misspecified, the same is true of the correction term in the regression equation, resulting in biased and inconsistent estimates of

the determinants of wages; see Olsen (1982). Following Pagan and Vella (1989) it is possible to test the assumption of joint normality by including the product of the linear prediction terms of the selection equation (raised to powers 1, 2 and 3) and the inverse Mills ratio for each individual. The null hypothesis of joint normality is rejected if these three additional variables are jointly significant. The Wald tests for these restrictions are reported in Table 10.

Table 10: Joint normality tests (P-values)

Demographic group	Null hypothesis of joint normality
Married women	0.0000
Married men	0.8058
Single women	0.0362
Single men	0.0001
Sole parents	0.7978

Table 10 shows that the null hypothesis of joint normality is rejected for three out of the five regressions. For married men and sole parents the assumption of joint normality cannot be rejected suggesting some confidence in the validity of these results. On the other hand, one might be wary of placing too much emphasis on the results of the determinants of the wages of singles and married females. Similar to the tests reported in Table 6, few studies on estimating wage equations report these tests, so we do not know whether these tests fail in other studies as well. Looking at Figures 1 through 5, the assumption of normality for the logarithm of the wage rates seems reasonable, so perhaps allowing for heteroscedasticity in the selection equation will improve the results from the above tests as well. However, as indicated before we continue use of the standard approach for the moment.

5 Wage Predictions

This section considers the question of how a wage rate may be assigned to unemployed individuals. In the simple case where the selection and wage equations contain a common set of variables, consider first the conditional mean log-wage rate, for an individual with given characteristics. For those who are employed, this is given by:

$$E\left(w_i \middle|_{E_i=1}\right) = x_i'\hat{\beta} + \hat{\rho}\hat{\sigma}_\varepsilon^2\hat{\lambda} \qquad (10)$$

Imputed wage rates for those who are unemployed can be obtained using the expression:

$$E\left(w_i \middle|_{E_i=0}\right) = x_i'\hat{\beta} - \hat{\rho}\hat{\sigma}_\varepsilon^2 \frac{\varphi\left(z_i'\hat{\gamma}\right)}{1-\Phi\left(z_i'\hat{\gamma}\right)} \qquad (11)$$

The use of the conditional mean log-wage is perhaps the most obvious choice for the predicted wage. It is also possible, for example, to take a random draw, for each individual, from the relevant conditional distribution. Indeed, in labour supply analyses there is no necessity to be restricted to using observed wage rates for those employed in the sample period: it would also be possible to take random draws from the relevant conditional distributions.

In the present context, the expression in (11) cannot be used without modification because some variables used in the estimation of the wage functions are not available for non-workers. In addition to the wage rate, neither the occupation nor the industry of non-workers is known. Although these variables could not be included in the selection equations, they were included in the wage equations because of their demonstrated importance in wage determination. Extraneous information on unemployment rates within the various occupation and industry groups are used to assign proportions within occupation and industry groups to the non-workers (see Table A.4). For a complete discussion of this see Creedy et al. (2001).

5.1 Marginal effects

This subsection provides selected examples of the extent to which a person's wage rate may change given a change in their observable characteristics.

Consider first what the impact of postgraduate qualifications is on the wage rates of individuals. A typical sole parent or married female with a postgraduate degree is expected to be offered a wage rate which is about 31 per cent higher than for those without post

secondary qualifications[12]. Single females without dependents and married men can expect a return from postgraduate qualifications of about 12 per cent, while single males without dependents exhibit the lowest (and insignificant) wage premium for a postgraduate qualification with wage rates only 11 per cent higher.

Second, lets consider what impact living in a capital city has on the wage rate of individuals. Wage rates are higher across all five demographic groups for individuals residing in the capital city of their State. Single males experience the smallest effect on their wage rates with less than a three per cent increase by living in a capital city. Sole parents, single females and married males and females all have wage rates which are between four and six per cent higher in capital cities.

Finally, consider what the impact of age is on the wage rates of individuals. To calculate the age effect, we need to take into account the coefficients of age and age squared. In addition the effect depends on the starting age. The effect for married men is an increase of 7.7[13] per cent for a ten-year increase in age from 25 to 35 years and a 3.0 per cent increase for a ten-year increase from 35 to 45 years. This reflects the turnaround point in people's early forties, from an increasing wage rate with age to a decreasing wage rate with age.

5.2 Selected Examples of Predicted Wages

This subsection provides selected examples of predicted wages obtained when unemployed individuals are assigned the sample occupation and industry characteristics.

Consider first a female unemployed sole parent with the following characteristics: aged 32 years; vocational qualification; no recent work experience; separated/widowed from a previous relationship; European born; residing in ACT/NT in a non-capital city; with no other income unit income; with two dependent children, one aged between 5 and 9 years

[12] This value is calculated by using the following formula: [exp(relevant coefficient) – 1]×100%. In this example that is: [exp(0.268)-1] ×100% =30.7%.

[13] The formula used in this calculation is [exp(coefficient of age + coefficient of age squared+2*(age at start/10)*(coefficient of age squared)) – 1]×100%. In this example that is: [exp(0.206-6*0.022)-1] ×100% =7.7%.

and the other between 10 and 15 years; living in 'other tenure'. The predicted or imputed wage obtained using (employed) sample averages for industry and occupation groups is found to be $9.87 per hour. We can also calculate a predicted wage using the model, which does not account for the censored labour supply observation[14]. This is $10.17, which is only slightly higher than the specification accounting for the censoring of labour supply over 49 hours. There are relatively few sole parents working long hours, so one would not expect a large difference in the outcomes from the two specifications.

Second, consider a single female without children; never married; aged 22 years; Australian born; residing outside the Sydney metropolitan region in NSW; with a vocational qualification; no recent work experience; living in 'other tenure' with no other income. The imputed hourly wage is found to be $10.48 ($10.63 in the model which does not account for censoring in labour supply).

Third, consider an unemployed single male without children; never married; aged 22 years; vocational qualification; no recent work experience; Australian born residing outside the Brisbane metropolitan region in Queensland; in rented accommodation. The imputed wage is $11.06 ($11.56 in the model which does not account for censoring in labour supply).

Fourth, consider an unemployed married female: aged 42 years; with one dependent child aged over 15 years; European born; residing in Perth; without formal educational qualifications; no recent work experience, but worked during last financial year; partner has vocational qualification but is currently not employed; other income is $25 per week; owns home outright. The basic imputed wage is $12.32 per hour ($12.70 in the model which does not account for censoring in labour supply).

Finally, consider an unemployed married male: aged 47 years with five dependent children (three of which are aged 5 to 9 years, two are aged 10 to 15 years); European born; residing in Melbourne; with a diploma; no recent work experience, but worked during last financial

[14] The coefficients for the models not accounting for the censoring of labour supply at 50 hours can be found in Tables A.5 to A7.

year; partner has no formal qualifications and is currently not employed; no other income; owns home outright. The basic hourly rate is $21.44 per hour. In a model not taking into account the censoring of labour supply over 49 hours per week this would have been $25.22. The difference for married men between the two specifications is much larger than for the other groups, because a large proportion of the group of married men falls in the category, which works 50 hours or more. Thus accounting for censoring of labour supply is more important in this group.

6 Conclusion

This paper has reported estimates of wage equations for Australian workers, using pooled data from the Income and Housing Costs Surveys for 1994/95, 1995/96, 1996/97 and 1997/98, the first four years for which continuous hours information is available for each individual. The process of assigning a wage rate to non-workers, as necessary in the context of labour supply analysis, was examined with special attention given to dealing with the situation where the wage equation includes variables that are not available for the unemployed (such as occupation and industry).

Additionally, wage information on individuals, who work more than 50 hours per week and for whom the exact number of hours is therefore unknown in the SIHC, is included as a range rather than approximated by an "exact" value. This prevents the overestimation of wage rates.

Finally, normality and homoscedasticity of the participation equation and joint normality of the participation and wage equation are tested in this paper. It was found that normality and homoscedasticity of the participation equation is rejected for all groups and joint normality is rejected for all groups except married men and sole parents. Given that most studies on the estimation of wage equations do not carry out these tests, it is difficult to compare these results to results from other studies. For the moment, we have continued to use the standard approach to estimate the wage equations for the different demographic groups, but in future research we will explore the implication of accounting for heteroscedasticity.

Appendix: Summary Statistics

Summary statistics for the various demographic groups are shown in Tables A.2 and A.3. Many variables are dummy variables taking (0,1) values, the tables show the proportions in each category for these variables. The samples used in the selection equations and the wage equations are different, so the summary statistics for each are reported in a separate table.

Information about the last full-time job of those unemployed in June 1995, taken from the Labour Force Survey (ABS Catalogue, number 6203, Table 28), were used to construct the proportions given in Table A.4.

Table A.1 Distribution of labour market status over the survey years

Sole parents	**1994/95**	**1995/96**	**1996/97**	**1997/98**	**Total**
Unemployed	35	30	39	49	153
%	*8.41*	*6.86*	*8.8*	*9.98*	*8.56*
NILF	189	188	205	204	786
%	*45.43*	*43.02*	*46.28*	*41.55*	*43.98*
Working < 50 hours	180	193	186	213	772
%	*43.27*	*44.16*	*41.99*	*43.38*	*43.2*
Working 50 hours plus	12	26	13	25	76
%	*2.88*	*5.95*	*2.93*	*5.09*	*4.25*
Total	416	437	443	491	1787
Single females					
Unemployed	118	118	116	86	438
%	*10.38*	*9.66*	*9.43*	*8.28*	*9.46*
NILF	181	183	183	193	740
%	*15.92*	*14.98*	*14.88*	*18.58*	*15.99*
Working < 50 hours	761	843	850	682	3136
%	*66.93*	*68.99*	*69.11*	*65.64*	*67.76*
Working 50 hours plus	77	78	81	78	314
%	*6.77*	*6.38*	*6.59*	*7.51*	*6.78*
Total	1137	1222	1230	1039	4628
Single males					
Unemployed	188	184	223	179	774
%	*13.37*	*13.23*	*14.97*	*12.83*	*13.62*
NILF	69	104	100	107	380
%	*4.91*	*7.48*	*6.71*	*7.67*	*6.69*
Working < 50 hours	938	930	973	925	3766
%	*66.71*	*66.86*	*65.3*	*66.31*	*66.28*
Working 50 hours plus	211	173	194	184	762
%	*15.01*	*12.44*	*13.02*	*13.19*	*13.41*
Total	1406	1391	1490	1395	5682
Married females					
Unemployed	124	116	125	89	454
%	*3.68*	*3.55*	*3.61*	*2.74*	*3.4*
NILF	1355	1269	1361	1312	5297
%	*40.21*	*38.80*	*39.35*	*40.32*	*39.67*
Working < 50 hours	1765	1745	1834	1710	7054
%	*52.37*	*53.35*	*53.02*	*52.55*	*52.82*
Working 50 hours plus	126	141	139	143	549
%	*3.74*	*4.31*	*4.02*	*4.39*	*4.11*
Total	3370	3271	3459	3254	13354
Married males					
Unemployed	189	167	163	154	673
%	*6.63*	*6.12*	*5.64*	*5.55*	*5.99*
NILF	183	214	202	229	828
%	*6.42*	*7.84*	*6.99*	*8.26*	*7.37*
Working < 50 hours	1732	1621	1768	1624	6745
%	*60.79*	*59.42*	*61.2*	*58.54*	*60.01*
Working 50 hours plus	745	726	756	767	2994
%	*26.15*	*26.61*	*26.17*	*27.65*	*26.64*
Total	2849	2728	2889	2774	11240

Table A.2: Sample Proportions: Selection Equations variable

	Sole parents	Single females	Single males	Married females	Married males
Age 15 to 19 years	0.0235	0.1469	0.1420	0.0055	0.0015
Age 20 to 24 years	0.0755	0.2398	0.2763	0.0499	0.0334
Age 25 to 29 years	0.1489	0.1497	0.1809	0.1149	0.0954
Age 30 to 34 years	0.1796	0.0761	0.1156	0.1463	0.1452
Age 35 to 39 years	0.2104	0.0575	0.0743	0.1538	0.1557
Age 40 to 44 years	0.1919	0.0490	0.0669	0.1481	0.1531
Age 45 to 49 years	0.1052	0.0674	0.0498	0.1354	0.1528
Age 50 to 54 years	0.0386	0.0637	0.0357	0.1026	0.1150
Age 55 to 59 years	0.0196	0.0646	0.0322	0.0747	0.0858
Age 60 to 64 years	0.0067	0.0851	0.0262	0.0687	0.0622
Number of months worked in last 7	2.8153	4.1940	4.3784	3.6451	5.3951
Work experience (last financial year)	0.5462	0.7770	0.8416	0.6239	0.8917
Separated/widowed	0.6961	0.2917	0.1681		
Australia (reference)	0.8131	0.8332	0.8458	0.7313	0.7216
Europe/Middle East	0.1226	0.1108	0.1058	0.1901	0.2069
Asia	0.0425	0.0411	0.0341	0.0576	0.0510
America/Africa	0.0218	0.0149	0.0143	0.0210	0.0206
Postgraduate	0.0308	0.0428	0.0280	0.0392	0.0657
Undergraduate	0.0616	0.1225	0.0949	0.0921	0.1077
Diploma	0.0755	0.0914	0.0790	0.0878	0.1142
Vocational qualification	0.1858	0.1709	0.2330	0.1714	0.2849
No post secondary qualification (reference)	0.6463	0.5724	0.5651	0.6096	0.4274
Other income/1000	0.0168	0.0157	0.0126	0.5794	0.3172
Child support income/1000	0.0268			0.0008	0.0000
NSW (reference)	0.2009	0.2349	0.2318	0.2262	0.2260
Victoria	0.2059	0.2275	0.2082	0.2154	0.2150
Queensland	0.1746	0.1793	0.1760	0.1747	0.1735
South Australia	0.1276	0.1124	0.1153	0.1126	0.1077
Western Australia	0.1393	0.1242	0.1369	0.1324	0.1335
Tasmania	0.0783	0.0637	0.0598	0.0704	0.0717
ACT/Northern Territory	0.0733	0.0579	0.0720	0.0682	0.0726
Capital city	0.5993	0.6737	0.6341	0.6030	0.6113
Number of dependents	1.7101			1.1116	1.1882
Youngest child aged 0 to 2 years	0.1975			0.1672	0.1821
Youngest child aged 3 to 4 years	0.1371			0.0673	0.0712
Youngest child aged 5 to 9 years	0.2781			0.1290	0.1419
Youngest child aged 10 to 15 years	0.2451			0.1180	0.1223
Own home (reference)	0.1293	0.1547	0.0783	0.3679	0.3279
Mortgage	0.2160	0.1214	0.1156	0.4152	0.4449
Rented	0.6150	0.4983	0.5734	0.1915	0.2007
Other tenure	0.0392	0.2234	0.2297	0.0238	0.0243
Partner employed				0.7964	0.6117
Partner has postgraduate qualification				0.0576	0.0405
Partner has undergraduate qualification				0.0978	0.0987
"Older" than partner				0.0108	0.1054
"Younger" than partner				0.1321	0.0140

Table A.3: Sample Proportions: Wage Equations

	Sole parents	Single females	Single males	Married females	Married males
Age 15 to 19 years	0.0060	0.1345	0.1285	0.0044	0.0011
Age 20 to 24 years	0.0325	0.2825	0.2830	0.0562	0.0324
Age 25 to 29 years	0.1036	0.1810	0.1976	0.1236	0.1017
Age 30 to 34 years	0.1602	0.0898	0.1247	0.1453	0.1528
Age 35 to 39 years	0.2313	0.0683	0.0765	0.1668	0.1657
Age 40 to 44 years	0.2410	0.0530	0.0684	0.1803	0.1624
Age 45 to 49 years	0.1470	0.0730	0.0493	0.1659	0.1599
Age 50 to 54 years	0.0530	0.0630	0.0325	0.1030	0.1164
Age 55 to 59 years	0.0193	0.0415	0.0265	0.0421	0.0732
Age 60 to 64 years	0.0060	0.0135	0.0130	0.0124	0.0346
Number of months worked in last 7	5.4663	5.3799	5.1794	5.9295	6.0369
Work experience (last financial year)	0.9048	0.9429	0.9343	0.9496	0.9687
Professional	0.2253	0.2157	0.1801	0.2273	0.3107
Paraprofessional	0.0819	0.0848	0.0760	0.0889	0.1052
Clerical or sales person	0.4386	0.5630	0.1983	0.5163	0.1503
Tradesperson or labourer	0.2542	0.1366	0.5456	0.1675	0.4337
Agriculture/Forestry	0.0205	0.0088	0.0375	0.0145	0.0272
Mining	0.0036	0.0024	0.0121	0.0054	0.0231
Manufacturing	0.1084	0.0848	0.2023	0.0920	0.2054
Construction	0.0157	0.0112	0.0931	0.0174	0.0803
Utility	0.0048	0.0026	0.0126	0.0043	0.0209
Retail/Wholesale Sales	0.1494	0.1995	0.2133	0.1672	0.1626
Transport	0.0325	0.0297	0.0574	0.0203	0.0685
Communications	0.0253	0.0135	0.0269	0.0132	0.0302
Financial/Business Services	0.1169	0.1816	0.1216	0.1501	0.1317
Other Services	0.5205	0.4647	0.2220	0.5133	0.2484
Australian born	0.8060	0.8626	0.8531	0.7620	0.7333
Europe/Middle East	0.1277	0.0862	0.1007	0.1660	0.1972
Asia	0.0349	0.0386	0.0323	0.0479	0.0488
America/Africa	0.0313	0.0127	0.0139	0.0241	0.0207
Postgraduate	0.0554	0.0539	0.0327	0.0578	0.0713
Undergraduate	0.0976	0.1486	0.1074	0.1248	0.1156
Diploma	0.1024	0.1030	0.0848	0.1063	0.1178
Vocational qualification	0.2145	0.1801	0.2436	0.1874	0.2913
No post secondary qualifications	0.5301	0.5144	0.5315	0.5237	0.4040
NSW (reference)	0.1831	0.2375	0.2368	0.2261	0.2247
Victoria	0.2120	0.2360	0.2090	0.2127	0.2151
Queensland	0.1639	0.1760	0.1736	0.1706	0.1737
South Australia	0.1133	0.1015	0.1088	0.1134	0.1058
Western Australia	0.1410	0.1263	0.1390	0.1263	0.1363
Tasmania	0.0867	0.0606	0.0567	0.0647	0.0689
ACT/Northern Territory	0.1000	0.0621	0.0760	0.0862	0.0756
Capital city	0.6012	0.6933	0.6445	0.6166	0.6192

Table A.3: Continued

	Sole parents	Single females	Single males	Married females	Married males
University qualification x (age 20 to 24 years)	0.0000	0.0565	0.0323	0.0066	0.0019
University qualification x (age 25 to 29 years)	0.0012	0.0515	0.0381	0.0248	0.0142
University qualification x (age 30 to 34 years)	0.0133	0.0241	0.0287	0.0273	0.0266
University qualification x (age 35 to 39 years)	0.0386	0.0244	0.0121	0.0343	0.0351
University qualification x (age 40 to 44 years)	0.0434	0.0112	0.0123	0.0374	0.0387
University qualification x (age 45 to 49 years)	0.0386	0.0138	0.0076	0.0297	0.0332
University qualification x (age 50 to 54 years)	0.0096	0.0094	0.0049	0.0147	0.0207
University qualification x (age 55 to 59 years)	0.0084	0.0088	0.0027	0.0056	0.0111
University qualification x (age 60 to 64 years)	0.0000	0.0026	0.0011	0.0023	0.0054

Table A.4: Occupation and Industry Proportions: Unemployed June 1995

Category	**Males**	**Females**
Industry Division		
Agriculture, Forestry and Fishing	0.06568	0.03792
Manufacturing	0.24968	0.17465
Construction	0.17768	0.01896
Wholesale Trade	0.03958	0.02595
Retail Trade	0.13684	0.19661
Accommodation, Cafes and Restaurants	0.04968	0.09980
Transport and Storage	0.02894	0.04797
Property and Business Services	0.05684	0.08483
Government Administration and Defence	0.04547	0.04291
Education	0.01979	0.05389
Health and Community Services	0.01389	0.11177
Cultural and Recreational Services	0.01853	0.02894
Personal and Other Services	0.02021	0.03992
Other industries	0.05010	0.05489
Occupational Group		
Managers and administrators	0.04755	0.02095
Professionals	0.05597	0.06686
Paraprofessionals	0.03072	0.04690
Tradespersons	0.22601	0.04291
Clerks	0.04545	0.25149
Sales and personal service	0.09932	0.29441
Plant and machine operators and drivers	0.14351	0.04391
Labourers and related	0.35143	0.23253

Table A.5: Wage Equations: Married Women and Men

	Women		Men	
	coefficients	**s.e.'s**	**coefficients**	**s.e.'s**
constant	1.717	0.086**	1.710	0.084**
Age/10	0.201	0.032**	0.273	0.031**
Age squared/100	-0.024	0.004**	-0.031	0.004**
# months worked in last 7	0.017	0.005**	0.003	0.004
Work exp (last financial year)	0.158	0.027**	0.159	0.028**
Tradesperson/labourer (reference)				
Professional	0.317	0.016**	0.204	0.011**
Paraprofessional	0.231	0.018**	0.157	0.014**
Clerical/sales	0.112	0.012**	0.061	0.012**
Agriculture/forestry (reference)				
Mining	0.260	0.062**	0.618	0.033**
Manufacturing	0.112	0.033**	0.257	0.024**
Construction	0.257	0.043**	0.231	0.026**
Utilities	0.248	0.068**	0.337	0.035**
Trade	0.060	0.033*	0.119	0.025**
Transport	0.183	0.042**	0.292	0.027**
Communication	0.183	0.047**	0.295	0.032**
Financial/bus	0.139	0.033**	0.243	0.025**
Services	0.082	0.031**	0.179	0.024**
Australia (reference)				
Europe/Middle East	-0.017	0.011	-0.031	0.010**
Asia	-0.062	0.019**	-0.152	0.018**
America/Africa	-0.032	0.026	-0.093	0.027**
No qualifications (reference)				
postgraduate	0.151	0.052**	0.079	0.050
undergraduate	0.097	0.048**	-0.012	0.047
diploma	0.092	0.015**	0.136	0.013**
vocational	0.024	0.011**	0.063	0.009**
NSW (reference)				
Victoria	-0.040	0.012**	-0.055	0.011**
Queensland	-0.063	0.013**	-0.044	0.012**
South Australia	-0.052	0.015**	-0.086	0.014**
Western Australia	-0.062	0.014**	-0.029	0.013**
Tasmania	-0.048	0.018**	-0.049	0.017**
ACT/Northern Territory	0.067	0.017**	0.070	0.017**
Capital city	0.056	0.009**	0.066	0.009**
Age * university degree	0.019	0.012*	0.056	0.011**
Mills ratio	0.107	0.031**	-0.005	0.043
σ_ε	0.345		0.365	
Number of observations	7434		9513	

Notes: ** coefficient is significant at the 5 per cent level, * coefficient is significant at the 10 per cent level.

Table A.6: Wage Equations, Single Women and Men

	Women		Men	
	coefficients	**s.e.'s**	**coefficients**	**s.e.'s**
constant	1.179	0.089**	1.021	0.087**
Age/10	0.620	0.030**	0.696	0.030**
Age squared/100	-0.072	0.004**	-0.080	0.004**
# months worked in last 7	-0.010	0.004**	-0.016	0.005**
Work exp (last financial year)	0.140	0.028**	0.101	0.031**
Tradesperson/labourer (reference)				
Professional	0.217	0.020**	0.218	0.018**
Paraprofessional	0.196	0.023**	0.136	0.021**
Clerical/sales	0.084	0.016**	0.079	0.014**
Agriculture/forestry (reference)				
Mining	0.545	0.112**	0.641	0.053**
Manufacturing	-0.001	0.052	0.205	0.029**
Construction	0.058	0.068	0.235	0.031**
Utilities	0.148	0.107	0.376	0.052**
Trade	-0.019	0.051	0.096	0.029**
Transport	0.157	0.057**	0.304	0.034**
Communication	0.139	0.065**	0.290	0.041**
Financial/bus	0.051	0.051	0.223	0.031**
Services	0.017	0.050	0.161	0.029**
Australia (reference)				
Europe/Middle East	-0.007	0.018	-0.001	0.018
Asia	-0.047	0.026*	-0.061	0.030**
America/Africa	-0.047	0.044	0.041	0.044
No qualifications (reference)				
postgraduate	0.109	0.048**	0.084	0.068
undergraduate	0.065	0.041	0.033	0.055
diploma	0.085	0.017**	0.080	0.020**
vocational	0.069	0.014**	0.105	0.013**
NSW (reference)				
Victoria	-0.023	0.014	0.005	0.015
Queensland	-0.048	0.016**	-0.008	0.016
South Australia	-0.003	0.019	-0.032	0.019*
Western Australia	-0.051	0.017**	0.021	0.017
Tasmania	-0.024	0.023	-0.029	0.024
ACT/Northern Territory	0.086	0.024**	0.031	0.023
Capital city	0.041	0.012**	0.029	0.013**
Age * university degree	0.031	0.011**	0.027	0.016*
Mills ratio	-0.068	0.043	-0.116	0.057**
σ_ε	0.284		0.341	
Number of observations	3398		4459	

Notes: ** coefficient is significant at the 5 per cent level, * coefficient is significant at the 10 per cent level.

Table A.7: Wage Equation: Sole Parents

	coefficient	Standard error
Constant	2.370	0.287**
Female	-0.151	0.038**
Age/10	-0.110	0.116
Age squared/100	0.013	0.015
# months worked in last 7	0.047	0.015**
Work exp (last financial year)	0.060	0.056
Tradesperson/labourer (reference)		
Professional	0.298	0.045**
Paraprofessional	0.239	0.053**
Clerical/sales	0.098	0.034**
Agriculture/forestry (reference)		
Mining	1.232	0.215**
Manufacturing	0.084	0.087
Construction	0.048	0.128
Utilities	0.481	0.199**
Trade	0.079	0.087
Transport	0.224	0.107**
Communication	0.260	0.111**
Financial/bus	0.130	0.089
Services	0.098	0.083
Australia (reference)		
Europe/Middle East	-0.032	0.038
Asia	-0.170	0.070**
America/Africa	0.015	0.073
No qualifications (reference)		
postgraduate	0.339	0.065**
undergraduate	0.204	0.050**
diploma	0.099	0.046**
vocational	-0.010	0.033
NSW (reference)		
Victoria	-0.076	0.040*
Queensland	-0.072	0.043*
South Australia	-0.076	0.047
Western Australia	-0.044	0.045
Tasmania	0.010	0.052
ACT/Northern Territory	0.093	0.053*
Capital city	0.059	0.030**
Mills ratio	0.206	0.083**
σ_ε	0.363	
Number of observations	830	

Notes: ** coefficient is significant at the 5 per cent level, * coefficient is significant at the 10 per cent level.

References

Creedy, J., A. Duncan, M. Harris and R. Scutella (2001), "Wage functions: Australian estimates using the Income Distribution Survey", *Australian Journal of Labour Economics*, 4(4), 300-321.

Ermisch, J. F. and Wright, R. E. (1994) Interpretation of negative sample selection effects in wage offer equations. *Applied Economics Letters*, 1, pp. 187-189.

Greene, W. (1981) Sample selection bias as a specification error: comment. *Econometrica*, 49, pp. 795-798.

Heckman, J. (1979) Sample selection bias as a specification error. *Econometrica*, 47, pp. 153-161.

Kalb, G. (1998) An Australian model for labour supply and welfare participation in two-adult households. Unpublished thesis, Department of Econometrics and Business Statistics, Monash University.

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

Miller, P. and Rummery, S. (1991) Male-female wage differentials in Australia: a reassessment. *Australian Economic Papers*, 30, pp. 50-69.

Olsen, R. (1982) Distributional tests for selectivity bias and a more robust estimator. *International Economic Review*, 23, pp. 223-240.

Pagan, A. and Vella, F. (1989) Diagnostic tests for models based on individual data: a survey. *Journal of Applied Econometrics*, 4, pp. s29- s59.