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LABOUR SUPPLY AND WELFARE PARTICIPATION IN AUSTRALIAN TWO-ADULT HOUSEHOLDS: Comparing 1986/87 with 1994/95

by

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Abstract

We estimate a simultaneous discrete choice model for welfare participation and labour supply of two-adult households in Australia using the Income and Housing Costs Survey of 1994/1995. Welfare participation is assumed to have a positive indirect effect (through income) and a negative direct effect on utility. This approach allows for non-participation of eligible people. The results are compared with those from an earlier study using the 1986/1987 Income Distribution Survey. The differences are discussed in the context of policy changes affecting welfare payments and of behavioural changes as they emerge from the models.

The results indicate that there is evidence of a significant disutility associated with welfare participation in both years. We also find that a change in the benefit withdrawal rate or the maximum benefit level does not seem to have a large effect on the labour supply of either adult.

JEL classification: J22, I38

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LABOUR SUPPLY AND WELFARE PARTICIPATION IN AUSTRALIAN TWO-ADULT HOUSEHOLDS: COMPARING 1986/87 WITH 1994/95

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INTRODUCTION

Many papers have been written on the effects of different types of government benefit payments on labour supply. Few, however, include a possible negative side effect of receiving benefits[1]. One reason for this possible negative effect might be that welfare recipients feel some embarrassment because of the social stigma involved in their accepting public assistance. This might discourage their welfare participation. Another reason for a negative effect might be transactional costs associated with the receipt of welfare payments. To my knowledge, all papers which included a disutility from welfare participation have analysed US data, except for Bingley and Walker (1997) who used UK data. As the US welfare system is quite different from those of other developed countries, it might be interesting to analyse data from other countries. In this paper we update a model estimated with Australian data from 1986-87 (Kalb, 1998). Instead of the 1986-87 data, 1994/95 data is used to estimate a model for labour supply and welfare participation. The results from the updated model will be compared with the previous results.

Compared to the US, Australia has a relatively generous welfare system in that everyone with inadequate income is eligible for some kind of welfare benefits. In the US, there are insurance type provisions for previous employees which usually have limited duration. In addition, there is Aid to Families with Dependent Children in the US for which only families with dependent children are eligible. Other people might be eligible for General Assistance. However, this scheme is more discretionary in nature. In the US, part of the benefits consist of Foodstamps, which normally have to be used in public. One would expect such benefits to be associated with a larger stigma effect than other more anonymous welfare payments.

Australia has no unemployment insurance, but only unemployment assistance, which is independent of previous work experience and earnings and provides benefits at a low level for an unlimited duration. Naturally, looking and being available for work is one of the prerequisites of being eligible for unemployed people. The basic structure of unemployment benefits has remained unchanged in Australia from 1986/87 to 1994/95. The most important change in unemployment benefit rules has

* I would like to thank Paul Kofman and Alan Powell for their comments. All remaining errors are, however, my responsibility.

1 Examples of exceptions are Moffitt (1983), Ashenfelter (1983), Fraker and Moffitt (1988), Woittiez, Lindeboom and Theeuwes (1994), Charette and Meng (1994), Hagstrom (1996), Hoynes (1996), and Bingley and Walker (1997).

been that people can have more free income from earnings in 1994/95 than in 1986/87. This free income from earnings is measured per person and cannot be transferred to a spouse, which should make it more worthwhile for both partners in a couple to look for work while receiving an unemployment benefit.

The purpose here is to estimate a simultaneous model of labour supply and welfare participation which allows a direct effect from welfare participation on the utility level, using recent Australian data. If the negative effect of welfare participation is too large, eligible households may decide not to participate in welfare. In order to adequately assess the effect of welfare payments on labour supply, inclusion of potential negative effects caused by participation in welfare is important. The results from a previous Australian study indicated that there was a significant negative effect of welfare participation on the utility level of households.

The emphasis of the basic framework is on the separation of income into different categories and on a correct representation of net income at all levels of gross income, taking taxes and benefit reduction into account. This results in a highly nonlinear and non-convex budget constraint. Estimation of a continuous labour supply model for two persons, using this budget constraint, would be too complicated, so labour supply is discretized. The approach here is different from those of other papers on models of welfare participation and labour supply. Following Van Soest (1995) we use the multinomial logit rather than a probit type specification in the discrete choice model. This allows us to choose a relatively large number of labour supply points for both adults in the household.

Finally, the effect that welfare payments have on labour supply or labour force participation is a research topic that has attracted ample attention in the overseas literature, but so far there has been relatively little research on labour supply in Australia. Notwithstanding the fact that in many ways Australia may be similar to the US or the UK, there are also several differences in the way welfare is set up and regarded, as well as in the composition of the population, which warrant a separate study. Thus, a motivation for this study is that a model based on recent Australian data, in which the effect of unemployment benefits on labour supply can be adequately assessed, is of interest in itself. The existence of such a model will allow simulations to be carried out, so the effect of policy changes – for example an introduction of a tax credit (similar to the earned income tax credit in the US) – on labour supply and welfare participation can be assessed.

Section I briefly discusses the economic model. Section II describes the data. Section III contains the econometric details. The results are discussed in Section IV. First the estimated parameters are discussed and compared to the results from 1986, where special attention is given to the disutility or stigma parameter. Then wage elasticities for some typical households and the simulated effects of an increase in the benefit level and a decrease in the maximum benefit withdrawal rate are presented. Finally, in Section V some conclusions are presented.

I. THE ECONOMIC MODEL

By setting up the model in the familiar neoclassical way, starting from utility maximization under a budget constraint, a logical and consistent framework can be built to analyse labour supply (see for example Deaton and Muellbauer, 1980, or

Killingsworth, 1983). We are interested in a two-adult household (with or without dependent children), where the adults choose their labour supply and the household's participation in welfare to optimize its utility. A simple utility maximizing modelcould look as follows:

(1) $\max U(x, lhh_1, lhh_2, d_W)$

subject to:

$T = lhh_1 + h_1$

$T = lhh_2 + h_2$

$$x = \int_0^{h_1} g_1(t_1, h_2)dt_1 + \int_0^{h_2} g_2(h_1, t_2)dt_2 + n(y_1) + n(y_2) + n(B(hc))d_W^*$$

Or if the three restrictions are taken together, the budget constraint may be written:

(2)
$$x + \int_{T-lhh_1}^{T} g_1(t_1, T\text{-}lhh_2)dt_1 + \int_{T-lhh_2}^{T} g_2(T - lhh_1, t_2)dt_2 =$$
$$\int_0^T g_1(t_1, T)dt_1 + \int_0^T g_2(T, t_2)dt_2 + n(y_1) + n(y_2) + n(B(hc))d_W^*$$

where:

$U(\,)$ is the utility function of a two-adult household,

lhh_1 and lhh_2 indicate the aggregate of leisure time and home production time per week of persons 1 and 2 respectively,

x indicates net income per week,

d_W indicates whether a household participates in welfare,

T is the total available time for each person in the household,

h_1 and h_2 are the hours of work of persons 1 and 2,

$g_1(\,,\,)$ and $g_2(\,,\,)$ are the marginal wages of persons 1 and 2,

y_1 and y_2 are the non-labour incomes of persons 1 and 2,

$B(hc)$ is the amount of benefit a household is eligible for given household composition hc,

$n(\,)$ is the amount of income after the deduction of taxes,

d_W^* is a binary dummy indicating the inclination of the household to participate in welfare if eligible.

The combination of leisure, income and welfare participation that delivers the highest utility to the household is regarded as the optimal choice. It is expected that utility increases with an increase in leisure and income and that it decreases with an increase in welfare participation. The disutility caused by welfare participation can be explained either by the existence of a stigma associated with welfare participation or by administrative and/or other costs of applying for welfare. This disutility might completely or partly offset the utility associated with the extra income, depending on the amount of extra income.

With regard to the assumption of free choice underlying this economic model, it should be noted that, in practice, voluntary non-workers often cannot be distinguished from involuntary non-workers. Neither is it known whether the observed labour supply is the optimal labour supply or, alternatively, whether people are restricted in their choice of number of hours worked by demand side factors. It would be interesting to analyse desired hours of work instead of actual hours of work or to allow for the restrictions in actual hours caused by the demand for labour. Bingley and Walker (1997), for example, incorporate involuntary unemployment as one of the 'choices' in their model. For the moment, actual hours are used here and it is assumed that they are equal to the desired hours of work.

II. THE DATA

The Income Distribution Survey 1986 and the Survey of Income and Housing Costs 1994-95, both released by the Australian Bureau of Statistics (ABS), have been used for the analysis. Both data sets have detailed income information for each person separately and for the household as a whole. This allows the budget constraint to keep its full complexity: a point of major importance given the main aim of our study. Some problems were encountered with the 1986 data, complicating the estimation procedure. Full details of the problem can be found in Kalb (1998); therefore it will not be discussed further here.

II.1. Selection Criteria for Inclusion in the Analyses

In this section, the selection criteria are discussed. The same selection criteria have been used for both years. They are the following:

- Only households that contain one income unit and consist of a head and a partner with or without dependants are included. For this group, it seems reasonable to adopt the assumption that the household takes joint decisions and maximizes a single utility function according to a common vision of the household's welfare.
- People of an age to be eligible for government paid age pensions are excluded. They are expected to behave differently from younger people.
- For the same reason of substantial differences, the self-employed and full-time students are also excluded.
- All people temporarily or permanently unable to work because of illness or disability are excluded from the analysis.
- People receiving a (military) service pension are not included, since these pensions are paid instead of age pension or in cases of disability.
- People who care for family members including a handicapped child and receive benefits for doing so, as well as people receiving a group of benefits not named anywhere else, are also excluded from the analysis.
- Finally, a few households detected in the data set of 1986 seemed not to be two-adult households (where resources are shared between the two adults).

After the above selection process, data sets of 2349 and 1964 households are left for analysis of 1986 and 1994 respectively.

Figure 1a: Labour Supply of Males and Females (1986-87)

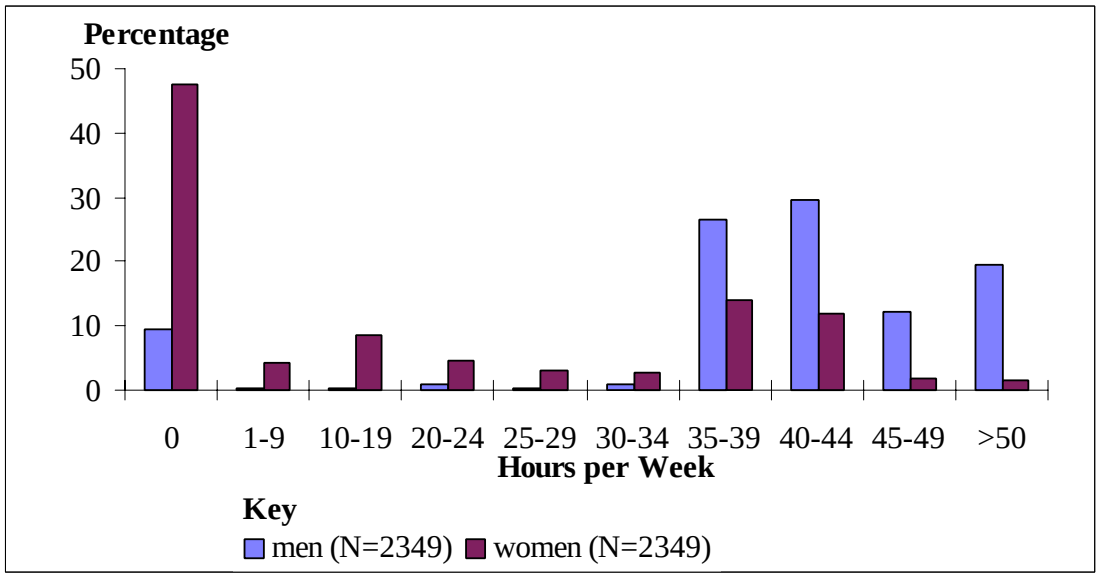
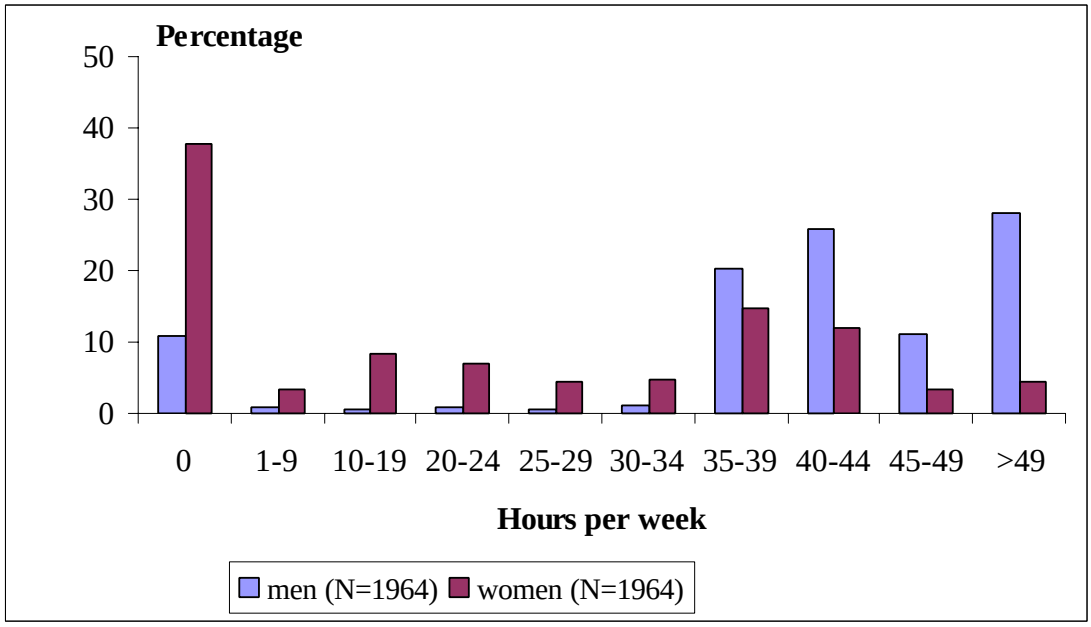


Figure 1b: Labour Supply of Males and Females (1994/95)



Figures 1a and 1b give an overview of the sample frequency distribution of (categorized) male and female working hours in the selected samples. The difference between men and women is obvious and as expected. Relatively more women work part time and more men work full time (especially over 45 hours per week) in both samples. Overall, in 1994 both men and women seem to work longer hours; especially the category over 49 hours per week has increased. In addition, women are much more likely to be working in 1994 than they were in 1986. For men, there seems to have been a slight increase in the proportion of non-workers over that period. This may have been caused by the slightly

higher unemployment rates in 1994 as compared to 1986 (around 9 per cent and 8.3 per cent respectively (ABS, 1987; ABS, 1995)).

Missing values or outliers (which may be measurement errors) result in the deletion of a few additional households in subsequent analyses. First, some values for wage income seem unrealistically small when compared to the corresponding hours worked. In Australia there is no Federal or state minimum wage covering all employees. Each award has its own minimum wage. Therefore, across states, occupations and industries, minimum wage levels vary. In addition, not all workers are covered by an award. The lowest value found in 1986[2], was the minimum weekly wage rate for adults in Federal awards for Brisbane of $164.30 per week (see *Queensland Yearbook 1988*, ABS, 1989b). Assuming the standard hours per week to be 40 (which might be a slight overestimate), this translates into a minimum hourly wage rate of $4.11 per hour. Therefore in the estimation of the wage equation all persons earning less than $4 per hour are excluded (the same selection is used to estimate the wage equation and the labour supply equation in both years). Second, all households that had a weekly income of less than $100 and $150 respectively are also excluded. When this happens, some observations may be wrongly excluded as it is possible that some households may live off their savings temporarily. In the final labour supply analysis 2280 cases remain for 1986 and 1914 cases remain for 1994.

II.2. Variables used in the Analyses

Table 1 gives summary statistics of the variables, which are used in the analysis. The background characteristics used to specify preferences in the utility function are listed here.

Age is known in categorized form of five-year intervals only for 1986. In 1994, people's age is exactly known for those under 25 and those over 54 years of age, while the ages between 25 and 54 are known in five-year intervals. Whenever the age is not exactly known, the midpoint values of each category are used. Younger and older persons are expected to have a higher preference for leisure.

Education is divided into the following categories for the 1986 model:

- never been to school or left school before the age of 14
- did not finish secondary school, left school before the age of 16
- did not finish secondary school, left school at 16 years or older
- finished secondary school or obtained secondary qualification since leaving school
- obtained a trade certificate
- obtained other certificate or diploma
- obtained bachelor degree or higher qualification
- obtained other qualification

2 Based on checking the 'Award Rates of Pa y Indexes' (ABS, 1988) and ABS Yearbooks.

Table 1: Summary Statistics

Variable	For 1994/95 (N=1964) %	For 1986-87 (N=2280) %
Hours worked by men		
0	11.0	9.5
1-9	0.8	0.3
10-19	0.5	0.3
20-24	0.8	0.8
25-29	0.6	0.2
30-34	1.2	0.9
35-39	20.2	26.5
40-44	25.8	29.7
45-49	11.2	12.3
>49	28.2	19.5
Hours worked by women		
0	37.7	47.6
1-9	3.5	4.2
10-19	8.5	8.5
20-24	6.9	4.7
25-29	4.5	2.9
30-34	4.7	2.7
35-39	14.6	14.1
40-44	11.9	12.0
45-49	3.4	1.7
>49	4.3	1.6
State of residence		
• New South Wales	21.4	24.1
• Victoria	21.8	20.2
• Queensland	18.1	16.8
• South Australia	10.9	12.8
• Western Australia	13.9	14.2
• Tasmania	7.0	7.5
• Territories	6.9	4.5
Residence in capital city	59.9	
Participation in welfare	6.2	5.0
Eligibility for welfare		6.7
Ethnicity men		3.2
Migrant men	28.3	
Recent migrant men	2.2	
Non-English speaking background men	9.1	
Ethnicity women		3.9
Migrant women	26.2	
Recent migrant women	3.1	
Non-English speaking background women	9.7	
Men who worked more than 35 weeks in last year		90.4
Men whose principal source of income came from work in last year	89.0	
Women who worked more than 35 weeks in last year		47.3
Women whose principal source of inc. came from work in last year	65.0	

Table 1 (continued)

Variable	For 1994/95 (N=1964) %	For 1986-87 (N=2280) %
Education of men (1986)		
• No school/ left before 14 years of age		3.5
• Left school at age 14 or 15		18.0
• Left school older than 15		11.7
• Secondary school/qualification		11.8
• Trade certificate (no field)		2.5
• Trade certificate (technical)		23.2
• Trade certificate (miscellaneous)		4.1
• Other certificate/diploma (business, commerce)		4.4
• Other certificate/diploma (education)		1.5
• Other certificate/diploma (medical)		0.8
• Other certificate/diploma (technology)		5.0
• Other certificate/diploma (social sciences, arts)		0.4
• Bachelor or higher (business, commerce)		2.9
• Bachelor or higher (education)		2.0
• Bachelor or higher (medical)		0.5
• Bachelor or higher (technology)		5.1
• Bachelor or higher (social sciences, arts)		1.7
• Other qualification		0.9
Education of men (1994)		
• No qualifications	42.9	
• Basic vocational qualification	1.9	
• Skilled vocational qualification	27.2	
• Diploma	10.7	
• University degree	17.3	
Education of women(1986)		
• No school/ left before 14 years of age		3.2
• Left school at age 14 or 15		31.8
• Left school older than 15		17.0
• Secondary school/qualification		11.4
• Trade certificate (no field)		0.9
• Trade certificate (technical)		0.1
• Trade certificate (miscellaneous)		2.9
• Other certificate/diploma (business, commerce)		10.4
• Other certificate/diploma (education)		4.9
• Other certificate/diploma (medical)		7.0
• Other certificate/diploma (technology)		0.6
• Other certificate/diploma (social sciences, arts)		0.9
• Bachelor or higher (business, commerce)		0.7
• Bachelor or higher (education)		3.0
• Bachelor or higher (medical)		0.4

Table 1 (continued)

	For 1994/95 (N=1964)	For 1986-87 (N=2280)
Variable	**%**	**%**
• Bachelor or higher (technology)		1.1
• Bachelor or higher (social sciences, arts)		2.2
• Other qualification		1.6
Education of women (1994)		
• No qualifications	58.4	
• Basic vocational qualification	6.5	
• Skilled vocational qualification	11.3	
• Diploma	9.8	
• University degree	14.1	
Youngest child is 0	8.9	
Youngest child is between 1 and 5	26.5	
Youngest child is between 6 and 11	18.0	
Youngest child is between 12 and 14	6.4	
	Mean (Standard Deviation)	
Variable	**1994/95**	**1986-87**
Number of children	1.35	1.37
	(1.24)	(1.25)
Age of youngest dependent child below 15 (if present)		4.95
		(4.33)
Unemployment benefits	10.70	8.96
	(41.67)	(40.88)
Mortgage debt	33162.76	14138.96
	(45150.99)	(19062.71)
Non-labour income of men	22.57	22.20
	(118.17)	(121.64)
Non-labour income of women	14.69	12.36
	(143.85)	(52.31)
Wage income of men	652.42	451.79
	(572.92)	(243.20)
Wage income of women	280.37	147.92
	(319.20)	(179.70)
All income of men	694.85	478.69
	(571.25)	(253.58)
All income of women	316.40	170.71
	(359.15)	(181.11)
Age of men	39.35	37.50
	(9.88)	(10.10)
Age of women	36.77	34.90
	(9.38)	(9.70)
Number of weeks worked last year by men		47.36
		(13.13)
Number of months worked during last 7 months by men	5.41	
	(2.47)	
Number of weeks worked last year by women		26.16
		(23.72)
Number of months worked during last 7 months by women	3.91	
	(3.10)	

In 1994, less detail is known, especially on the lower education levels. The available categories are:

- no qualifications
- basic vocational qualifications
- skilled vocational qualifications
- associate or undergraduate diploma
- higher or bachelor degree or postgraduate diploma

Education is expected to increase the preference for work, because time and money have been invested in human capital. Apart from the financial rewards, one would also expect a high-skill job to be more interesting than a low-skill job and hence more desirable.

The *number of dependent children* in each household is calculated by adding the number of dependent children from 0 to 20 years old (0 to 24 years old in 1994). This variable is expected to be especially important for the female adult in the households. Children are likely to increase the value of time at home, which is reflected in a higher preference for leisure in the model.

The survey records the *age of the youngest dependent child under 15 years of age* in the household. The effect of dependent children in the household is likely to be bigger when young children are present.

The *value of the outstanding mortgage* is likely to be simultaneously determined with labour supply and thus an endogenous variable itself. Our cross-sectional data does not allow us to specify a model that would take this into account. Therefore, it is modelled as having an effect on preferences. However, it should be realized that the decision to buy a house and take out a mortgage is probably influenced by labour supply now and the prospects of labour supply in the future.

Variables expected to be relevant to the wage rate are described below.

Age and Age^2, because age reflects the experience people are likely to have had in the labour market. If the interest were in the separate effects of schooling and experience, this would not be an adequate specification (Mincer, 1974; Rosenzweig, 1976). However, here the goal is to predict a wage rate for the non-workers and the separate effects are not so important.

Education, which is expected to determine the wage level to a great extent.

The *field* in which the highest educational qualification is attained for those people who have qualifications beyond secondary school, is available for the 1986 data only. The categories used here are:

- *administrators, lawyers, business professionals:* a degree or diploma in administration (including secretarial work), business, commerce, law
- *professionals in education:* a degree or diploma in education or teacher training
- *medical professionals and para-professionals:* a degree or diploma in the medical field (including nursing and para-medics)

- *technologists and technicians:* a degree or diploma in science, engineering, architecture, agriculture, forestry veterinary science, transport, communication or a certificate in metal, building, electrical, wood and furniture or mechanical and automotive
- *social scientists, social workers, graduates in the humanities:* a degree or diploma in social sciences, arts and humanities
- *miscellaneous:* a certificate in service, food and drink, printing and allied, or footwear, clothing and textiles.

A combined variable using information from the highest education level and from the field of qualification is used in the analysis of the 1986 data. Wages can differ widely over the different fields of education.

In 1986, a proxy for *ethnicity* is generated by creating a dummy variable that takes the value one for all people who arrived in Australia after 1980 from origins other than the United Kingdom. This variable is intended to identify recent immigrants who possibly have difficulties with the language and/or culture of Australia. These difficulties might have an adverse effect on the wage rate. In 1994, three dummy variables are used to identify firstly, migrants in general; secondly, recent migrants, that is those who arrived in 1991 or later; and thirdly, migrants from a non-English speaking background. The latter group is an approximation, since the possible countries of birth were not grouped by first language. We have excluded migrants originating from Europe and USSR (since a large group of immigrants comes from the UK) and from Northern America. We have decided not to exclude migrants from Oceania and Antarctica[3], even though this category includes New Zealand.

In 1986, *recent work experience* is represented by a dummy variable, which takes the value of one if the person has been employed during more than 35 weeks in the previous year. In this way, people just starting a career or people with a break in their career can be identified. People with up-to-date skills and experience are likely to receive higher pay. In 1994, the employment duration in the previous year is unknown. To make an allowance for the difference between those who are likely to have worked in the previous year and those who are unlikely to have done so, we assign the value one to a dummy variable indicating that the principal source of income in the previous year was from wages and salaries or from one's own business (but zero otherwise). In addition, the number of months during which the respondent was employed in the seven months preceding the interview is included as an indicator of recent work experience.

State of residence indicates the state or territory. Unfortunately, the Northern Territory and the Australian Capital Territory are categorized as one group, which is a disadvantage for the estimation of the wage equation, as the job markets in these two regions differ considerably. For 1994, a variable indicating whether the household lives in or outside a capital city is also available.

Other important variables in the analysis are noted below.

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3 This is how the Australian Bureau of Statistics has defined the categories of immigrants.

Non-labour income (excluding the unemployment benefit) is constructed by adding all income from investments, rents and dividends to superannuation payments, compensation payments and other regular income (excluding income from the first homebuyer scheme in 1986).

The *wage rate* cannot be exactly determined in most cases. Only *weekly income from wage and salary* is known which has to be divided by the unknown exact number of 'hours worked' to get the wage rate in 1986. In 1994, the exact number of hours is observed up to 50 hours per week. For people working 50 or more hours a week we only know the maximum possible wage rate.

Participation in welfare payments is represented by a dummy variable, which is one when the household receives unemployment benefits.

The last variable is *eligibility for welfare payments.* This variable has been calculated using household composition and household income. This variable is an approximation as not *all* the details necessary to determine eligibility are available. However, the main determining variables are available to us. It appears that a few more families are eligible than those who have applied for the benefits.

III. ECONOMETRIC SPECIFICATION

In Section I an economic model was introduced that serves as a starting point for specifying an econometric model. Computational restrictions and available data, however, limit the econometric models that might be successfully estimated. In the following sections, possible options are discussed.

III.1. Specification of a Labour Supply and Welfare Participation Model

Dealing with a Nonlinear and Non-convex Budget Constraint

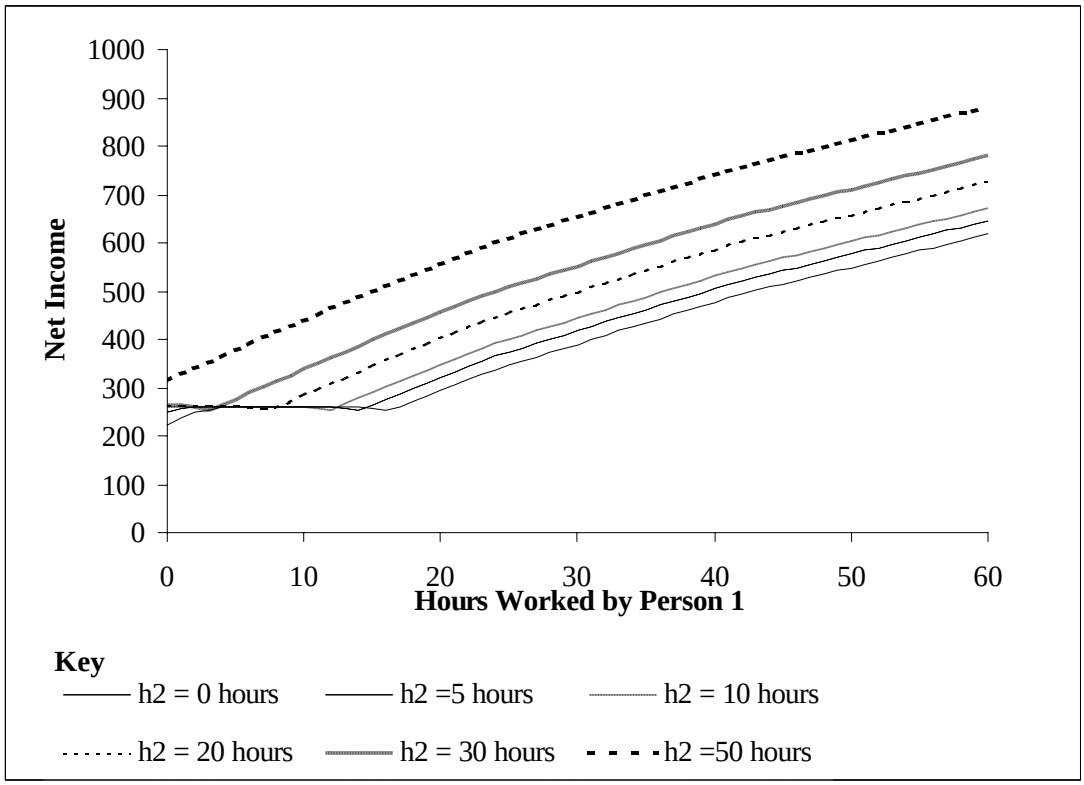
Including taxes and benefits for two persons in the budget constraint produces a highly nonlinear constraint. Looking at the benefit and tax regimes of 1986-87 and 1994/95[4] leads us to expect many kinks in the budget constraint. Since we prefer to keep the representation of taxes and benefits as close to reality as possible, a complex budget constraint cannot be avoided. To illustrate the possible implications of the tax and benefit rates of 1986 for the shape of a budget constraint, Figure 2 takes a hypothetical household consisting of two adults and two children under 16 years, where Person 1 has a market wage of $16.00 per hour and Person 2 has a market wage of $7.00 per hour.

In Figure 2 the working hours of Person 2 are fixed and net income is calculated over the number of hours worked by Person 1. It can be seen that in the lower regions of income the marginal wage rate at a certain number of hours for Person 1 also depends on the number of hours supplied by Person 2. It is clear that the lines that represent the budget constraint are nonlinear. In the case where one only considers one potential worker at a time, the labour supply estimation can already be quite

4 For an overview of the basic rules, see Appendix A.

complex[5]. The complexity is even greater in the case where households with two potential workers are analysed, subject to their joint budget constraint, which includes both taxes and benefits.

Figure 2: Net Household income when Hours of Person 2 are Fixed and Wage Rates are $16.00 for Person 1 and $7.00 for Person 2 in 1986-87



Restricting the number of possible working hours to a limited set of discrete values (as is done by many authors facing the same problem), appears an attractive solution. For this limited set of hours, one can calculate the level of utility that each possible combination of hours would generate, according to the specified utility function. An additional advantage of the discrete approach is that coherency does not have to be imposed before using maximum likelihood methods to estimate the model, as would be necessary in the case of continuous labour supply for some utility functions (see Van Soest, Kapteyn and Kooreman, 1993).

Instead of being defined on a continuous set of working hours, $h_1, h_2 \in [0,T]$, in the discrete choice case the budget constraint is defined on a discrete set of points $h_1 \in A=\{0,dh_{11},dh_{12},...,dh_{1m}\}$ and $h_2 \in B=\{0,dh_{21},dh_{22},...,dh_{2k}\}$ on the interval $[0,T]$[6]. Using these sets, the net income $x(h_1,h_2)$ is calculated for all $(m+1)\times(k+1)$ combinations of h_1 and h_2 (where m+1 is the number of discrete points for h_1 and

5 See e.g. Burtless and Hausman (1978), Hausman (1979), Hausman (1985) or Moffitt (1986) for a continuous labour supply approach with a nonlinear (non-convex) budget constraint.

6 0, dh_{11}, dh_{12}, etc represent the discrete values that labour supply can take.

k+1 is the number of discrete points for h_2). By increasing the number of different hours in the choice set, the quality of the representation improves. However, the computational load also increases, so a compromise between quality and computational feasibility is necessary. In addition to this discrete choice of hours, partipation in welfare is a choice variable as well. This choice variable can only take two different values: one for participation and zero for non-participation, so $d_W \in C = \{0,1\}$. For all working hours where households are still eligible for a benefit, an additional value for the net income $x(h_1, h_2, d_W)$ has to be calculated. So net income x is dependent on labour supply and wage rates of both adults, on non-labour income, on household composition and on participation in benefits (d_W). Wage rates, non-labour income and household composition are exogenous in this model. The model becomes:

(3) $\max U(x, lhh_1, lhh_2, d_W)$

subject to:

(4) $(x, lhh_1, lhh_2, d_W) \in BC(w_1, w_2, y_1, y_2, hc)$

where:

$$BC(w_1, w_2, y_1, y_2, hc) = \{(x, T-h_1, T-h_2, d_W); (h_1, h_2, d_W) \in A \times B \times C \text{ and}$$
$$x = w_1h_1 + w_2h_2 + y_1 + y_2 + B(hc, w_1h_1 + w_2h_2 + y_1 + y_2)d_W -$$
$$\tau(B.d_W, w_1h_1 + y_1, w_2h_2 + y_2, hc)\},$$

w_1 and w_2 are the gross wage rates of Person 1 and Person 2,

BC is the set of discrete points h_1, h_2 and d_W plus the net income x which is calculated for each of these points,

A, B and C are the sets of discrete points from which values can be chosen for h_1, h_2 and d_W,

B is the amount of benefit, for which the household is eligible, given household composition and income,

τ is the tax function that indicates the amount of tax to be paid.

In the discrete choice model, it is not necessary to know the marginal wage rates. Therefore, the budget constraint can be written as total gross income minus the tax that has to be paid on this total income. The tax and benefit rules are explained in Appendix A.

Assuming that the observed combination of hours is the optimal combination as perceived by the household, a likelihood function can be formed. The contribution of each household to the likelihood function is the probability that the observed hours indeed result in an optimal utility for the household of interest when compared with all other possible choices for hours. Thus, the elementary part of the likelihood function looks as follows:

$$\text{(5)}\qquad \begin{aligned}&\Pr(U(x((lhh_1, lhh_2, d_W)_r),(lhh_1, lhh_2, d_W)_r, \varepsilon_r) \geq \\ &\quad U(x((lhh_1, lhh_2, d_W)_s),(lhh_1, lhh_2, d_W)_s, \varepsilon_s) \text{ for all } s)\end{aligned}$$

where:

r stands for the combination h_1, h_2 and d_W that is observed,

s stands for all (k+1)×(m+1) other possible combinations that can be made, given the discrete choice sets for hours worked and participation in welfare, ε_r and ε_s represent error terms.

Adding an error term to the utility function prevents contributions to the likelihood in any data point from becoming zero. It allows for optimization errors made by the household. Alternatively, the error term can sometimes be interpreted as unobserved specific utility components. By choosing different functional forms for this error term (e.g. normal or type I extreme value), a different discrete choice model results (e.g. a multinomial probit or logit model). After specifying a functional form for utility, parameters of this model can be estimated by maximum likelihood.

The option of receiving welfare is only available when certain income requirements are fulfilled. This means that in most cases the household can only receive welfare payments when the number of working hours is low. The participation in welfare according to the model above is assumed to be a voluntary decision together with the number of hours worked. Therefore, the case where the number of hours worked is rationed is not covered by this model.

Specification of the Utility Function

For the sake of convenience the utility function used here is the translog specification (following Van Soest, 1995), to which a dummy term is added for participation in welfare[7]. This is in line with the approach of other papers on labour supply and welfare participation, in which it is also assumed that the disutility from welfare participation is separable from the utility from leisure and goods. The utility derived from leisure, income and welfare participation can be written as:

$$\text{(6)}\qquad \begin{aligned}U(x,h_1,h_2,d_W) = {} & \beta_x \ln(x) + \beta_1 \ln(80-h_1) + \beta_2 \ln(80-h_2) + \alpha_{xx}(\ln(x))^2 + \\ & \alpha_{11}(\ln(80-h_1))^2 + \alpha_{22}(\ln(80-h_2))^2 + 2\alpha_{x1}\ln(x)\ln(80-h_1) + \\ & 2\alpha_{x2}\ln(x)\ln(80-h_2) + 2\alpha_{12}\ln(80-h_1)\ln(80-h_2) - \varphi d_W\end{aligned}$$

where the αs,β s, and φ are parameters that have to be estimated.

This utility function has a simple form, and heterogeneity of preferences is easy to include. Here the total endowment of time (T) is chosen to be equal to 80 hours per week. A disadvantage of this functional form is that utility is not automatically quasi-

7 Only participation and non-participation are distinguished. The amount of participation, as could be expressed by measuring the value of the benefit received, is not taken into consideration as far as its direct effect on the utility is concerned.

concave. However, if the two conditions outlined below are fulfilled at a data point, then U is quasi-concave at that point (Van Soest, 1995).

First, U has to increase with *x*:

$$(7) \qquad 2(\alpha_{xx}\ln(x)+\alpha_{1x}\ln(80-h_1)+\alpha_{2x}\ln(80-h_2))+\beta_x > 0$$

and second, the matrix of second order derivatives of income x with respect to leisure of person 1 and person 2 (HX) has to be positive definite:

$$(8) \qquad HX = -U_x^{-1}\begin{bmatrix} x_{lhh_1} & 1 & 0 \\ x_{lhh_2} & 0 & 1 \end{bmatrix} HU \begin{bmatrix} x_{lhh_1} & x_{lhh_2} \\ 1 & 0 \\ 0 & 1 \end{bmatrix}$$

where:

U_x is the partial derivative of U with respect to income x;

HU is the matrix of second order partial derivatives of U;

$x_{lhh_1} = -\dfrac{U_{lhh_1}}{U_x}$, the marginal rate of substitution of leisure of person 1 with income x;

x_{lhh_2} is the same as above, but for leisure of person 2;

U_{lhh_1} is the partial derivative of U with respect to leisure of person 1;

U_{lhh_2} is the partial derivative of U with respect to leisure of person 2.

In a model with continuous hours of labour supply, these conditions would have had to be imposed a priori to guarantee coherency, as has been mentioned earlier. This would have complicated the maximum likelihood estimation. In the approach taken here, these two conditions can be tested at all data points after estimation of the parameters.

To account for differences in preferences between households, the parameters β, α and φ can be made dependent on some household characteristics. For the moment it is assumed that no unobserved heterogeneity is present in the preferences and only β_1 and β_2 depend on personal and household characteristics (see section II.2). Simple linear specifications are chosen.

Choosing an extreme value specification for the error term in (5) results in a multinomial logit model (see Maddala, 1983) where the relatively simple likelihood contribution looks as follows:

$$(9) \qquad L = \frac{\exp(U_{i'j'k'})}{\sum_{i,j,k}\exp(U_{ijk})}$$

where:

i indicates the labour market status of Person 1;

j indicates the labour market status of Person 2;

k indicates welfare participation. $k \in \{0,1\}$, where 0 stands for non-participation and 1 for participation in welfare.

U_{ijk} is the level of utility derived from the state where person 1 has labour market status i, person 2 has labour market status j and the household has welfare participation k.

Expression (9) denotes the probability that the utility in the observed situation is higher than the utility in any other situation. This specification is also chosen by Van Soest (1995), who successfully specified 36 different discrete points. In the 1986 analysis, seven labour supply points for each person are included. Labour supply of the two persons and welfare participation were represented by up to 98 different discrete points. This helps to represent eligible and nearly eligible households in an appropriate category, which is a close approximation to the observed labour supply and welfare participation.

Due to the independence of irrelevant alternatives assumption underlying the multinomial logit model, the error terms cannot be interpreted as reflecting random preferences, but only as random optimization errors. Random preferences can be incorporated in the model by adding random components to the preference parameters. For the 1986 data the added complexity seems too cumbersome given the data problems; therefore, these extensions of the model are left for future research on the 1994 data.

III.2. Unobserved Wages

Like other researchers in this area, we have to deal with unobserved market wages for people who are not working. The best way to deal with unobserved wages is to incorporate them into the likelihood function and estimate wages and labour supply simultaneously. However, this is computationally more difficult and it is not attempted often[8]. Because in the 1986 study additional complications played a role, the simplest solution was implemented then and is used here as well, for the moment. The wage equation is estimated separately and estimated wages are used as if they represented the true values of the unobserved wages[9]. The drawback of this approach is that it assumes labour supply to be linear in the logarithm of the wage rate and it ignores the simultaneity of wages and labour supply. In future research the error term of the wage equation might be included and integrated out of the likelihood to account for the often serious inaccuracy of the estimated wage rates. To correct for a possible selection bias as a result of only observing wage rates for workers the

8 Exceptions are, for example, Fraker and Moffitt (1988), Gerfin (1993) and Murray (1996).

9 Van Soest (1995) uses this approach and points out that most of the papers in a special issue on Taxation and Labor Supply in Industrial Countries of the Journal of Human Resources (Moffitt, 1990) follow this approach as well.

Heckman correction term for participation is included in the wage equation (Heckman, 1979).

Once all the parameters of the wage equation are estimated, estimated wage rates for the non-participants can be generated using the wage equation with the estimated correction term for the non-participants.

IV. Results from the Estimation of the Labour Supply Model

In this section, the focus is on the labour supply equation; the results from the participation and wage equations are presented in Appendix B. Labour supply and welfare participation are estimated using imputed wage values for the non-workers as described in the previous section.

For the estimation of the labour supply model an additional five and 16 records are lost for 1986 and 1994 respectively, because the observations on the household's welfare participation and their calculated eligibility are contradictory. The remaining data sets consist of 2275 and 1898 households respectively.

IV.1. Discussion of the Results

Table 2 gives the parameter estimates of the translog specification of the utility function for 1986 and 1994. The model has been estimated with seven labour supply points, even though in the 1986 study it was found that specifying the model with fewer points did not make much difference in calculated elasticities. The seven discrete points of labour supply that are distinguished are: 0 hours for non-participants, 5 hours for people working from 1 to 9 hours, 15 hours for people working from 10 to 19 hours, 25 hours for people working from 20 to 30 hours, 35 hours for people working from 30 to 39 hours, 45 hours for people working from 40 to 49 hours and 55 hours for people working more than 49 hours.

The effects of different characteristics on the preference for leisure of both adults in the household are the first results to be discussed. The results from both years are discussed simultaneously. They seem to be quite similar with respect to both the significance and direction of the effects.

To begin with the parameterized preference for leisure for the male adult, a significant negative effect[10] is found when the number of children in the household increases and when the age of the person increases. A negative effect is further observed in both years for households facing a higher mortgage and for households where the man has a higher level of education. In 1986, men whose spouse has a high education also had a lower preference for leisure. The only characteristic that seems to have a significant positive effect on the preference for leisure is age squared, which combined with the linear effect of age means that the preference for leisure decreases for men up to 31 years of age in 1986 and 39 years of age in 1994, after

10 This indicates a lower preference for leisure and thus a larger taste for work.

Table 2: Estimated Parameters of the Labour Supply Model

	1986-87			1994/95	
	Estimated coefficient	t-ratio		Estimated coefficient	t-ratio
β_x (income)	16.7588	4.92	β_x (income)	2.3816	0.54
β_1 (leisure person 1)			β_1 (leisure person 1)		
Constant	-2.3221	-0.43	Constant	6.2485	1.20
Number of children	-0.3915	-4.28	Number of children	-0.4466	-5.01
Age of youngest child			*Age of youngest child*		
			• 0	-0.3936	-1.24
• 0 - 5	0.1946	0.75	• 1- 5	0.2543	1.05
• 6 - 12	0.1568	0.57	• 6 - 11	0.0135	0.05
Age man/10	-1.8822	-2.80	Age man/10	-2.1354	-3.39
Age^2 man/100	0.3047	3.66	Age^2 man/100	0.2743	3.56
Mortgage/10 000	-0.1293	-2.85	Mortgage/10 000	-0.1119	-6.04
Education men (low)[c]			*Education men (no qual.)*		
			• basic vocational	0.0682	0.13
• medium	0.0763	0.42	• skilled vocational	-0.7155	-4.07
• high	-0.6696	-2.80	• diploma	-0.5577	-2.20
			• degree	-0.8177	-3.34
Education women (low)			*Education women(no qual.)*		
			• basic vocational	0.2340	0.79
• medium	-0.3571	-1.53	• skilled vocational	-0.1178	-0.50
• high	-0.6631	-3.41	• diploma	-0.0084	-0.03
			• degree	-0.2999	-1.18
β_2 (leisure person 2):			β_2 (leisure person 2):		
Constant	32.8757	5.36	Constant	15.7542	2.97
Number of children	0.3181	2.36	Number of children	0.5708	5.03
Age youngest child			*Age youngest child*		
			• 0	4.2108	8.44
• 0 - 5	4.8096	13.35	• 1- 5	2.4010	8.18
• 6 - 12	1.3497	4.01	• 6 - 11	-0.1157	-0.41
Age woman/10	-0.0653	-0.07	Age woman/10	-1.7920	-2.32
Age^2 woman/100	0.1290	1.11	Age^2 woman/100	0.3119	3.09
Mortgage/10 000	-0.1856	-3.83	Mortgage/10 000	-0.0496	-2.82
Education women(low)			*Education women(no qual.)*		
			• basic vocational	-0.8107	-2.55
• medium	-0.3214	-1.15	• skilled vocational	-0.4654	-1.79
• high	-0.6289	-2.75	• diploma	-0.6947	-2.50
			• degree	-1.6604	-6.39
Education man (low)			*Education man (no qual.)*		
			• basic vocational	0.2212	0.38
• medium	0.3298	1.44	• skilled vocational	-0.1335	-0.67
• high	0.7905	2.83	• diploma	0.2824	1.01
			• degree	0.3991	1.56
α_{xx}	1.8251	18.07	α_{xx}	0.6501	3.43
α_{11}	0.3516	1.09	α_{11}	-0.9441	-3.10
α_{22}	1.1509	3.16	α_{22}	-0.4078	-1.30
α_{1x}	0.2916	1.36	α_{1x}	0.2264	1.15
α_{2x}	-3.1508	-12.47	α_{2x}	-0.8071	-3.94
α_{12}	0.7815	3.68	α_{12}	0.4975	2.69
φ (stigma effect)	4.2928	16.42	φ (stigma effect)	0.6394	4.15

Table 2 (continued)

	1986-87		1994/95
Loglikelihood	-6518.36	Loglikelihood	-6208.53
Loglikelihood with only the constant	-6834.06	Loglikelihood with only the constant	-6480.52

[a] Seven discrete points of labour supply are distinguished for each person: 0 hours for non-participants, 5 hours for people working from 1 to 9 hours, 15 hours for people working from 10 to 19 hours, 25 hours for people working from 20 to 30 hours, 35 hours for people working from 30 to 40 hours, 45 hours for people working from 40 to 50 hours and 55 hours for people working more than 49 hours.

[b] Education levels are divided into: *low* for not finishing secondary school or not having any secondary qualifications, *medium* for finishing secondary school or having any secondary qualification/trade certificate and *high* for another certificate or diploma or for having a bachelor's degree or higher.

which it increases with age. Thus the age, where this minimum in the preference for leisure is achieved, has changed between 1986 and 1994.

As one would expect, the preference for leisure of the female adult seems to be much higher than that of her male partner, at least as far as this is reflected in the size of the constant term of β_2. A significant negative effect is observed for women in households with higher mortgage obligations and for women with higher education levels. However in 1994, women with only a basic vocational qualification seem to prefer leisure even less than other women who do not at least have a university degree. Surprizingly, age does not seem to have a significant influence on female preference for leisure in 1986, but in 1994 this has changed and a minimum preference for leisure is observed around 29 years of age.

All variables related to children have a significant positive effect on the preference for leisure, except for children between six and 11 years old in the 1994 model where its parameter is negative and insignificant. As one would expect, and as is seen in many other studies (Australian examples are Eyland, Mason and Lapsley, 1982 and Ross, 1986), having a child below five years of age has a large positive effect on the female preference for leisure. When the youngest child is between six and 12 years old a similar but much smaller effect is observed in 1986, but in 1994, this effect seems to have completely disappeared.

Further, in 1986 when the male partner holds a high education qualification, a positive effect on the leisure preference of the woman is observed as well. Comparative advantages in the labour market seem to influence the labour supply of females, as one would expect, so a higher education level of their partner increases their value for leisure. Rather the opposite effect can be observed for men. It seems strange that when women have a higher education and are thus more competitive on the labour market, their partners apparently value leisure time less. One would expect that with a decrease of the comparative advantage of women working in the household, men would prefer to work less and spend more time in the household or at least not to work more[11]. In the model of 1994, the parameters of a higher education

11 A possible explanation for the expected effect not being present might be that the group of men married to women with high education levels have characteristics which cause them to have lower preferences for leisure. More research and data would be necessary to find the underlying

level of the partner still have the same signs as in 1986, although the effects are no longer significant.

Besides the linear terms, there are also quadratic terms involved in the translog utility function. Taking the first derivative with respect to leisure time of Person 1, the following expression for the marginal utility of leisure for Person 1 is obtained:

$$U_1 = \frac{\beta_1 + 2\alpha_{11}\ln(lhh_1) + 2\alpha_{12}\ln(lhh_2) + 2\alpha_{1x}\ln(x)}{lhh_1}$$

Similar expressions can be formulated for the leisure time of Person 2 and for net income. From this formula and the results in Table 2 we can conclude that in both models Persons 1 and 2 seem to enjoy having leisure time together. If one of the two persons has more leisure time, the marginal utility of leisure of the other person also increases. There seems to be no significant effect of income on the marginal utility of leisure time of Person 1 or vice versa. Net income and leisure time for Person 2 seem to be exchangeable. More income means that the marginal utility for leisure of Person 2 is lower and more leisure means a lower marginal utility of income.

The last parameter in Table 2 is the stigma/cost parameter associated with receipt of welfare payments. The results indicate that there is a positive and significant effect. This means that participating in welfare lowers the utility level of the household. Welfare payments are not just 'free' income for which no work has to be done, but they have a negative side effect attached to them when received by a household. Thus, there is a threshold that people need to overcome before applying for unemployment benefits. The threshold is higher when this estimated parameter is higher. It does not mean that people will not apply for welfare, but it does indicate that applying for welfare is not as attractive as some people seem to think. These results lead one to expect some households not to take up the benefits for which they are eligible, especially when low amounts of benefits are involved[12] (as observed in the real world).

To explore the economic significance of the 'stigma' value found, utility levels for a reference household are calculated and the difference between several situations is compared with the estimated size of the 'stigma' effect (see Table 3). The reference household consists of a man and a woman, each aged 30 years, without children. Both persons have a lowest educational level and there is no outstanding mortgage. We examine household income levels around the maximum benefit level. Using the estimated parameters from the 1986 model it is found that an exogenous increase of $50 in non-labour weekly income, which raises total weekly income from $150 to $200 (before any resultant change in labour supply is taken into account), is insufficient to offset the disutility arising from participation in welfare; that is, to a first approximation, the stigma effect in monetary terms is not less than $50 per week

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reason for the correlation between the higher education level of women and the preference for leisure of their partners.

12 Duclos (1997) has estimated a welfare participation model based on the same idea. He assumes that people will only apply for benefits when the benefit entitlement outweighs the 'cost' of participation.

for the household in this example. The increase in income would only result in a rise in utility of about three units, whereas the stigma effect is -4.29 units.

Table 3: Utility Levels (Excluding the Stigma' Effect) for Some Typical Households[a]

1986-87 (for comparison: the estimated stigma effect is –4.29)			
Without children		**Two children, the youngest under five**	
Situation	Utility	Situation	Utility
x=150, h1=30, h2=0[b]	184.98	x=200, h1=30, h2=0	209.49
x=170, h1=30, h2=0	186.23	x=220, h1=30, h2=0	210.53
x=200, h1=30, h2=0	187.93	x=250, h1=30, h2=0	211.98
x=170, h1=0, h2=0	189.77	x=220, h1=0, h2=0	213.87
x=170, h1=0, h2=20	184.57	x=220, h1=0, h2=20	207.56
x=170, h1=20, h2=20	182.51	x=220, h1=20, h2=20	205.64
x=200, h1=0, h2=20	186.61	x=250, h1=0, h2=20	209.29
1994/95 (for comparison: the estimated stigma effect is –0.64)			
Without children		**Two children, the youngest between one and five**	
Situation	Utility	Situation	Utility
x=230, h1=30, h2=0	64.94	x=310, h1=30, h2=0	79.26
x=260, h1=30, h2=0	65.46	x=340, h1=30, h2=0	79.69
x=290, h1=30, h2=0	65.94	x=370, h1=30, h2=0	80.08
x=260, h1=0, h2=0	66.10	x=340, h1=0, h2=0	80.08
x=260, h1=0, h2=20	64.63	x=340, h1=0, h2=20	77.72
x=260, h1=20, h2=20	64.37	x=340, h1=20, h2=20	77.61
x=290, h1=0, h2=20	65.18	x=370, h1=0, h2=20	78.17

[a] The typical household consists of a man and a woman of 30 years of age. Both persons have the lowest education level and there is no outstanding mortgage.

[b] x stands for net household income, h1 represents the hours worked by the man and h2 represents the hours worked by the woman.

Examining the 1994 model, it is found that an exogenous increase of $60 in non-labour weekly income, which raises total weekly income from $230 to $290, is sufficient to offset the disutility arising from participation in welfare. The stigma effect estimated in 1994 is lower than the stigma effect estimated in 1986. However, a $30 increase in income to $260 would not be sufficient. The increase in income would only result in a rise in utility of about 0.52 units compared to –0.64 units for the stigma effect.

If the male partner can earn $170 per week by working 30 hours in 1986, this would be preferred over not working and receiving the same amount in benefits. The female preference for leisure is much higher: according to the model, she would

decline to work 20 hours unless more money could be earned than by participation in welfare. An additional $30 per week, however, would make working preferable over not working and being on welfare. Having children makes working an even less attractive option for women, while for men not much seems changed.

In 1994, $260 per week earned through 30 hours of work by the male partner would result in the same utility level as not working and receiving the same amountin benefits. Like in the 1986 model, the female preference for leisure is much higher than the male preference for leisure. In 1994 it is even higher than in 1986 since an additional $30 per week would still not make working preferable over not working and being on welfare. Having children makes working an even less attractive option for women, while for men not much seems changed in 1986, whereas in 1994 male preferences for leisure seem to increase somewhat if they have children.

From this example, it is clear that the size of the stigma parameter is relevant in terms of changing the preferred options. On several occasions, the difference in utility levels between the different options open to the household is smaller than the size of the stigma parameter. This means that adding the stigma term can change preferences from being on welfare to not being on welfare.

Similar significant results have also been found in other studies. In Hoynes (1996), a significant stigma effect of participation in welfare on the utility level of two-adult households in the US can also be seen. In the same study, in an alternative specification, the stigma parameter has been made dependent on personal characteristics. However, none of these variables is estimated to have a significant effect. Moffitt (1983) found a strongly significant stigma effect for female heads in the US. He also analysed the relation between the amount of benefits received and this effect and found no significant relationship. This seems to indicate that welfare recipience per se has a negative effect on utility, which is invariant with respect to the amount received. Hagstrom (1996) estimates labour supply and welfare (food stamp) participation jointly for married couples, also in the US. He does not have an explicit stigma parameter, but there is evidence of several variables that have a negative effect on welfare participation. Assets and other income decrease welfare participation, which Hagstrom explains by the positive relationship of assets with the stigma of receiving food stamps. Smith (1997), however, estimates a non-significant stigma coefficient. Compared to the other articles, the percentage of people participating in the welfare programme is relatively high in his data. This might be partly explained by the fact that his US data consist of lone mothers only. The stigma or costs involved with welfare might be of less importance to them because they have children to care for and working might just not be an option for them. Bingley and Walker (1997) investigate the 'stigma' effect of an in-work benefit, Family Credit, rather than the out-of-work benefits for lone mothers in the UK. They find that the average utility loss from Family Credit participation is equivalent to the utility loss associated with a reduction in income of £5.91 per week (compared to average Family Credit benefits of £25 per week).

The translog utility function is not automatically quasi-concave. Therefore, one needs to check for it after estimation in the way that is explained in Section III.1. It is

found that the first condition is fulfilled for both specifications in 100 per cent of the cases in both years. The second condition is fulfilled for 97.63 per cent of the cases in 1986 and 99.16 per cent in 1994. From the above results, it can be concluded that the utility function is quasi-concave in a vast majority of the cases.

IV.2. Uncompensated Wage Elasticities

One way of illustrating the implications of the results found here, is to calculate elasticities. Ninety per cent confidence intervals are calculated for each elasticity of interest by using simulation techniques. Parameter values for our labour supply model are drawn from a multivariate normal distribution with the vector containing our point estimates as its mean and the variance-covariance matrix of the parameter estimates as its variance. We draw 1000 independent sets of parameter values and calculate the implied elasticities. The width of the resulting range of elasticity values indicates how accurate the elasticities are that can be calculated from the model. Own-wage and cross-wage elasticities are calculated for both Persons 1 and 2 in six different typical households. The typical households studied are couples without children and with two children (where the youngest is under five years in 1986 or between one and five years in 1994) on three different wage rate levels (low, average and high). A low wage here means Person 1 has a gross wage rate of $6 per hour and Person 2 has a gross wage rate of $5 per hour. Average wage rates of respectively $11.26 and $9.75 per hour have been used[13]. 'High' wages here are $17 for Person 1 and $15 for Person 2. The wage rates used in 1994 are about one third higher, since the wage index has increased by about 33 per cent from 1986 to 1994. The results are reported in Tables 4 (1986) and 5 (1994).

From the tables, it can be seen that the expected number of working hours is somewhat higher in 1994 than in 1986. This is in line with the observed actual labour supply in the samples from 1986 and 1994.

It is clear from Table 4 that the own-wage and cross-wage elasticities at low wage levels are in most instances higher in absolute terms than in the cases with higher wages. It iinteresting to note that for low wage rates (and low hours) male elasticities are also high, which is an unusual finding. A similar observation can be done in Table 5, although the elasticities are much lower in 1994 than in 1986. Fraker and Moffitt (1988) find that own-wage elasticities for female heads of households decrease with an increase in the wage rates. Thus, the above high wage elasticities for males earning lower wage rates seem to be similar to what they find for female heads. In 1994, men with children seem to be less affected by this drop in the elasticity levels.

In the lower wage households, the cross wage elasticities are also positive for both years, which is unusual. However, one can imagine that households on low income are

13 These were the average wages in November 1986, as reported in the *Yearbook Australia 1988* (ABS, 1989: 323).

Table 4: Labour Supply and Welfare Participation Elasticities[a] in 1986/87

	lab. supply elasticity person 1			lab. supply elasticity person 2			Welfare part. elasticity		
	Q50[b]	**Q5**	**Q95**	**Q50**	**Q5**	**Q95**	**Q50**	**Q5**	**Q95**
Low wage family[c] no children									
		E(h1)[d] = 37.87			E(h2) = 11.43			E(dW) = 0.10	
Wage1	0.831	0.611	1.122	0.404	0.207	0.662	-6.841	-7.344	-6.331
Wage2	0.106	0.047	0.177	2.320	2.174	2.465	-1.982	-2.276	-1.721
Low wage family, two children, where the youngest is between 0 and 5 years old									
		E(h1) = 26.76			E(h2) = 3.08			E(dW) = 0.44	
Wage1	2.688	2.151	3.234	1.506	1.227	1.756	-4.412	-5.101	-3.734
Wage2	0.212	0.161	0.266	1.634	1.494	1.763	-0.425	-0.502	-0.355
Average wage family[e] No children									
		E(h1) = 41.64			E(h2) = 33.78			E(dW) = 5.04 10^{-5}	
Wage1	0.173	0.152	0.193	-0.046	-0.103	0.005	-7.448	-7.842	-7.056
Wage2	-0.118	-0.143	-0.094	0.836	0.710	0.963	-5.815	-6.300	-5.361
Average wage family, two children, where the youngest is between 0 and 5 years old									
		E(h1) = 42.53			E(h2) = 13.09			E(dW) = 1.87 10^{-3}	
Wage1	0.148	0.125	0.169	-0.370	-0.452	-0.280	-7.789	-8.214	-7.363
Wage2	-0.087	-0.107	-0.068	2.034	1.929	2.134	-2.585	-2.946	-2.279
High wage family[f] no children									
		E(h1) = 41.24			E(h2) = 42.44			E(dW) = 1.13 10^{-7}	
Wage1	0.120	0.105	0.135	0.015	-0.013	0.038	-7.249	-7.686	-6.852
Wage2	-0.106	-0.127	-0.083	0.346	0.299	0.395	-6.256	-6.718	-5.815
High wage family, two children, where the youngest is between 0 and 5 years old									
		E(h1) = 41.65			E(h2) = 22.48			E(dW) = 1.24 10^{-5}	
Wage1	0.091	0.074	0.110	-0.230	-0.297	-0.167	-7.390	-7.779	-7.047
Wage2	-0.117	-0.140	-0.093	0.961	0.877	1.049	-4.196	-4.599	-3.816

[a] All elasticities are calculated for a typical household with the following characteristics: both adults are 35 years old, have a medium level education and do not have a mortgage. Other non-labour income is 10 dollars per week for both persons.

[b] Q50 indicates the median value of the elasticity, Q5 indicates the fifth percentile and Q95 indicates the ninety-fifth percentile.

[c] Person 1 has a wage rate of $6 per hour and Person 2 has a wage rate of $5 per hour.

[d] E(h1) indicates the expected value of hours worked by Person 1 for the typical household. Similar expressions are used for the hours worked by Person 2 and the probability of welfare participation.

[e] Person 1 has a wage rate of $11.26 per hour and Person 2 has a wage rate of $9.75 per hour.

[f] Person 1 has a wage rate of $17 per hour and Person 2 has a wage rate of $15 per hour.

highly likely to be eligible for unemployment benefits. This implies that the marginal tax rate can drop considerably with an increase of family income above the level where benefits are still payable. This drop could encourage someone to increase working hours when the gross wage rate of the partner increases, since it would result in an increase in his or her own net wage rate.

Table 5: Labour Supply and Welfare Participation Elasticities[a] in 1994/95

	lab. supply elasticity person 1			lab. supply elasticity person 2			Welfare part. elasticity		
	Q50[b]	**Q5**	**Q95**	**Q50**	**Q5**	**Q95**	**Q50**	**Q5**	**Q95**
Low wage family[c] no children									
	E(h1)d = 39.06			E(h2) = 24.11			E(dW) = 0.14		
Wage1	0.319	0.203	0.475	0.168	0.072	0.286	-2.436	-2.727	-2.157
Wage2	0.088	0.040	0.151	0.734	0.604	0.864	-1.433	-1.670	-1.217
Low wage family, two children, where the youngest is between 1 and 5 years old									
	E(h1) = 33.52			E(h2) = 7.08			E(dW) = 0.35		
Wage1	0.241	0.148	0.352	0.184	0.129	0.246	-1.242	-1.404	-1.082
Wage2	0.010	0.001	0.022	0.495	0.438	0.560	-0.180	-0.219	-0.148
Average wage family[e] No children									
	E(h1) = 43.22			E(h2) = 34.36			E(dW) = 4.32 10^{-3}		
Wage1	0.077	0.049	0.109	-0.082	-0.137	-0.033	-3.045	-3.361	-2.724
Wage2	-0.075	-0.100	-0.054	0.386	0.312	0.465	-2.189	-2.479	-1.925
Average wage family, two children, where the youngest is between 1 and 5 years old									
	E(h1) = 42.82			E(h2) = 14.99			E(dW) = 3.85 10^{-2}		
Wage1	0.205	0.147	0.276	0.009	-0.075	0.096	-3.015	-3.362	-2.665
Wage2	0.008	-0.006	0.024	0.811	0.726	0.897	-1.066	-1.242	-0.907
High wage family[f] no children									
	E(h1) = 43.24			E(h2) = 38.47			E(dW) = 2.27 10^{-4}		
Wage1	0.088	0.068	0.111	-0.065	-0.113	-0.026	-3.004	-3.343	-2.669
Wage2	-0.089	-0.120	-0.064	0.261	0.210	0.320	-2.570	-2.902	-2.260
High wage family, two children, where the youngest is between 1 and 5 years old									
	E(h1) = 44.99			E(h2) = 20.20			E(dW) = 3.38 10^{-3}		
Wage1	0.080	0.059	0.104	-0.212	-0.290	-0.137	-3.292	-3.670	-2.916
Wage2	-0.050	-0.069	-0.034	0.697	0.627	0.768	-1.481	-1.743	-1.250

a All elasticities are calculated for a typical household with the following characteristics: both adults are 35 years old, have a skilled vocational qualification and do not have a mortgage. Other non-labour income is 10 dollars per week for both persons.

b Q50 indicates the median value of the elasticity, Q5 indicates the fifth percentile and Q95 indicates the ninety-fifth percentile.

c Person 1 has a wage rate of $8 per hour and Person 2 has a wage rate of $6.67 per hour.

d E(h1) indicates the expected value of hours worked by Person 1 for the typical household. Similar expressions are used for the hours worked by Person 2 and the probability of welfare participation.

e Person 1 has a wage rate of $15 per hour and Person 2 has a wage rate of $13 per hour.

f Person 1 has a wage rate of $22.67 per hour and Person 2 has a wage rate of $20 per hour.

The elasticity values for average and high wage rates in Tables 4 and 5 are similar to those found in the literature. In most other research, elasticities are calculated for average persons or households. Values range from negative values (Blundell, 1997) to Killingsworth (1983: 119-25), it can be seen that the variation found in different studies is even larger. Here, the own-wage elasticities are much lower than for the low-wage earners and cross-wage elasticities are mostly negative, except for women in households without children, where the cross-wage elasticity is virtually zero for average- and high-wage earners.

Female own-wage and cross-wage elasticities tend to be higher than the male elasticities[14]. This can however be partly explained by the fact that women work fewer hours. When the expected number of working hours (E(h2)) are examined, it can be seen that the expected hours increase with the wage rates, especially for women. This is what one would expect given the values for own-wage elasticities. For women with children the own wage elasticity increases from low to average wages and decreases again from average to high wages. In 1994, this might be caused by the home child care allowance which provides all carers of dependent children (mostly women) with a basic allowance of $30 per week irrespective of their partners' income. The allowance is withdrawn at a rate of 25 per cent for individual income over $5.43 per week. This might be a disincentive for women on low wages in particular to work more hours. In 1986, there was a dependent spouse with children rebate, which was paid out to the partner in the form of lower taxes.

Households with and without dependent children can also be compared. Female labour supply drops dramatically with the presence of children. This is in line with the parameter estimates of the labour supply model in Table 2 and with results from other research. In the households with the higher wages, men seem to increase their labour supply slightly when children are present. Men with low wages however, seem to have much lower working hours and households participate more often in welfare when children are present, especially in 1986. When looking at the low-wage households[15] in 1986 with two or more children in the data set, we observe that about 31 per cent (33 out of 107) are participating in welfare, which is high compared to the rest of the population. Thus, the results found in Table 4 seem to be confirmed by the data. However, one should realize that the wages of people on welfare are not actually observed but are imputed values using estimated wage equations.

Alternatively, the lower predicted hours of work might be partly caused by the fact that Family Income Supplementation[16] (FIS) is not included in the 1986 model. FIS was a scheme that allowed people on low incomes to apply for additional family support of $17 per child per week. The same amount was also available to people with children on unemployment benefits as an additional benefit. Our model could be extended by an additional choice to apply for FIS. The choices for FIS and for welfare participation are interdependent. Households can choose for one of the two welfare schemes or they can choose to participate in neither. By not including FIS in the model, families with children appear to have more to lose when not participating in welfare than childless families, resulting in the lower expected labour supply of men to remain eligible for welfare. However, the number of households actually receiving FIS payments in the 1986 data set is very low, as are most of the amounts paid. Whiteford and Doyle (1991) also found that take-up of FIS was very low. In addition, the quality of the information seems poor, since in some cases FIS is stated

14 This is also commonly found in other studies. See, for example, Wales and Woodland (1976, 1977), Killingsworth (1983), Van Soest (1995), Hagstrom (1996), Hoynes (1996) and Blundell (1997).

15 These are defined as the households where both adults have a wage rate of less than seven dollars per hour.

16 FIS was the predecessor of the current higher rate of Family Payment.

to be paid to relatively high-income households. We decided to leave the choice for participation in FIS out of the model for the moment[17], as it would also complicate estimation.

The elasticity of welfare participation has the expected sign in all cases. It is clear that it is much more responsive to male than female wage rates in the cases where women only work few hours. An increase of the woman's wage rate in these instances has little impact on the decision on welfare participation, since her additional income contribution is only small. Therefore, the increase might not be sufficient to become independent of welfare. It is also obvious from the table that families with adults on low market wages are more likely to participate in welfare than others are. For households with the highest wage rates, the expected welfare participation is extremely low.

IV.3. Policy Simulations

The final analysis in this study compares the actually observed levels of labour supply and welfare participation to those predicted by the models (see Table 6). Households are predicted to be in that category of labour supply and welfare participation, for which the estimated probability is higher than the probability of being in any of the other categories. For men, the 40 to 49 hours category is heavily overpredicted and there are too many part-time workers in the lowest hours categories (1 to 29 hours) in 1986. Many other models have also had this problem of overprediction of part-time hours. Van Soest (1995) suggests that this may be caused by not taking into account the fact that the demand for part-time workers is low, so there are restrictions in the offered hours of work. In 1986, the overprediction is not extreme for either men or women.

In the 1994 model, the category over 49 hours is heavily overpredicted, while all other categories are underpredicted. On the other hand, the estimated mean hours worked gives a somewhat better result. Obviously, the predicted probability of working in one of the low-hours categories is too small to be the maximum probability sufficiently often to match the data, even for those who are more likely to work fewer hours. The introduction of an employment equation to account for involuntary unemployment may help to correctly predict worked hours[18], since it would introduce the influences of the demand side of the labour market. It should also provide a better estimate of potential labour supply without demand side effects entangled within it.

According to Table 6, in both years women are too often categorized as non-participants, low hours part-time workers and as working over 50 hours (although the discrepancy is modest in the first two cases).

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17 We actually decided to leave income from FIS out of the model altogether, as take-up was so low.

18 See for example, Laisney, Lechner, Van Soest and Wagenhals (1992), Bingley and Walker (1997) or Duncan, Giles and MacCrae (1999).

Table 6: Actual and Simulated Labour Supply of Men and Women in our Data Set

1986-87								
	Men				Women			
Hours	Actual	Sim.	Sim.1[a]	Sim.2[b]	Actual	Sim.	Sim. 1	Sim. 2
Non-welfare participants								
0	87	9	7	9	982	1172	1131	1176
1 - 9	5	11	13	11	91	64	54	60
10 - 19	5	25	21	26	196	199	203	205
20 - 29	22	29	28	29	174	244	237	240
30 - 39	636	270	266	270	380	207	204	208
40 - 49	967	1686	1631	1684	309	144	138	138
≥ 50	444	139	143	138	34	139	142	142
Welfare participants								
0	104	1	3	1	102	106	166	108
1 – 9	2	104	161	106	3	0	0	0
10 - 19	1	1	2	1	1	0	0	0
20 - 29	1	0	0	0	1	0	0	0
30 - 39	1	0	0	0	1	0	0	0
40 - 49	0	0	0	0	1	0	0	0
≥ 50	0	0	0	0	0	0	0	0

1994/95								
	Men				Women			
Hours	Actual	Sim.	Sim.1[a]	Sim.2[b]	Actual	Sim.	Sim. 1	Sim. 2
Non-welfare participants								
0	75	1	1	1	605	770	764	773
1 - 9	7	0	0	0	58	96	95	96
10 - 19	8	0	0	0	158	101	100	101
20 - 29	23	8	8	8	218	302	301	302
30 - 39	415	188	184	188	371	298	298	299
40 - 49	714	633	629	635	287	161	161	161
≥ 50	539	1057	1056	1059	84	159	159	159
Welfare participants								
0	108	0	0	0	106	9	17	6
1 – 9	5	0	4	0	5	2	3	1
10 - 19	1	8	14	6	3	0	0	0
20 - 29	2	2	1	1	3	0	0	0
30 - 39	0	1	1	0	0	0	0	0
40 - 49	1	0	0	0	0	0	0	0
≥ 50	0	0	0	0	0	0	0	0

[a] Simulation with a 10 per cent increase in the unemployment benefit level.
[b] Simulation with a 10 percentage point decrease (from 100 per cent to 90 per cent) in the highest deduction rate of earned income from benefits.

The number of welfare participants predicted in the simulation and the actual number of welfare participants are similar in 1986. There is, however, a striking difference between the

simulated and the actual hours worked by men in households on welfare. Looking at our model and at the unemployment benefits rules this might not be so surprizing as thought at first sight. At zero or low hours of labour supply, people normally have lower preferences for leisure and the first $30 of income does not have any impact on benefit payments. The next $40 is deducted from the benefits at a rate of 50 per cent and after that any additional earnings are deducted on a dollar for dollar basis. Given that one participates in welfare, working a low number of hours is likely to be optimal, since the marginal preference for leisure and the marginal tax rate are likely to be low at that level of labour supply. After the first few hours the deduction rate in the benefit scheme increases to 100 per cent, so working more hours then becomes a less attractive alternative. In reality, jobs with low hours are scarce, so households (especially their male adult members) might be restricted in their labour supply and not be able to work at all.

Table 6 also shows that the predicted number of welfare participants in 1994 is much too low. This is related to the severe overprediction of male working hours. Introduction of an employment equation to account for involuntary unemployment will hopefully improve both the male labour supply prediction and the predicted household's welfare participation.

From these simulations, we have calculated the expected welfare participation to be equal to 5.4 per cent in 1986 and 6.2 per cent in 1994; the expected hours worked by Person 1 is 40.18 hours in 1986 and 40.79 hours in 1994 and the expected hours worked by Person 2 is 16.41 hours in 1986 and 20.56 hours in 1994. After simulating an increase in the maximum benefit level by 10 per cent, the expected values are respectively: 7.5 and 8.2 per cent, 39.50 and 40.23 hours and 16.28 and 20.36 hours. A decrease in the highest withdrawal rate for earned income by 10 percentage points from 100 per cent to 90 per cent produces expected values of: 5.7 and 7.1 per cent, 40.14 and 40.61 hours and 16.40 and 20.48 hours.

The 10 percentage point decrease in deduction rates does not seem to have much effect on labour supply. These results are similar to those of Moffitt (1983), Fraker and Moffitt (1988), Hoynes (1996), Hagstrom (1996) and Keane and Moffitt (1996). A 10 per cent increase in the benefit level has more effect, although still not a very large one. Moffitt (1983), Fraker and Moffitt (1988), Hoynes (1996) and Hagstrom (1996) find larger effects for this change as well. Comparing their results to those of the present study is hard since the percentage change in the benefit level is different for all the studies cited. The population which Moffitt (1983), Fraker and Moffitt (1988), and Keane and Moffitt (1996) used in their studies is different from our population as well, so that the welfare participation rates in their samples are much higher than those in our sample. Hoynes (1996) and Hagstrom (1996) have a reasonably comparable sample of two-adult households with only slightly higher participation rates in welfare. Overall, it can be concluded that the model estimated here seems to dictate similar behaviour patterns with respect to changes in deduction rates and maximum benefit levels as the models estimated in the above articles.

V. CONCLUSION AND FURTHER WORK

In this paper we estimated a simultaneous labour supply and welfare participation model with Australian data (Income Distribution Survey 1986 and Survey of Income and Housing Costs 1994-95) allowing for a direct negative effect from welfare participation on the utility level. Welfare participation choice is an important issue when one is interested in the effect of changes in welfare payments.

The labour supply estimates are mostly consistent with the existing literature and so are the estimated elasticities. The elasticities in 1986 are larger than those in 1994, but the patterns in both years are similar. The additional parameter to measure disutility from welfare participation together with the introduction of the welfare participation choice into the model means that the model allows for households who are eligible for welfare, but are not taking up their benefits. It is found that this parameter is significant in both a statistical and an economic sense. The effect seems somewhat larger in 1986 than in 1994.

Using the estimated model to simulate policy changes can give some insight into the implications of the model. From the simulations performed in this study, it can be seen that neither changing the benefit level nor a change in the withdrawal rate of the benefits seem to have a large effect on labour supply in either year. These results are similar to the results found using US data.

From the samples in both years (see figures 1a and 1b or table 1), it can be observed that working hours have increased for women and, to a smaller extent, for men as well. Both men and women seem more likely to work more than 49 hours per week and women are much less likely to be non-working in 1994, although men are slightly more likely to be non-working in 1994 than they were in 1986. The latter is possibly caused by the somewhat higher unemployment rate in 1994 as compared to 1986. This overall increase in working hours is also reflected in the expected number of working hours estimated by the models. From tables 4 and 5, it can be seen that the increase in expected number of working hours has occurred across the board, for low to high wage earners, for men and women, and for people with and without children. The only exception are high-wage women without children, who have a lower number of expected working hours in 1994 than in 1986.

For women, the increase in expected hours can be explained by the fact that values are gradually changing over time. An increasing number of people are no longer expecting women to be full-time housewives and/or mothers. Consequently, more women participate in the labour market now than they did before. In addition to the higher participation rate, the proportion of women working longer hours, and in particular women working more than 45 hours per week, has increased as well. The reason why men would work longer hours in 1994 than in 1986 is less clear. In this period, tax rates have fallen substantially for all income ranges, which could have stimulated labour supply. In addition, people on unemployment benefits were allowed to keep a larger part of their earned income without a reduction in benefit payments in 1994 than in 1986. This might have had an effect on low-wage earners. Both possibilities have been simulated with the 1994 model (see Table 7).

A reduction in the tax rates by ten percent would increase expected male labour supply by 1.1 per cent (from 40.78 to 41.24 hours) and expected female labour supply by 2.1 per cent (from 20.56 to 21.00 hours). The observed increase in male labour supply from 1986 to 1994 is about 1.5 percent and for women about 25 per cent. So for men, the modest increase may at least partly be explained by the decrease in tax rate, but the expected increase in female labour supply falls short of the observed increase. This indicates that there has been another, more important, change in behaviour perhaps caused by a change in values as explained in the previous paragraph.

Table 7: Actual and Simulated Labour Supply of Men and Women in our Data Set

	1994/95							
	Men				Women			
Hours	Actual	Sim.	Sim.1[a]	Sim.2[b]	Actual	Sim.	Sim. 1	Sim. 2
Non-welfare participants								
0	75	1	0	1	605	770	770	768
1 - 9	7	0	1	0	58	96	88	95
10 - 19	8	0	0	0	158	101	87	101
20 - 29	23	8	8	8	218	302	287	302
30 - 39	415	188	171	187	371	298	295	298
40 - 49	714	633	584	631	287	161	178	161
≥ 50	539	1057	1124	1057	84	159	183	159
Welfare participants								
0	108	0	0	0	106	9	8	11
1 – 9	5	0	0	1	5	2	2	3
10 - 19	1	8	7	11	3	0	0	0
20 - 29	2	2	2	1	3	0	0	0
30 - 39	0	1	1	1	0	0	0	0
40 - 49	1	0	0	0	0	0	0	0
≥ 50	0	0	0	0	0	0	0	0

[a] Simulation with a 10 per cent decrease in the tax rates.

[b] Simulation with an increase (from 30 to 40 dollars per week) in the free income range for benefit recipients.

The simulation of an increase from 30 to 40 dollars per week in the available free income for benefit recipients only shows a quite small negative effect on labour supply. Female labour supply decreased by 0.04 hours (0.2 per cent) and male labour supply decreased by 0.08 hours (0.2 per cent) only.

The most striking changes in the effect that characteristics have on the preference for leisure are observed for women. First, the presence of a youngest child whose age exceeds six years does not affect the leisure preference of women in 1994, whereas it increased female leisure preference in 1986. Second, one of the lower

educational levels (basic vocational) has a comparatively strong negative effect on the preference for leisure in 1994 and third, age seems to matter whereas it did not in 1986. Data from a later year could be used to check whether these changes remain (and perhaps become more pronounced) or whether they are only observed in this particular data set.

The 1994 data seems suitable to use in a more realistic and sophisticated model. First, the introduction of an employment equation in the model will account for involuntary unemployment. For non-working respondents in the Survey of Income and Housing Costs 1994-95 it is known whether they were looking for part-time employment, looking for full-time employment or not looking for employment. This identifies those who are out of the labour force and those who are unemployed. It also gives an indication of desired labour supply.

Second, the multinomial logit is computationally convenient, but has the potential disadvantage that the error terms in the model can only be interpreted as optimization errors and do not reflect random preferences. An extension of the model, to allow for unobserved heterogeneity in some of the parameters, could deal with this.

Third, the wage equation and labour supply equation could be estimated simultaneously, integrating out unobserved wages, thus taking the wage prediction uncertainty into account.

Finally, the choice to apply for Home Child Care Allowance and the choice for Additional Family Payments could be endogenized.

Appendix A: TAX AND BENEFIT RULES 1986/87 AND 1994/95

Since only couples with or without children are part of this study, the overview is restricted to this group.

Unemployment Benefits 1986/87[19]:

Maximum rate for couples	$177.10 per week
per additional child	$17.00 per week (no tax)
Income test: free area (0 % reduction)	$0.00-$30.00 per week
50 % reduction of benefit	$30.00-$70.00 per week
100 % reduction of benefit	more than $70.00 per week

Job Search Allowance and Newstart Allowance 1994/95[20]

Maximum rate for couples with children	$132.65 per week per person
Maximum rate for couples without children:	
Per person over 20 years of age	$132.65 per week
Per person between 18 and 20 years of age	$120.75 per week
Per person younger than 18 years of age	$109.20 per week
Income test: free area (0 % reduction)	$0.00-$30.00 per week per couple
50 % reduction of benefit	$30.00-$70.00 per week per couple
100 % reduction of benefit	more than $70.00 per week per couple
Extra free area for earnings per person	$25.00 per week per person

Family Allowance (1986/87)

For families with children younger than 16 years old, or children of 16 or 17 years old, who are dependent students, or children of 18 to 24 years old, who are from disadvantaged families.

Rate: 1 child	$ 5.25 per week
2 children	$12.74 per week
3 children	$21.71 per week
4 children	$30.69 per week
each additional child	+ $10.48 per week

There is neither tax nor an income test on family allowance.

Basic Family Payment (1994/95)

For families with children younger than 16 years old, or children of 16 or 17 years old, who are dependent students, or children of 18 to 24 years old, who are from disadvantaged families.
Not paid if annual income is over $60,000 for a household with one dependent child.
For each additional child an extra $3000 per year may be earned.
Rate:

1 child	$10.65 per week
2 children	$21.30 per week
3 children	$31.95 per week

19 The details of the benefits are taken from the annual report of the Department of Social Security (1986). The rules, described here, are as they were at 30 June 1986.

20 Information on several allowances and rebates in 1994/1995 was obtained from a spreadsheet developed by Gerry Redmond, Social Policy Research Centre, University of New South Wales.

4 children	$46.15 per week
each additional child	+ $14.20 per week

There is no tax on the basic family payment.

Family Income Supplement (1986-87)

Not available for beneficiaries or pensioners, who have additional child support integrated in their benefit or pension.

Maximum rate	$17.00 per week per child (no tax)
Income test: free area	$0.00-$241 per week
50 % reduction	more than $241.00 per week

Additional Family Payment (1994/95)

Maximum rate	
For children under 13 years of age	$32.10 per week per child (no tax)
For children between13 and 15 years of age	$45.30 per week per child (no tax)
For children over 15 years of age	$17.00 per week per child (no tax)
Income test: free area	$0.00-($409.45+$11.97*number of dependent children) per week
50 % reduction	more than ($409.45+$11.97*number of dependent children) per week

No tax payable.

Tax Rates 1986-87[21]

Tax free area	$0.00-$93.79 per week
24.42 %	$93.80-$239.74 per week
26.50 %	$239.75-$241.66 per week
29.42 %	$241.67- $373.99 per week
44.25 %	$374.00-$537.02 per week
46.83 %	$537.03-$671.27 per week
57.08%	more than $671.27 per week

Tax Rates 1994/95

Tax free area	$0.00-$103.56 per week
20 %	$103.57-$396.99 per week
34 %	$397.00-$728.77 per week
43 %	$728.78- $958.90 per week
47 %	more than $958.90 per week

Tax Rebates 1986-87

For a dependent spouse with children:

Maximum rate	$19.75 per week (on taxable income of main earner)
Income test: free area	spouse earns less than $34.25 per week
25 % reduction	spouse earns more than $34.25 per week

For a dependent spouse without children:

Maximum rate	$15.92 per week (on taxable income of main earner)
Income test: free area	spouse earns less than $5.41 per week

21 The taxation rules as described here are taken from the Taxation Statistics of 1986/1987 published by the Australian Taxation Office (1989).

25 % reduction	spouse earns more than $5.41 per week
For beneficiaries:	
Maximum rate	$5.37 per week
Income test: free area	income of couple is less than $180.97 per week
12.5 % reduction	income of couple is more than $180.97 per week

Tax Rebates 1994/95

For a dependent spouse with children:

Home child care allowance (instead of previous tax rebate)	
Maximum rate	$30.00 per week
Income test: free area	spouse earns less than $5.43 per week
25 % reduction	spouse earns more than $5.43 per week
No tax payable.	

For a dependent spouse without children:

Maximum rate	$23.22 per week (on taxable income of main earner)
Income test: free area	spouse earns less than $5.41 per week
25 % reduction	spouse earns more than $5.41 per week
For beneficiaries:	
Maximum rate	$5.37 per week
Income test: free area	income of couple is less than $180.97 per week
12.5 % reduction	income of couple is more than $180.97 per week

For low-income earners (individual assessment)

Maximum rate	$2.88 per week
Income test: free area	individual earns less than $5.41 per week
4% reduction	individual earns more than $5.41 per week

Medicare Rates 1986-87

Levy rate	1%
Free area	$239.82 + (number of children) * $29.34

Medicare Rates 1994/95

Levy rate	1.4%
Free area	$409.76 + (number of children) * $40.27
Phase-in percentage	20%

Appendix B: TABLES OF THE PARTICIPATION AND WAGE EQUATIONS

Table B.1: A Probit Model of the Labour Force Participation of Men and Women (1986/87)

	Men		Women	
	Parameter	t-ratio	Parameter	t-ratio
Constant	-2.6359	-3.36	-2.1603	-3.47
Number of children (no children)				
• number = 1-2	-0.2357	-1.32	-0.0544	-0.40
• number > 2	-0.4626	-2.06	0.0722	0.43
Age of youngest child (no/older children)				
• youngest child 0-4	0.1843	0.97	-0.5972	-4.50
• youngest child 5-12	0.1443	0.73	-0.2354	-1.77
ln(outstanding mortgage)	0.0058	0.52	0.0081	1.11
ln(other non-labour income)	-0.0876	-3.15	-0.0442	-2.10
ln(wage income of partner)	0.0583	2.88	0.0569	2.88
State (New South Wales)				
• Victoria	-0.1580	-1.02	-0.1512	-1.45
• Queensland	-0.0042	-0.03	-0.1805	-1.64
• South Australia	-0.2461	-1.46	-0.0040	-0.03
• West Australia	-0.1009	-0.60	-0.0958	-0.83
• Tasmania	0.2622	1.11	-0.1912	-1.28
• Territories	-0.2764	1.05	0.0946	0.53
Age/100	8.6852	2.22	6.8545	2.05
$(Age/100)^2$	-11.557	-2.46	-11.143	-2.54
Ethnicity (dummy variable)	0.7241	2.61	0.3354	1.94
Work experience previous year in weeks	0.0550	18.69	0.0470	28.31
Education (no school/ left before 14)				
• left school at age 14 or 15	0.1303	0.60	0.0932	0.46
• left school older than 15	0.4260	1.74	0.1762	0.83
• secondary school/qualification	0.4225	1.69	0.1449	0.65
• trade certificate (no field)	0.0769	0.23	-0.3357	-0.80
• trade certificate (technical)	0.2739	1.25	0.2535	0.94
• trade certificate (miscellaneous)	0.2435	0.77	[a]	
• other certificate./diploma (business,commerce)	0.5905	1.86	0.1905	0.86
• other certificate/diploma (social sciences, arts)	[a]		-0.1535	-0.40
• other certificate/diploma (education)	0.5805	1.02	0.6008	2.35
• other certificate/diploma (medical)	0.8673	2.50	0.3088	1.32
• other certificate/diploma (technology)	[a]		0.2617	0.55
• bachelor or higher (business, commerce)	1.4802	2.80	0.2879	0.67
• bachelor or higher (social sciences, arts)	[a]		0.2217	0.73
• bachelor or higher (education)	0.8264	1.52	0.4833	1.66
• bachelor or higher (medical, technology)	0.7045	2.03	0.7482	2.00
• other qualification	1.0446	1.29	-0.3150	-0.93
loglikelihood	-373.072		-836.104	
ln(L(0)) [b]	-734.876		-1625.484	
Adjusted pseudo-R^2 [c]	0.49		0.48	
			Predicted Participation	
Actual participation	no	yes	no	yes
no	131	91	963	155
yes	34	2093	182	1049

[a] This category and the previous one are aggregated.

[b] Ln(L(0)) is the maximum log likelihood function when all parameters except the Constant are set to 0.

[c] This is calculated by $1 - \frac{\ln(L) / (T - k)}{\ln(L(0)) / (T - 1)}$, where k is the number of independent variables.

Table B.2: A Probit Model of the Labour Force Participation of Men and Women (1994/95)

	Men		Women	
	Parameter	t-ratio	Parameter	t-ratio
Constant	-1.9759	-2.61	-1.2918	-1.81
Number of children (no children)				
• number = 1-2	0.4501	1.78	-0.1994	-0.74
• number > 2	0.3931	1.32	-0.1404	-0.47
Age of youngest child (no/older children)				
• youngest child 0	-0.3671	-1.13	-1.3975	-4.46
• youngest child 1-5	-0.6864	-2.39	-0.4163	-1.52
• youngest child 6-11	-0.5978	-2.11	0.2027	0.72
• youngest child 12-14	-0.8008	-2.43	-0.0260	-0.09
(outstanding mortgage)/10000	0.0795	4.17	0.0218	1.78
(other non-labour income)/1000	0.4096	2.41	0.2079	0.71
(wage income of partner)/1000	-0.4253	-1.84	-0.2336	-3.12
Participation of partner (dummy variable)	0.3925	2.37	0.5666	4.04
State (New South Wales)				
• Victoria	-0.1185	-0.72	-0.2906	-1.98
• Queensland	0.0474	0.28	-0.2860	-1.88
• South Australia	-0.4139	-1.83	-0.1400	-0.77
• West Australia	-0.0400	-0.22	-0.2646	-1.56
• Tasmania	0.1674	0.68	0.0504	0.26
• Territories	0.2318	0.72	0.2295	1.05
Living in capital city (dummy variable)	0.0741	0.61	0.1237	1.17
Age/10	0.5693	1.46	0.0206	0.05
$(Age/10)^2$	-0.0848	-1.81	-0.0290	-0.54
Migrant (dummy variable)	-0.1024	-0.74	-0.0083	-0.06
Recent migrant (dummy variable)	0.5131	1.55	-0.1465	-0.54
Non-English speaking background (dummy var.)	-0.0346	-0.17	-0.1302	-0.63
Work experience previous year (dummy variable)	1.3325	10.67	1.0903	9.97
Number of months worked of the last seven	0.2799	14.35	0.3580	18.69
Education (no qualification)				
• basic vocational qualification	-0.1463	-0.34	0.0345	0.18
• skilled vocational qualification	0.0823	0.60	-0.0235	-0.16
• diploma	0.0136	0.07	0.3920	2.08
• degree	0.4061	2.24	0.4910	3.26
loglikelihood	-306.760		-430.563	
ln(L(0)) [a]	-678.379		-1301.587	
Adjusted pseudo-R^2 [b]	0.54		0.66	
	Predicted Participation			
Actual participation	No	yes	No	yes
no	141	74	656	85
yes	35	1741	79	1144

[a] Ln(L(0)) is the maximum log likelihood function when all parameters except the Constant are set to zero.

[b] This is calculated by $1 - \frac{\ln(L) / (T - k)}{\ln(L(0)) / (T - 1)}$, where k is the number of independent variables.

Table B.3: Estimated Wage Equation for Males and Females (1986-87)

	Males		Females	
	Parameter	t-ratio[a]	Parameter	t-ratio
Constant	1.1548	7.05	1.1087	5.81
State (New South Wales)				
• Victoria	-0.0309	-1.59	0.0076	0.32
• Queensland	-0.0385	-1.92	-0.0613	-2.33
• South Australia	-0.0604	-2.70	0.0384	1.40
• West Australia	0.0317	1.51	-0.0153	-0.56
• Tasmania	-0.0412	-1.48	-0.0948	-2.76
• Territories	0.0979	3.01	0.0795	2.20
Age/10	0.3085	6.27	0.2092	3.15
$(Age/10)^2$	-0.0327	-5.36	-0.0258	-2.90
Ethnicity (dummy variable)	0.0407	1.03	-0.0616	-1.39
Work experience previous year in weeks	0.0077	3.85	0.0078	4.11
Education (no school/ left before 14)				
• left school at age 14 or 15	0.0390	0.94	0.1917	3.24
• left school older than 15	0.0858	1.95	0.2107	3.47
• secondary school/qualification	0.1606	3.67	0.2316	3.75
• trade certificate (no field)	0.0526	0.96	0.2203	2.09
• trade certificate (technical)	0.1263	3.06		
• trade certificate (miscellaneous)	0.0452	0.91	0.1832[b]	2.55
• other certificate/diploma (business, commerce)	0.3341	6.67	0.2619	4.24
• other certificate/diploma (education)	0.2351	3.69	0.4464	6.76
• other certificate/diploma (medical)	0.2605	3.31	0.3894	6.17
• other certificate/diploma (technology)	0.3291	6.68	0.6986	6.16
• other certificate/diploma (social sciences,arts)	-0.0073	-0.07	0.2936	3.07
• bachelor or higher (business, commerce)	0.4872	8.81	0.6373	6.37
• bachelor or higher (education)	0.3318	5.57	0.6199	8.93
• bachelor or higher (medical)	0.4500	4.65	0.7512	6.96
• bachelor or higher (technology)	0.4681	9.61	0.6867	7.80
• bachelor or higher (social sciences, arts)	0.3198	4.94	0.5347	7.42
• other qualification	0.0818	1.04	0.2102	2.36
Correction term	0.1477	1.58	0.2493	3.53
Variance	0.0784	30.15	0.0653	22.52
Number of observations	2102		1201	
E(loglikelihood)	1625.12		1038.44	
McFadden Measure[c]	0.10		0.29	
Percentage hours in correct category	27.3		37.8%	

[a] The values for these t-ratios are an overestimate of the real values, as the extended formula for the covariance matrix to account for the estimation of the Heckman term P was not used.

[b] The categories technical and miscellaneous trade certificate are taken together.

[c] McFadden, Puig and Kirschner (1977) proposed a prediction success index for a probabilistic choice model:

$$psi = \sum_{i=1}^{m} \left[\frac{n_{ii}}{n_{..}} - \frac{n_{.i}^2}{n_{..}^2} \right] \Bigg/ \left[1 - \sum_{i=1}^{m} \left(\frac{n_{.i}^2}{n_{..}^2} \right) \right]$$

$n_{..}$ is the total number of observations,
n_{ii} is the number of correct predictions for alternative i,
$n_{.i}$ is the number of observations predicted to choose alternative i.
The maximum value of this index is one.

Table B.4: Estimated Wage Equation for Males and Females (1994/95)[a]

	Males		Females	
	Parameter	t-ratio[b]	Parameter	t-ratio
Constant	1.9202	9.78	1.4387	7.63
State (New South Wales)				
• Victoria	-0.0469	-1.39	-0.0281	-0.82
• Queensland	-0.0466	-1.45	-0.0408	-1.18
• South Australia	-0.0796	-2.29	-0.0968	-2.81
• West Australia	-0.0619	-1.62	-0.0360	-0.91
• Tasmania	0.0230	0.57	-0.1254	-3.59
• Territories	0.1258	2.64	0.0687	1.51
Capital city (dummy variable)	0.0755	3.05	0.0593	2.51
Age/10	0.2557	2.88	0.3657	3.94
$(Age/10)^2$	-0.0290	-2.64	-0.0417	-3.29
Migrant (dummy variable)	-0.0323	-1.18	-0.0387	-1.19
Recent migrant (dummy variable)	0.0359	0.40	-0.0065	-0.06
Non-English speaking background (dummy var.)	-0.0296	-0.76	-0.0217	-0.48
Work experience previous year(dummy variable)	0.0992	1.23	0.1751	2.80
Number of months worked of the last seven	0.0013	0.14	0.0242	2.38
Education (no qualifications)				
• basic vocational qualification	0.0825	0.95	-0.0336	-0.95
• skilled vocational qualification	0.0155	0.63	0.0783	2.30
• diploma	0.0939	2.52	0.2315	5.87
• degree	0.2346	6.96	0.2799	8.29
Correction term	-0.0899	-0.82	0.1549	2.11
Variance	0.3954	28.45	0.3644	27.66
Number of observations	1711		1193	
loglikelihood	-882.47		-521.12	
Loglikelihood with only the constant	-948.47		-616.47	

[a] The equation is estimated by interval regression, because for people working more than 49 hours per week the exact number of working hours is not known. As a result, the wage rate for these people is not exactly known. It is only known to be below a certain value, which is the weekly income from wages and salaries divided by 50 (the minimum hours worked in this category).

[b] The values for these t-ratios are an overestimate of the real values, as the extended formula for the covariance matrix to account for the estimation of the Heckman term P was not used.

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