

Simulating the Behavioural Effects of Welfare Reforms Among Sole Parents in Australia*

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This paper derives and estimates an econometric model of labour supply among sole parents in Australia, using modelling techniques which treat the labour supply decision as a utility maximising choice between a given number of discrete states. The model is then used to look at the likely effects of actual and hypothetical welfare policy reforms. Model estimates are based upon net incomes generated by the Melbourne Institute Tax and Transfer Simulator (MITTS), developed at the Melbourne Institute in collaboration with the Department of Family and Community Services (FaCS).

I Introduction and Background

The Australian Federal Government's stated commitment to tax reform (Costello 1998) has reignited the debate on tax and welfare policy (see *inter alia* Beer 1998a, 1998b; Dawkins *et al.* 1998; Ingles 1998; Keating & Lambert 1998). One of the main concerns which informs this debate is the extent to which the tax and social security systems combine to give exceptionally high effective marginal tax rates (EMTR). Indeed, EMTR in excess of 100 per cent are not uncommon in the literature (see for example, Beer 1998b; Ingles 1998). Implicit in all such studies is the contention that high EMTR create significant employment disincentives for low-wage workers and families with children. Nevertheless, it is rare to find studies

which seek to quantify the extent of these employment disincentives. In the main, EMTR are imputed assuming that hours worked do not change. This may well be appropriate for particular demographic groups (for example, prime-aged single men). However, it is not so true for sole parent families in Australia, for whom a wider range of employment states can be observed. To characterise such groups' labour supply options through marginal effective tax rates (or replacement rates, or average tax rates) gives only a partial indication of work disincentives. A detailed microeconomic modelling approach is necessary to provide a fuller understanding of the employment effects of non-linear taxes and social security programs. The first objective of this paper is to analyse the labour market behaviour of sole parents in Australia, taking into account the full budget constraint faced by the individual. The second objective is to use this model to simulate the potential employment effects of a range of (actual and hypothetical) reforms which might affect sole parent households.

The choice of labour supply model for such an analysis must be informed by a number of

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considerations. Firstly, the model must deal appropriately with non-linear taxes in estimation. For many households (particularly one-parent families), the Australian tax and transfer system impacts quite heavily on the budget constraint. Income taxes, medicare, various allowances, pensions and family payments combine to generate highly non-linear and typically non-convex budget constraints.¹ Secondly, the model specification must differentiate effectively among those observed not to work. In particular, for sole parents, the presence of potentially high fixed costs of employment (primarily due to childcare costs and other barriers to employment) are an important concern and the econometric approach must be sufficiently flexible to control for such.

These considerations lead us to model the employment choices of sole parents in Australia along the lines suggested by Van Soest (1995) and Keane and Moffitt (1997), where the hours choice set open to the individual is assumed to be finite. This discrete approach is advantageous in a number of respects. Non-linear tax schedules are dealt with straightforwardly in estimation in a manner which does not force unreasonable restrictions on the parameters of the economic model. The preference model is fully structural and testable against economic theory. The model may also be extended to control for fixed costs and random preferences in estimation. The implementation of these methods requires detailed knowledge of the budget sets faced by sole parent families. In our empirical work we use the Melbourne Institute's Tax and Transfer Simulator (MITTS) to provide this information (Creedy & Duncan 1999).

The plan of the paper is as follows. The following Section provides a descriptive analysis of the employment choices among sole parents in Australia, looking in particular at the extent to which the system of taxes and government transfers are likely to influence those choices. In Section III we describe the basic structural discrete choice model. Section IV contains the empirical labour supply estimates, and Section V

illustrates how this model may be applied to simulate the labour supply effects of (both actual and hypothetical) policy reforms. In Section VI we offer some concluding remarks.

II Employment and Incomes Among Single Parent Households in Australia

In common with most other developed countries, the structure of allowances, pensions and family payments in the Australian tax and transfer system, combine to supplement incomes at low levels of earned income, at the cost of introducing high EMTR over a potentially broad range of feasible hours choices. It is important to be clear about the likely direction of the employment incentives that such systems generate, and how changes to the tax and transfer system might lead to changes in the incentive to work. It is well known that a change to marginal tax rates has an ambiguous effect on the number of hours worked by those currently in work – the income and substitution effects move in opposite directions. However, there has been little attempt to quantify the extent of these effects.

Single parent households are an interesting demographic group on which to focus, for a number of reasons.² The presence of children in the household, and the fact that the sole parent is in the main the principal carer of those children, generates a tension between the need for income and the need (and desire) for the mother to spend time with her children. Data from the Income Distribution Survey (IDS) shows around 45 per cent of the population of sole parents to be in some form of paid employment. As observed in the data, those sole parents in employment are more likely to be employed on part-time and low-hours contracts, and more likely to draw from a lower wage offer distribution than other comparable demographic groups. In consequence, sole parents have become (in proportionate terms) one of the principal client groups for social assistance and family payment programs.

To demonstrate the potential effects of the tax and transfer system on employment incentives, Table 1 shows the distribution of EMTR for a sample of households drawn from the IDS,

¹ A basic model of the style of Hausman (1979) or Wales and Woodland (1979) is computationally infeasible in these circumstances. Moreover, it has been suggested that the structure of the Hausman method biases predicted wage elasticities to a significant degree (see for example, Gourieroux *et al.* 1980, Mroz 1987).

² Our preference would be to model separately the labour supply patterns of male and female single parent households. However, given the lack of data on the former group (fewer than 10 per cent of single parents in Australia are male), we restrict the sample to female single parent households only.

TABLE 1
Distribution of Effective Marginal Tax Rates: January 2000 Tax System

	Proportions with Marginal Effective Tax Rates in the Range:							Av.
	0-10	11-30	31-40	41-50	51-70	71-100	>100	
Couple, no children	48	5	17	22	2	2	3	26
Couple, with children	23	3	20	42	1	9	2	39
Single, no children	45	7	26	14	1	8	0	25
Single, parents	59	0	5	16	7	10	2	25

TABLE 2
Distribution of Full-time Replacement Rates: January 2000 Tax System

	Proportions with Replacement Rates in the Range:								Av.
	0-20	21-40	41-50	51-60	61-70	71-80	81-90	>91	
Couple, no children	0	6	6	11	51	18	7	1	64
Couple, with children	0	2	3	6	17	35	33	3	74
Single, no children	1	26	19	22	15	15	1	0	51
Single, parents	1	1	3	8	55	30	1	0	66

evaluated at observed hours, using the tax and transfer system in place in January 2000 and IDS data for 1999. For couples, the EMTR are calculated for an increase in hours of the primary income earner. Around 60 per cent of sole parents have a zero EMTR, but these are all non-employed households whose instantaneous rate of withdrawal of social assistance payments is zero. For those in work, we find a broad range of potential EMTR, some in excess of 100 per cent. In comparison with other groups, sole parent households are more likely to face high EMTR in excess of 60 per cent.

Table 2 describes replacement rates (calculated as in-work, relative to out-of-work, income) for the same sample. Compared with single adults without children, it is clear that sole parent families (on average) face significantly higher replacement rates.

Our ultimate aim in this study is to move towards a full economic model of employment choices for sole parent households which takes explicit account of the influence of taxes and transfers on the returns to employment. To do so requires that we place some structure on the labour supply decisions of sole parents, and this provides a point of departure for the remainder of the paper.

III An Economic Model of Labour Supply

(i) A Basic Structural Model of Labour Supply

The basic structural model of labour supply in this paper presumes that individuals derive utility from net household income Y – shared between current and future consumption) and leisure L – or equivalently, hours of work H through the identity $H \equiv T - L$ for some time endowment, T). Let these preferences be represented by:

$$U = U(Y, L; X), \quad (1)$$

where X represents individual characteristics. Behavioural decisions are constrained to lie within a budget set defined in terms of: gross hourly wage rates W ; total household income V from assets and other unearned sources; hours of work, H ; and the tax system $t(H, W, V; X)$. This budget set takes the form:

$$Y = WH + V - t(H, W, V; X) - FC(Z_c), \quad (2)$$

where $t(H, W, V; X)$ represents tax payments minus government transfers (assumed to depend on both earned income WH , unearned income V and household characteristics X) and $FC(Z_c)$ is a measure which captures the apparent fixed costs of employment for a sole parent with characteristics Z_c .

The individual is assumed to maximise the preference function (1) over a discretised hours set $H_{(.)} \in \{H^1, H^2, \dots, H^P\}$ according to the group-
ing rule:

$$\begin{aligned} H_{(.)} &= H^1 && \text{if } H \leq H_1^B \\ &= H^2 && \text{if } H_1^B < H \leq H_2^B \\ &\dots\dots\dots \\ &= H^P && \text{if } H > H_{P-1}^B. \end{aligned}$$

This gives P alternative values for $H_{(.)}$.³ Family net incomes may then be calculated for each discrete hours point in the set $H_{(.)}$ as:

$$\begin{aligned} Y[H_{(.)}] &= WH_{(.)} + V - t(H_{(.)}, W, V; X) \\ &\text{for } H_{(.)} \in \{H^1, H^2, \dots, H^P\}. \end{aligned} \quad (3)$$

The sole parent chooses $H_{(.)}$ to solve the following optimisation problem:

$$\max_{H_{(.)} \in \{H^1, H^2, \dots, H^P\}} U(Y[H_{(.)}], T - H_{(.)}; X). \quad (4)$$

For estimation purposes, random disturbances specific to each labour market state are added, giving stochastic utilities of the form:

$$U_{H_{(.)}}^* = U(T - H_{(.)}, Y_{H_{(.)}}; X) + \varepsilon_{H_{(.)}}. \quad (5)$$

The random terms $\varepsilon_{H_{(.)}}$ for $H_{(.)} \in \{H^1, H^2, \dots, H^P\}$, are assumed to be independently distributed as a Type I Extreme Value variate, yielding probabilities of choosing state $H_{(.)} = H^j$ of the form:

$$\begin{aligned} \Pr[H_{(.)} = H^j; X] &= \Pr[U_{H^j}^* > U_{H^p}^* \\ &\text{for all } j \neq p, p \in \{1, \dots, P\}] \\ &= \frac{\exp[U(T - H^j, Y_{H^j}; X)]}{\sum_{k=1}^P \exp[U(T - H^k, Y_{H^k}; X)]}. \end{aligned} \quad (6)$$

For the basic structural model, the likelihood contribution corresponding to equation 6 is:

$$L(\phi|X) = \sum_{j=1}^P d_j \ln \Pr[H_{(.)} = H^j|X] \quad (7)$$

where $d_j = \mathbf{1}(H_{(.)} = H^j)$.

³ This approach removes many of the complexities of a non-linear tax schedule, but at the cost of introducing rounding errors in the hours levels used for estimation. This may have a detrimental effect on the reliability of the parameters estimated under a discrete regime, and should be subjected to sensitivity analysis. In the subsequent analysis we consider 11 possible hours choices, so that $H_{(.)} = \{0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50\}$ where $H_1^B = 2.5, H_2^B = 7.5, H_3^B = 12.5, H_4^B = 17.5, H_5^B = 22.5, H_6^B = 27.5, H_7^B = 32.5, H_8^B = 37.5, H_9^B = 42.5$ and $H_{10}^B = 47.5$.

For the empirical analysis the quadratic direct utility function favoured by Keane and Moffitt (1997) and Duncan and Giles (1998) is chosen, whereby:

$$U(H, Y) = \alpha_{yy} Y^2 + \alpha_{hh} H^2 + \alpha_{yh} YH + \beta_y Y + \beta_h H. \quad (8)$$

This function is tractable, yet permits a wide range of possible behavioural responses.⁴ Observed heterogeneity is introduced linearly through parameters β_y and β_h such that:

$$\beta_y = \beta_{y0} + \beta'_{y1} X \quad (9)$$

$$\beta_h = \beta_{h0} + \beta'_{h1} X \quad (10)$$

for exogenous characteristics X . The characteristics we include in the empirical estimates include dummies for the age of the youngest child, age and education. Similarly, we also allow α_{yy} and α_{hh} , to vary across observed characteristics (age of youngest child). One can additionally include random preference terms to the basic specification. We choose to enter random preference terms through the linear utility parameters (9) and (10), giving

$$\beta_y^* = \beta_{y0} + \beta'_{y1} X + v_y \quad (11)$$

$$\beta_h^* = \beta_{h0} + \beta'_{h1} X + v_h. \quad (12)$$

The stochastic preference terms $\{v_y, v_h\}$ are assumed to be jointly normally distributed. Although now the likelihood function has no analytical closed form, estimation can be undertaken via the method of Simulated Maximum Likelihood (see McFadden 1989; Hajivassiliou & Ruud 1994).

(ii) Specification Issues

Controlling for Missing Wages

In a typical sample survey of data on individual employment choices, wage rates among non-workers are not observed. This poses a problem when simulating behavioural responses, since the budget constraint over which a nonemployed single parent is assumed to optimise will clearly depend on the hourly wage rate that she would command were she to enter paid employment. One common solution to this problem is to

⁴ See Stern (1986) for an excellent discussion of the properties of this and other functions.

estimate the expected market wage rate received by individuals with a given set of observed characteristics. This conditional wage expectation may be used in place of missing data for non-workers when estimating econometric models of labour supply.⁵

Introducing fixed costs in estimation

In this study, we choose to follow Callan and Van Soest (1996) by directly imputing a fixed cost measure as part of the structural of the economic model. The fixed cost equation takes the form:

$$FC = X'_{FC}\gamma + v_f, \quad (13)$$

where the unobserved fixed cost component v_f is normally distributed around zero mean, and X_{FC} are instruments which are chosen to capture potential variations in fixed (or search) costs. The stochastic term v_f may be correlated with the random preference parameters ε_Y and ε_H . The fixed cost equation 13 is easily incorporated into estimation. As fixed costs only impact on workers, the utilities $U(T - H, Y_H; X)$ entering the likelihood function via equation 6, now become $U(T - H, Y_H - FC; X)$ for all states $H^j > 0$. To observe a working single parent in the presence of fixed costs therefore requires that:

$$\max_{H(\cdot) \neq 0} U(T - H(\cdot), Y_{H(\cdot)} - FC; X) > U(Y_0, T; X). \quad (14)$$

We do not interpret the fixed cost measure (13) in a narrow sense as an estimate of the financial fixed costs of employment. Rather, we take it to represent the 'shadow' or 'psychic' fixed costs associated with employment, whereby sole parents act *as if* they faced a monetary fixed cost FC , which are imputed directly. Indeed, the fixed cost equation 13 in this discrete structural model performs very much the same role as the selection equation in continuous labour supply studies which use the Heckman (1979) selection method.

⁵ We estimate wage rates for the single parents in our sample using wage functions as reported in Creedy *et al.* (2001). The wage equations include a series of controls (including industry and occupational information, regional unemployment rates) which do not feature in rules used to calculate family net incomes. This ensures that any wage and net income effects are identified through data, and not simply through the non-linearity of the structural model.

IV Empirical Results

(i) Data

The data used in this analysis come from a pooled series of four IDS, made available through the Australian Bureau of Statistics, over the years 1994–1995 to 1997–1998. The survey collects information on the sources and amounts of income received by persons resident in private dwellings throughout Australia. It provides fairly explicit information on the characteristics of income units and persons surveyed, for example, information on individual, family and household incomes, labour market attachment, as well as standard personal demographics. The survey is continuous throughout the financial year, with around 650 households interviewed each month. We exclude self-employed and retired households from the estimation sample, along with any extreme outliers and missing values, leaving a working sample of 2063 sole parent households. To generate the required net incomes we use MITTS, a microsimulation model of the Australian tax and benefit system that calculates tax and medicare liabilities, allowance and pension entitlements and family payments for the four IDS years. The financial returns for each working age individual to employment at all possible hours are calculated using gross and net incomes at these levels. For the waged their current wage was assumed to remain unchanged, and for the unwaged, wages were imputed based on their personal characteristics. The use of MITTS allows us to generate highly accurate financial budget constraints for each individual in the sample.

(ii) Model Estimates

A range of estimates for the labour supply behaviour of sole parent households are reported in Table 3. We choose a labour supply regime with 11 hours states in which the parents are allocated 1 hours level in the set $H(\cdot) = \{0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50\}$ such that each individual is allocated to the 'closest' discrete hours point. For example, $H(\cdot) = 35$ if observed hours H are between 33 and 37.

The specifications are considered sequentially: the first model (1) is a simple specification in which we estimate a utility function with constant parameters (i.e. parameters which do not vary with observed characteristics). In the second model (2) we allow for observed heterogeneity to enter the linear and quadratic terms of the basic utility function parameters; in model (3) we add to

TABLE 3
Model Estimates – Utility Function Only; Observed Heterogeneity and Constant Fixed Costs

	Model (1)		Model (2)		Model (3)	
$\alpha_{YY} \times 100$	-0.498	0.148**	-0.909	0.226**	-1.668	0.533**
×1 (Youngest child 0–2)	–	–	0.812	0.222**	-0.701	0.469
×1 (Youngest child 3–4)	–	–	0.296	0.371	0.135	0.477
×1 (Youngest child 5–9)	–	–	0.702	0.219**	0.980	0.481**
$\alpha_{HH} \times 100$	0.316	0.017**	0.165	0.024**	-0.011	0.027**
×1 (Youngest child 0–2)	–	–	0.098	0.040**	-0.012	0.053
×1 (Youngest child 3–4)	–	–	0.008	0.048	-0.006	0.051
×1 (Youngest child 5–9)	–	–	0.010	0.034	0.044	0.043
α_{YH}	1.050	0.185**	2.542	0.307**	0.511	0.240**
×1 (Youngest child 0–2)	–	–	0.098	0.040**	0.012	0.053
×1 (Youngest child 3–4)	–	–	-0.008	0.048	-0.006	0.051
×1 (Youngest child 5–9)	–	–	-0.010	0.034	0.044	0.043
α_{YH}	1.050	0.185**	2.542	0.307**	0.511	0.240**
β_Y	0.707	0.183**	0.643	0.246**	1.564	0.436**
×1 (Youngest child 0–2)	–	–	-1.156	0.335**	0.572	0.400
×1 (Youngest child 3–4)	–	–	-0.352	0.542	-0.161	0.327
×1 (Youngest child 5–9)	–	–	-0.766	0.315**	-0.666	0.347*
# Children	–	–	-0.152	0.054**	0.183	0.064**
×1 Aged over 40	–	–	-0.074	0.096	-0.205	0.089**
×1 Qualification	–	–	0.256	0.083**	0.069	0.071
β_Y	-0.261	0.012**	-0.227	0.016**	-0.036	0.021*
×1 (Youngest child 0–2)	–	–	-0.055	0.026**	-0.033	0.024
×1 (Youngest child 3–4)	–	–	-0.011	0.033	-0.017	0.023
×1 (Youngest child 5–9)	–	–	-0.002	0.022	-0.033	0.020*
# Children	–	–	-0.008	0.004**	-0.009	0.002**
×1 Aged over 40	–	–	0.013	0.006**	0.005	0.004
×1 Qualification	–	–	0.007	0.006	0.020	0.003**
Fixed costs/100	–	–	–	–	2.880	0.480**
Log-Likelihood	-5,525		-5,377		-5,073	
Likelihood Ratio Test, χ^2_{df}			(2) vs (1)	296 (<i>df</i> = 18)	(3) vs (2)	608 (<i>df</i> = 1)

** and * significant at 5 and 10% size, respectively (two-sided).

the second specification a constant fixed cost term. The control variables chosen to account for variation in tastes for work were dummies for the age of the youngest child (0–2, 3–4 and 5–9) for the quadratic terms and; additionally for the linear terms: the total number of children; whether the individual was aged 40 or over and; whether they possessed any postcompulsory educational qualifications.

In Table 4 the specification is further augmented to allow firstly for fixed costs to vary with a series of observed characteristics (model 4). The fifth specification (model 5), incorporates independent random preference heterogeneity, which is subsequently extended to allow these random preference terms to be freely correlated (model 6).

For the simpler specifications (Table 3), a formal Likelihood Ratio testing criterion clearly suggests the superiority of the more flexible functional form of model (2) over model (1) and also model (3) over model (2). This is despite the fact that the preferences parameters of this specification appear to have been estimated with less precision individually than for either model (1) or (2).

The coefficients on both the linear income and hours terms, and their squares, suggest increasing and diminishing marginal utility of income, and decreasing and diminishing marginal utility for hours worked, as expected. Introducing observed heterogeneity (model 2), suggests that the marginal disutility of hours worked is greatest when the

TABLE 4
Model Estimates – Varying Fixed Costs and Random Preference Heterogeneity

	Model (4)		Model (5)		Model (6)	
$\alpha_{YY} \times 100$	-1.617	1.212	-1.320	0.300**	-1.483	0.356**
$\times 1$ (Youngest child 0–2)	-1.631	1.290	-2.779	0.922**	-2.640	0.782**
$\times 1$ (Youngest child 3–4)	-0.305	1.115	-0.790	0.592	-0.728	0.556
$\times 1$ (Youngest child 5–9)	0.946	1.020	0.601	0.363*	0.650	0.378*
$\alpha_{HH} \times 100$	-0.018	0.033	-0.064	0.030**	-0.039	0.030
$\times 1$ (Youngest child 0–2)	0.054	0.062	0.093	0.057*	0.105	0.057*
$\times 1$ (Youngest child 3–4)	0.037	0.063	0.033	0.055	0.041	0.053
$\times 1$ (Youngest child 5–9)	0.049	0.043	0.061	0.044	0.056	0.042
α_{YH}	0.473	0.350	-0.309	0.421	-0.280	0.396
β_Y	1.458	0.920	1.895	0.345**	2.253	0.404**
$\times 1$ (Youngest child 0–2)	1.778	1.415	2.403	0.887**	2.247	0.731**
$\times 1$ (Youngest child 3–4)	0.544	1.137	0.829	0.585	0.0698	0.529
$\times 1$ (Youngest child 5–9)	-0.618	0.692	-0.587	0.271**	-0.629	0.307**
# Children	0.187	0.121	0.198	0.069**	0.246	0.081**
$\times 1$ Aged over 40	-0.211	0.118*	-0.270	0.106**	-0.325	0.129**
$\times 1$ Qualification	0.102	0.078	0.109	0.103	0.050	0.118
β_H	-0.029	0.037	0.011	0.018	-0.019	0.019
$\times 1$ (Youngest child 0–2)	-0.075	0.048	-0.099	0.031**	-0.100	0.029**
$\times 1$ (Youngest child 3–4)	-0.056	0.047	-0.063	0.030**	-0.061	0.027**
$\times 1$ (Youngest child 5–9)	-0.037	0.020*	-0.046	0.020**	-0.043	0.018**
# Children	-0.009	0.003**	-0.005	0.003*	-0.006	0.003**
$\times 1$ Aged over 40	0.005	0.004	0.003	0.004	0.006	0.004
$\times 1$ Qualification	0.021	0.004**	0.020	0.003**	0.019	0.004**
Fixed costs/100	2.985	1.105**	2.899	0.238**	2.481	0.250**
$\times 1$ Capital city	0.020	0.087	0.035	0.072	0.038	0.065
# Pre-school children	-0.848	1.193	-0.907	0.352**	-0.630	0.234**
# School aged children	0.092	0.168	-0.189	0.128	-0.195	0.107*
$\times 1$ New South Wales	0.382	0.100**	0.327	0.097**	0.287	0.088**
σ_Y^2	–	–	0.651	0.308**	1.1418	0.579**
σ_H^2	–	–	0.000	0.000	0.001	0.001
σ_{FC}^2	–	–	0.003	0.007	0.092	0.046**
$\sigma_{Y,H}^2$	–	–	–	–	-0.033	0.017*
$\sigma_{Y,FC}^2$	–	–	–	–	-0.353	0.110**
$\sigma_{H,FC}^2$	–	–	–	–	0.008	0.004**
Log-Likelihood	-5,063		-5,050		-5,045	
Likelihood Ratio Test, χ_{df}^2	(4) vs (3)	20 ($df = 4$)	(5) vs (4)	25 ($df = 3$)	(6) vs (5)	12 ($df = 3$)

** and * significant at 5 and 10% size, respectively (two-sided).

youngest child is very young (0–2), and lessens as the youngest child ages. The total number of children again increases the marginal disutility of work, although those single parents over 40 years of age are less averse to the number of hours worked. In terms of the parameters on squared hours, only the youngest child being 0–2 years of age, appears to exert any affect. With regard to income, the reference group (with youngest child over 10 years of age) appear to exhibit the strongest marginal utility of income, and as the

number of children rises, so this marginal utility of income falls. Age appears unimportant, whereas the more highly educated have a higher marginal utility of income. Both the presence of the youngest child being 0–2 and 5–9, have a positive effect on the square of the income term.

When fixed costs are introduced, this appears to absorb the effect of previously significant variables. Of the significant variables, their effects appear to be consistent with those obtained from model (2). The monetary equivalent to these

TABLE 5
Percentage Model Predictions (based on 1,000 random draws)

	Actual	Predicted					
		(1)	(2)	(3)	(4)	(5)	(6)
$H \leq 2.5$	58.3	39.9	41.9	53.6	53.5	55.1	59.0
$2.5 < H \leq 7.5$	3.0	17.6	15.6	3.3	3.3	1.8	1.9
$7.5 < H \leq 12.5$	3.3	8.5	7.8	3.8	3.8	2.9	2.9
$12.5 < H \leq 17.5$	2.9	4.7	4.7	4.0	4.0	3.4	3.2
$17.5 < H \leq 22.5$	3.5	3.1	3.3	4.3	4.2	3.9	3.6
$22.5 < H \leq 27.5$	2.7	2.4	2.7	4.4	4.4	4.4	4.0
$27.5 < H \leq 32.5$	2.9	2.3	2.6	4.6	4.6	4.9	4.3
$32.5 < H \leq 37.5$	4.7	2.5	2.8	4.9	4.9	5.3	4.6
$37.5 < H \leq 42.5$	11.6	3.3	3.5	5.2	5.2	5.8	5.1
$42.5 < H \leq 47.5$	2.7	5.3	5.3	5.7	5.7	6.1	5.5
$H > 47.5$	4.5	10.3	9.8	6.3	6.3	6.3	5.9
% Correctly predicted		26.9	30.2	37.9	38.1	39.5	42.0

shadow fixed costs are predicted to be around \$290 per week. The introduction of variable fixed costs in model (4), Table 4, again appears to be an improvement on the basis of the Likelihood Ratio criterion. Average (shadow) fixed costs are now estimated to be around \$220 per week. It also suggests that there is a significant increase in fixed costs arising from living in New South Wales (although interestingly, the effect of the number of children on fixed costs appears to be imprecisely estimated).

We find some improvement in the precision of the preference parameters when random preference heterogeneity terms are added (models 5 and 6). Average (shadow) fixed costs are now estimated to be around \$230 per week, and remain significantly higher in New South Wales. Sole parents with younger children have a greater marginal disutility of hours worked, as do the less formally educated. On the other hand, those with younger children tend to have a higher marginal utility of income, as would be expected. In terms of the squared preference terms, those on hours remain imprecisely estimated, while only the youngest child being aged 0–2 has an effect on the squared income term. Overall, there is little difference between the parameters of the most general specification (model 6) and the model with variable fixed costs but no random preference heterogeneity (model 4).

(iii) *Some Model Evaluations*

Given the complexities of the model specifications involved, it is not obvious how one might evaluate and interpret the above results. One

attractive option is to consider how well the model predicts the distribution of hours choices, compared with the observed hours distribution. To do this, we use the parameters of each model in our series to predict the probability of an individual being in a particular state. One simple approach is to allocate each individual to that outcome which yields the maximum probability. Comparing these predictions with the actual states yields the so-called 'Hit and Miss' tables which are familiar in more standard discrete choice models. However, if standard techniques are used to do this (i.e. those based on the maximum probability rule), such discrete choice models generally tend to heavily over-predict the empirically most frequently chosen outcome. This result stems from the fact that the random elements of the model are explicitly ignored in its subsequent evaluation.

As an alternative method of model evaluation, we simulate the preferred labour supply choice for each observation in the sample using the underlying economic model (in this instance, equation 5) using resampling methods (see Duncan & Weeks 1998). The results of this evaluation exercise are presented in Table 5 for all of the model specifications, and clearly show that the models that allow for varying fixed costs (models 4–6) predict better than those that do not (1–3). The main reason for this is that if one ignores the fixed costs of employment, one is likely to severely under-estimate the probability of working zero hours and over-estimate the probability of working few hours. One can see this from the marked reduction in the probability of working fewer than 12 h once fixed costs are introduced into the

specification. As indicated by the Likelihood Ratio tests, models (4) to (6) perform well, being marginally more accurate than model (3) which assumes constant fixed costs.

Although not reported, the implied indifference curve maps for a range of demographics are all broadly consistent with economic theory (increasing with hours of work and generally being concave over the feasible range of hours and income levels).

V Simulating Employment Responses to Policy Reform

The model of preferences estimated in the previous section may be used to simulate the potential impact of tax and/or welfare policy reform on participation and hours choices among sole parent households. The principal which underpins this microsimulation approach is relatively straightforward and attractive; the practical implementation less so. The basic idea in behavioural microsimulation is to bring the estimated preference function for sole parent households (which varies by observed demographic characteristics) together with a detailed description of the net incomes which would be enjoyed at each possible hours alternative. By doing so, we arrive at an optimal employment choice under some benchmark tax system. We then introduce a new tax system following some policy reform. This alters the budget constraint, and therefore potentially alters the optimal choice of hours following the policy reform. By comparing the simulated employment optima for a large and representative sample of sole parent households, we are able to build a pattern of employment transitions which indicate both the direction and degree of behavioural response to the tax reform.⁶

For a discrete choice model of labour market status of the form described above, there is inevitably less accuracy both in the budget constraint information brought to bear in estimation and in the microsimulated hours responses to tax policy reform. Specifically, hours responses are limited in accuracy to the number of discrete

⁶ Microsimulation methods of this sort are necessarily partial equilibrium in nature; to move to a more general framework including potential demand-side and price impacts of labour supply responses, would be computationally infeasible. Nevertheless, given that we are modelling the behaviour of a relatively small demographic group in the population, a partial equilibrium model does not appear unreasonable.

hours bands into which the simulation sample is divided, and to the nominal value for hours of work allocated to observations falling within each band. While this may be entirely appropriate for certain demographic groups (for example, married male workers) and certain tax reforms, it is by no means a universally acceptable feature. We know, for example, that the labour market decisions of sole parent households are relatively marginal or flexible, reflecting the high value such households place on non-work time.

The methods by which discrete models of labour market status are applied to discrete microsimulation are to a degree under-developed. One approach is to restrict attention to aggregated groups in the simulation sample and to summarise probabilities of occupation of each discrete state before and after some policy reform. This tends to conceal the impact of reform at the individual level, making it difficult to assess how the behaviourally adjusted cost of the reform might be judged, and what might be the impact of a reform targeted either at a specific demographic group or over a specific range of hours.⁷ If one requires simulated responses at the level of the individual, on the other hand, it is not immediately obvious which is the most appropriate strategy to adopt.

A better strategy, and the one adopted in this paper, respects the probabilistic form of the discrete model. Specifically, the estimated model is used to predict the probability of choosing each hours level in the set $H_{(.)} = \{0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50\}$ under the January 2000 tax system, and under a range of alternative policy scenarios. We use resampling methods to generate estimates of the probability of transition from one labour market state to another following a policy reform. We do this by:

1. Drawing repeated realisations of the random elements of the model (which requires a series of draws from Type I Extreme Value and Multivariate Normal Distributions for, respectively, state specific errors and random taste parameters);
2. Allocating each individual to the most preferred labour market state following each random draw; and

⁷ One might think, for example, of a reform to in-work support along the lines of the US EITC (Sholz 1996) or the new WFTC in the UK (Treasury 1998).

3. Averaging these resampled transitions frequencies to arrive at simulated transitions probabilities for each observation in the sample.

By aggregating individual transitions probabilities, it is possible to simulate the overall labour supply response to a tax policy reform, and to model how those simulated transitions might affect the cost to the Government of the reform.

(i) *Employment Effects of Policy Reform: Some Specific Examples*

To illustrate how our model can be applied to simulate the potential employment impact of tax and/or welfare reform in Australia, we consider the employment response of sole parent households to a range of policy reforms to the January 2000 tax system in Australia. Some reforms have actually taken place, others are entirely hypothetical and are chosen merely to illustrate the potential of behavioural microsimulation to inform the policy debate. Specifically, we consider:

- Reform 1: reduce the Single Parent Pension withdrawal taper from 50 per cent to 40 per cent;
 Reform 2: reduce the withdrawal tapers for Family Payment from 50 per cent to 30 per cent (for the Basic payment) and from 100 per cent to 30 per cent (for higher payments);
 Reform 3: abolish the Single Parent tax rebate;
 Reform 4: increase the standard rate of income tax from 20 per cent to 30 per cent.

Tables 6 and 7 evaluate the impact of these reforms in terms of employment responses, and Table 8 indicates the extent to which these hours responses act to modify the anticipated cost to the government of the policy reform.

Reform 1: Reduce the Single Parent Pension

Withdrawal Taper

The Single Parent Pension withdrawal taper was reduced from 50 per cent to 40 per cent in July 2000. The reform has the effect of increasing incomes for those working mothers who were either on partial Single Parent Pension (SPP), or worked to a point which just disqualified them from receiving any SPP. The reform makes part-time employment relatively more attractive, and has the potential to induce employment responses which might alter the expected costs to the government.

Table 6 summarises the simulated employment responses among the sample of sole parent households. We take the January 2000 tax and transfer system as our benchmark (and so uprate all data to January 2000 prices). Following the reduction in the SPP withdrawal taper, we simulate a set of transitions probabilities from one hours level to another using the methods described in the previous section. On average, the SPP reform was found to increase the participation rate of single parent households by around 2.5 per cent. The model simulates some movement in hours among working single parents, principally among full-time employees who might take advantage of the increased generosity of SPP at part-time hours levels by reducing their labour supply (see Table 6, panel 1). Interestingly, these behavioural responses act to reduce the net cost of the SPP reform to the government, at least in respect of sole parent households (Table 8). Since more sole parents are modelled to work following the reform, income tax revenues increase while allowance and SPP costs reduce among sole parents. There are some offsetting

TABLE 6
Simulated Employment Effects of Policy Reforms

	Behavioural Response to Policy to Reforms (%)			
	Reform 1	Reform 2	Reform 3	Reform 4
Non-work–work (%)	2.46	0.36	–	0.21
Work–non-work (%)	–	–	4.05	3.02
Workers working more	0.17	0.22	0.41	0.31
Workers working less	0.82	0.28	0.27	0.85
Average hours change	0.55	0.15	–1.22	–1.24
Cost change (static, %)	1.25	1.04	–4.33	–1.74
Cost change (behavioural, %)	0.60	0.48	0.46	4.05

TABLE 7
Simulated Employment Transitions following of Policy Reforms

Reform 1: Reduce Single Parent Pension Withdrawal Taper from 50% to 40%

Hours	Before	After	Difference	Post-reform Hours Range					
				0	1-10	11-20	21-30	31-40	>40
0	58.9	56.4	-2.5	56.4	0.1	0.6	0.9	0.6	0.2
1-10	6.5	6.6	0.1	-	6.4	-	-	-	-
11-20	6.5	7.7	1.0	-	-	6.7	-	-	-
21-30	5.6	6.9	1.3	-	-	-	5.6	-	-
31-40	15.7	15.8	0.1	-	0.1	0.2	0.1	15.1	-
>40	6.5	6.6	0.1	-	-	0.1	0.1	-	6.3

Reform 2: Reduce Family Payment Tapers (50% to 30% basic, & 100% to 30%)

Hours	Before	After	Difference	Post-reform Hours Range					
				0	1-10	11-20	21-30	31-40	>40
0	58.9	58.6	-0.3	58.6	-	-	-	0.1	0.2
1-10	6.4	6.4	0	-	6.4	-	-	-	-
11-20	6.8	6.7	-0.1	-	-	6.7	-	-	-
21-30	5.6	5.8	0.2	-	-	-	5.6	-	-
31-40	15.6	15.8	0.2	-	-	-	0.1	15.5	-
>40	6.6	6.7	0.1	-	-	-	-	-	6.4

Reform 3: Abolish Single Parent Rebate

Hours	Before	After	Difference	Post-reform Hours Range					
				0	1-10	11-20	21-30	31-40	>40
0	58.9	63	4.1	58.9	-	-	-	-	-
1-10	6.4	6.2	-0.2	0.4	5.9	-	-	-	-
11-20	6.8	5.7	-1.1	0.9	-	5.7	-	-	-
21-30	5.6	5.0	-0.6	0.5	-	-	5.0	-	-
31-40	15.6	14.1	-1.5	1.5	0.1	-	-	13.9	0.1
>40	6.6	6.1	-0.5	0.6	-	-	-	-	5.9

Reform 4: Increase Basic Income Tax Rate from 20% to 30%

Hours	Before	After	Difference	Post-reform Hours Range					
				0	1-10	11-20	21-30	31-40	>40
0	58.9	61.8	2.9	58.7	-	-	-	-	-
1-10	6.4	7.1	0.7	0.1	6.4	-	-	-	-
11-20	6.8	6.5	-0.3	0.3	-	6.3	-	-	-
21-30	5.6	5.3	-0.3	0.4	-	-	5.1	-	-
31-40	15.6	13.5	-2.1	1.6	0.2	0.1	-	13.4	0.1
>40	6.6	5.9	-0.7	0.6	0.1	-	-	-	5.7

cost increases (principally from Family Payments), but the net cost to the government is reduced when employment responses are factored into overall costings. Specifically, we find a net cost increase of 1.25 per cent following the SPP rate reduction in the absence of modelled employment responses, but this cost increase reduces to 0.6 per cent once behavioural changes have been accounted for.

Reform 2: Reduce Family Payment Tapers

This reform to the structure of Family Payments (with a reduction from 50 per cent to 30 per cent in the taper for Basic Family Payment, and a reduction from 100 per cent to 30 per cent in the taper for higher Family Payments) was implemented in July 2000. Again, we find there to be a positive employment response to this reform,

TABLE 8
Effects of Policy Reforms on Tax Revenues and Welfare Costs

	Percentage Change in Revenue/Costs							
	Reform 1		Reform 2		Reform 3		Reform 4	
	<i>static</i>	<i>adj.</i>	<i>static</i>	<i>adj.</i>	<i>static</i>	<i>adj.</i>	<i>static</i>	<i>adj.</i>
Income Tax	1.4	2.0	–	0.3	–	–4.3	26.0	19.2
Medicare	1.4	–1.6	–	1.3	–	–5.5	–	–9.5
Family Payment	0.5	1.2	1.8	1.6	–	0.9	–	1.5
Family Tax Payment/Assistance Allowances	–	–	–	–	–	–	50.0	50.0
Pensions	2.6	0.8	–	0.7	–	4.9	–	5.1
Pharmaceutical Allowance	–	–	–	0.2	–	0.3	–	0.2
Rent Allowance	5.2	6.4	–	0.7	–	2.3	–	3.4
Tax Rebates	–	0.5	3.3	3.5	–	0.5	–	1.0
Cost change (%)	–0.2	–0.2	–	0.1	–87.1	–86.6	2.4	3.2
	1.3	0.6	1.0	0.5	–4.3	0.5	–1.7	4.1

although the effects are more modest than for the first reform discussed earlier. Nevertheless, the estimated net cost to the government is again halved once behavioural responses are taken into account.

Reform 3: Abolish the Single Parent Tax Rebate

The Single Parent tax rebate, an additional concession in the tax liabilities among working sole parent households, was set at \$1243 per annum in January 2000. As an illustration of the potentially adverse consequences of tax reform on employment incentives, we simulate the behavioural impact of an abolition of the tax rebate on sole parent families. This will penalise sole parent taxpayers by up to \$23.30 per week, and is likely to have negative employment consequences. The model simulates around 4 per cent of sole parents to move out of the labour market following the abolition. In cost terms, a reform which looked to have generated a net saving for the government (over 4 per cent in net costs in respect of sole parent households) in the absence of any behavioural responses, was found in fact to increase costs once employment responses were taken into account. An inspection of the third columns in Table 8 reveals that revenues from income taxation and medicare fall as sole parents withdraw from the labour market, whereas allowance and pension costs increase for those sole parents whose entitlements increase following their reduction in labour market attachment. This is a revealing demonstration of the need to take explicit account of employment responses for a

full assessment of the costs of tax and transfer reform.

Reform 4: Increase the Basic Rate of Income Taxation from 20 to 30 per cent

Next we consider a purely hypothetical reform, used for illustration purposes only. As with the previous reform, we find a considerable employment response to an increase in income taxation, with 3 per cent of single parent households moving out of the labour market. Costs are of course affected; what looked initially like a revenue earner actually turns out to cost the government money once behavioural responses have fully been accounted for.

VI Conclusions

In this paper, we model the labour supply of sole parents as the outcome of a discrete choice among a finite set of hours alternatives. Our estimation strategy controls both for random preference heterogeneity and for fixed costs. A direct quadratic utility function was employed for the individual's preferences. Non-linear tax schedules were handled by the use of the MITTS model to generate net incomes over the required hours spectrum. In the absence of controls for fixed costs, the model was found to underestimate the probability that sole parents would work no hours. All models were found to be broadly consistent with economic theory, and the implied indifference maps were found to conform to the expected pattern, at least over the feasible set of hours and income choices.

The model was used to simulate the likely behavioural responses to the introduction of a range of actual and hypothetical policy reforms in Australia. The simulated employment responses to actual policy reforms introduced recently in Australia are small but positive for sole parent households. Results also suggest that static micro-simulation models which do not allow for behavioural responses can lead to non-negligible biases in the financial costs to the government of tax and transfer reforms.

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