Modelling Labour Supply Responses in Australia and New Zealand

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

29 January 2009

Paper prepared for the New Zealand Tax Reform - Where to Next?
Conference in Wellington, 11-13 February 2009

Draft Version
Please do not quote

Abstract
This paper aims to describe two sets of labour supply models, for Australia and New Zealand respectively. Both models use a similar specification; they are discrete choice structural labour supply models incorporating a large amount of detail on the relevant tax and transfer systems. The Australian models are based on Survey of Income and Housing Cost data between 1994 and 1998, and on data between 1999 and 2004, the New Zealand models are based on Household Economics Survey data between 1991 and 2001. In both countries, separate models are estimated for single men, single women, single parents and couple families. Average wage elasticities are derived and compared for a range of different subgroups.

* Acknowledgments: I have used material from earlier work with Hielke Buddelmeyer, Lixin Cai, John Creedy and Rosanna Scutella in the preparation of this paper. The work on New Zealand was commissioned by New Zealand Treasury between 2003 and 2005. All responsibility for this paper lies with the author.

1. Introduction

This paper discusses the use of labour supply modelling to inform behavioural responses in tax policy microsimulation models. Typically, as in this case, discrete choice structural labour supply models are chosen for their ability to incorporate detailed tax and social security system information. Given the use of these microsimulation models to predict the effect of tax policy changes this is obviously important.

A distinguishing feature of microsimulation models is the use of a large cross-sectional dataset providing information about the characteristics of individuals and households, including their labour supply, earnings and in some cases, but not in the models discussed in this paper, expenditure. Therefore an advantage of microsimulation models is that they are able to replicate to a large extent the heterogeneity observed in the population.

A behavioural microsimulation model estimating labour supply responses to policy changes consists of three components. The first, discussed in Section 2, is an accounting or arithmetic microsimulation model, sometimes called a static model. This component computes net household incomes for a sample of households, for current, previous and hypothetical tax-benefit regimes.

The second component is a quantifiable behavioural model of individual tastes for net income and labour supply (or equivalently, non-work time), which is used to simulate individuals' preferred labour supply under a given set of economic circumstances. The third component consists of a procedure to allocate to each individual a preferred supply of hours conditional on the relevant tax-benefit system. Analysing simulated changes in this allocation of labour supply, between some base tax system and a counterfactual regime, forms the essence of behavioural microsimulation. These two components are described in Section 3.

The microsimulation models for Australia and New Zealand, the Melbourne Institute Tax and Transfer Simulator (MITTS) and TaxMod[1] respectively, are then described briefly in Section 4, where emphasis is placed on giving an informal explanation of the way in which labour supply variations are modelled in the behavioural component of both models. Although microsimulation models deal with a wide range of types of individual and household, it is useful to compare some aggregated measures regarding labour supply variations in response to wage changes with those available from independent studies. These elasticities summarise the responsiveness of individuals and households to one aspect of financial incentives according to the labour supply models used in the microsimulation. Such comparisons are made in Section 5 for Australia and New Zealand.

[1] This is the predecessor of TaxWell, the current microsimulation model developed by New Zealand Treasury.

Elasticities are convenient as a summary measure since the parameters of the utility function themselves, which drive the labour supply responses, are not very informative with regard to the responsiveness to financial incentives that can be expected from the different types of individuals. Section 6 briefly concludes.

Before discussing microsimulation modelling in the next few sections, it is important to mention that microsimulation models, such as the ones described in this paper are supply-side partial equilibrium models. Behavioural components concentrate on examining the effects on variations in the hours of work that individuals wish to supply of changes in the tax structure. The demand for labour is not taken into account. Hence, depending on what happens to the demand for labour, individuals may in reality not be able to work their desired number of hours. Large changes in the tax structure, designed for example to increase the labour force participation of benefit recipients, may also have effects on the demand for labour. In partial equilibrium models, there is an additional assumption that changes in the tax and transfer system have no effect on individuals' wage rates. Microsimulation models also typically provide a static overview of one point in time and do not allow for life-cycle dynamics. Decisions on labour force participation could be different when only short-term implications are taken into account compared with decisions based on a longer time horizon. Finally, in both models it is assumed that everyone who is eligible for a social security payment will take it up, independent of the amount of the payment and the effort required to obtain the payment.

2. Non-behavioural Microsimulation

The majority of large-scale tax simulation models are non-behavioural or arithmetic. That is, no allowance is made for the possible effects on individuals' consumption plans or labour supplies of tax changes. It is sometimes said that they provide information about the effects of tax changes on the 'morning after' the change. This section describes a typical arithmetic microsimulation model in subsection 2.1, followed by a discussion of the data required to build this type of model in subsection 2.2. This is followed in subsection 2.3 by discussion of an important component of any tax policy microsimulation model, the tax and transfer system.

2.1 A Typical Arithmetic Model

Advantages of non-behavioural models include the fact that they do not involve the need for estimation of econometric relationships, such as labour supply or commodity demand functions. They are relatively easy to use and quick to run, and can therefore be used by a wide range of users. Furthermore, since no econometric estimation is required, they retain the full extent of the heterogeneity available in the survey data used.

When examining the effects of policy changes, these models generally rely on tabulations and associated graphs, nationally and for subgroups, of the amounts of tax paid and social security payments received (and changes in these) at various percentile income levels. The more sophisticated models may have extensive built-in 'back end' facilities allowing computation of a range of distributional analyses and tax progressivity measures, along with social welfare function evaluations in terms of incomes.

Arithmetic models are typically used to generate profiles, again for various household types, of net income at a range of gross income levels. These profiles are useful for highlighting potential discontinuities, and are helpful when trying to redesign tax and transfer systems in order to overcome such discontinuities and/or excessively high marginal tax rates over some income ranges.

2.2 The Data

Reference has already been made to the data requirements of tax models. This raises special problems for modellers in Australia. The two large-scale household surveys that are potentially useful are the Household Expenditure Survey (HES) and the Survey of Income and Housing Costs (SIHC) both collected by the Australian Bureau of Statistics (ABS). The former does not contain sufficient information about hours worked by individuals while the latter does not contain information about expenditure patterns. The SIHC is a representative sample of the Australian population, containing detailed information on labour supply and income from different sources, in addition to a variety of background characteristics of individuals and households. The measurement of income in the HES is known to be unreliable, so that in developing models for the analysis of direct taxes and transfer payments, it is not surprising that reliance has been placed on the SIHC. This means that it is not straightforward to include indirect tax in Australian direct tax models.[2] The extension of models to cover consumption taxes would require some elaborate data merging.

When analysing actual or proposed policy changes, it is preferred to use data which are as close to the relevant time period as possible to avoid having a starting point that is too different from reality. Given the delays in the release of data by the ABS and the occasional changes in surveying frequency of the SIHC, this can be difficult to achieve. For example, when simulating the effect of the tax and social security changes of July 2000, only 1997/1998 data were available at the time. MITTS updates all financial information to the relevant year; that is, the amounts of income in 1997/1998 were increased to reflect the corresponding July 2000 amounts. To update incomes, the Consumer Price Index is used, and to update wage rates, the average male and female wage indices are used. However, if

[2] Indirect tax models for Australia include the Demand and Welfare Effects Simulator (DAWES) developed in Creedy (1999).

the tax and social security system is substantially different in the year for which the data are obtained from the year for which a change needs to be simulated, the different incentives arising from the different systems in the two years might well have caused labour supply changes. To take this possibility into account, MITTS can also update labour supply in the base dataset if required.

An alternative approach to deal with this issue is to run two simulations instead of one simulation and compare the pre-reform and post-reform systems via a common third system, which is to be used as the base system in both simulation runs. This third system has to be the system in place at the time the data were obtained. This approach was used in Buddelmeyer *et al.* (2004a, b) and in Buddelmeyer, Dawkins and Kalb (2004), where data from 2000/2001 were used to evaluate the 2004 system against alternative systems.

For New Zealand, the Household Economic Surveys, all released by Statistics New Zealand (NZSTATS), were used in TaxMod. In the period relevant to this paper, these surveys were released on a yearly basis from 1991/92 to 1997/98, but are currently undertaken only once every three years. The survey collects information on the sources and amounts of income received by persons resident in private dwellings throughout New Zealand, along with data on a range of characteristics for all individuals within the household. Individuals in each household are linked by a household number and family number, so that household characteristics such as income and the number and age of children can be derived by using information from other records in the same household. As for Australia, the detailed information on income allows the budget constraint to keep its full complexity. Each surveyed household has a weight associated with it, which represents how common households of that type are in the population. Thus the sample can be weighted up to estimate features of the entire private-household population in New Zealand.

Information on household expenditure is also available in the HES but this is not used in TaxMod. The primary focus of TaxMod is tax and benefits. The only expenditure data it uses relates to rent paid, since that affects eligibility for accommodation supplement, one of the social security payments in New Zealand. TaxMod uses most of the income data, which includes income from current jobs, from jobs that finished in the last 12 months, from interest, dividends, lottery winnings, etc. TaxMod ignores benefit amounts recorded in HES, but takes note of benefit duration. This simplifies treatment of benefits because it allows TaxMod to model changes to benefits rates, which is necessary when policy changes are proposed or when the year being modelled is not the year in which the data was collected. When projecting the population forward, market incomes are inflated, and the appropriate benefit rates/superannuation rates for the year being modelled are applied, based on length of eligibility. In general, monetary variables can be updated to particular years, using the quarterly Consumer Price Index as published by Statistics New Zealand. Furthermore, the observed nominal wages can be adjusted by average wage increases for men or women as relevant.

2.3 The Tax and Transfer System

Detailed knowledge of the tax and social security system is required to build a microsimulation model. This sometimes involves several government departments and the full details are rarely codified in accessible forms. Actual tax and transfer systems are typically extremely complex and contain a large number of taxes and benefits which, being designed and administered by different government departments, are usually difficult to integrate fully. The complexity increases where several means-tested benefits are available, because of the existence of numerous eligibility requirements. It is only when detailed information about individuals is available that it becomes possible to include the complexities of actual tax and transfer systems in a simulation model.

However, it is unlikely that household surveys contain sufficient information to replicate realistic tax systems fully. In some cases, for example where asset values are required in the administration of means tests, it may be necessary to impute values, which may not always be possible. Furthermore, regulations regarding the administration of taxes and transfers often leave room for some flexibility in interpretation. In particular, the administration of means tests or other benefits may allow a degree of discretion to be exercised by benefit officers who deal directly with claimants. Changes in the interpretation of (possibly ambiguous) rules, or the degree to which some rules are fully enforced, can take place over time. Furthermore, there may be changes in people's awareness of the benefits available, and the eligibility rules, thereby affecting the degree of take-up.

Given these limitations, even large-scale models may not be able to replicate actual systems entirely. Thus they may not accurately reproduce aggregate expenditure and tax levels. Similarly, the same problems may give rise to distortions in measuring the extent to which redistribution occurs. Another difficulty is that household surveys may contain non-representative numbers of some types of household and benefit recipient. It is usually necessary to apply a set of grossing-up factors, or sample weights, to enable a more accurate aggregation of results to the population level.

3. Behavioural Microsimulation

Behavioural models are often essential when assessing proposed policy changes, because many tax policy changes are designed with the aim of altering the behaviour of individuals. In the context of consumption, environmental taxes such as carbon taxes are used to reduce the demand for harmful goods. For example, some policies are designed to induce more individuals to participate in paid employment or, for those already working, to increase their hours of work.

The production of behavioural microsimulation tax models, allowing for labour supply variations, represents a considerable challenge and has involved substantial innovations in labour supply modelling. On labour supply modelling in the context of tax simulation models, see, for example, Apps and Savage (1989), Banks, Blundell and Lewbel (1996), Blundell *et al.* (1986), Creedy and Duncan (2002), Creedy and Kalb (2005), Duncan (1993), Duncan and Giles (1996) and Moffitt (2000). On behavioural responses in EUROMOD (a European microsimulation model including tax and transfer systems of a number of European countries), see Klevmarken (1997). Examples of behavioural microsimulation analyses using MITTS or TaxMod-B can be found in Buddelmeyer, Creedy and Kalb (2007).

Even where labour supply is not the main focus of a policy, there may be unintended consequences which affect other outcomes. Measures of the welfare losses, for example resulting from increases in taxes, are overstated by non-behavioural models which rely on 'morning after' changes in tax paid, rather than allowing for substitution away from activities whose relative prices increase as the result of the policy change. In addition, estimates of the distributional implications of tax changes may be misleading unless behavioural adjustments are modelled.

This section first describes a typical behavioural microsimulation model, before discussing the issue of modelling nonparticipation in the labour force.

3.1 A Typical Behavioural Microsimulation Model

Existing behavioural microsimulation models are restricted in the types of behaviour that are endogenous. At most, individuals' labour supplies and household demands are modelled. Variables such as household formation, marriage and births, along with retirement, labour training and higher education decisions, are considered to be exogenous and independent of the tax changes examined (these are usually longer-term decisions). Typically, labour supply in just one job is examined, so that the possibility of working additional hours at a different wage rate is ignored. The wage rate is usually calculated by dividing total earnings by the total number of reported hours worked.

A component which evaluates the net income corresponding to any given number of hours worked by each individual is a fundamental component of a behavioural model. This produces, for each individual, the precise budget constraint relating net income to hours worked. The behavioural part of the model can then be used to evaluate which part of the individual's constraint is optimal. This component is in effect an associated non-behavioural model which is applied across the range of possible labour supply for each individual.

Behavioural microsimulation models have, to some extent, a lower degree of population heterogeneity than non-behavioural models. This is because econometric estimation of the important relationships must involve the use of a limited range of categories. For example, in estimating labour supply behaviour, individuals may be divided into groups such as couples, single males and single females, and single-parent households. The number of groups is limited by the sample size, but many variables, such as age, location, occupation and education level, are used to estimate the relevant functions. In addition, individual-specific variability may be re-introduced to ensure that the optimum labour supply in the face of current taxes actually corresponds, for each individual, to the level that is observed in the current period.

3.2 Simulating Changes in Labour Force Participation

An important policy issue relates to the nature of tax and transfer changes designed to encourage more people to participate in the labour market. Hence this is likely to provide a focus for behavioural microsimulation studies, but this is also precisely the area that raises the greatest difficulty for modellers. There are several reasons for this. First, there is less information about nonparticipants in survey data. For example, it is necessary to impute a wage rate for non-workers, using estimated wage equations and allowing for selectivity issues. In addition, variables such as industry or occupation, which are often important in wage equations, are not available for non-workers. A second problem is that there are fixed costs associated with working, irrespective of the number of hours worked. These are usually difficult to estimate due to data limitations. Finally, labour supply models typically treat nonparticipation as a voluntary decision, giving rise to a corner solution. However, demand-side factors may be important and there may be a discouraged worker effect of unemployment, which is difficult to model.

A choice must be made between continuous and discrete hours labour supply estimation and simulation. Earlier studies of labour supply used continuous hours models, involving the estimation of labour supply functions. In this case, it is important that the results are such that hours worked can be regarded as the outcome of utility maximisation. In other words, it must be possible to recover the indirect utility function by integration.[3] This contrasts with discrete hours estimation and microsimulation, where net incomes, before and after a policy reform, are required only for a finite set of hours points. The discrete hours approach has substantial advantages in estimation, since it allows for the

[3] On the integrability condition in labour supply models, see Stern (1986).

complexity of the tax and transfer system and avoids the problems with endogeneity between the net wage and hours worked which are present when a standard labour supply function is estimated. Furthermore, estimation involves direct utility functions, which may depend on many individual characteristics. The determination of optimal labour supply is easier, since utility at each of a limited number of hours levels can readily be obtained and compared. The use of direct utility functions also means that no integration from estimated supply functions is required in simulation. In addition, modelling the move in and out of the labour market is relatively straightforward in the discrete model compared to the continuous model. The discrete hours approach is used in the MITTS and the TaxMod models, which are described in the following section.

4 MITTS and TaxMod

The specific features of the Australian and New Zealand microsimulation models are described in Sections 4.1 and 4.2 respectively. This is followed by a discussion of the use of labour supply modelling in MITTS and TaxMod-B in Section 4.3. The same approach is used in both microsimulation models.

4.1 MITTS

The Melbourne Institute Tax and Transfer Simulator (MITTS) is a behavioural microsimulation model of direct taxes and transfers in Australia. MITTS was designed to examine tax policy reforms which capture labour supply responses to changes in budget constraints, and is the first full-scale simulation model of its kind in Australia. The results reflect only the supply side of the labour market, and a discrete hours framework is used in which individuals can move between specified discrete hours levels, rather than being able to vary hours continuously.

Since the first version was completed in 2000, and described in detail in Creedy *et al*. (2002), it has undergone a range of substantial developments. In the present version of MITTS, SIHC data from 1994/1995, 1995/1996, 1996/1997, 1997/1998, 1999/2000, 2000/2001, 2002/2003 and 2003/2004 can be used. One set of econometric estimates of preferences underlying the behavioural responses are based on data observed between 1994 and 1998 and another set is based on data observed between 1999 and 2004. Details of the first set of wage and labour supply parameters used in MITTS can be found in Kalb and Scutella (2002) and Kalb (2002). All results are aggregated to population levels using the household weights provided with the SIHC.

In MITTS, the arithmetic tax and benefit modelling component is called MITTS-A. This component also provides, using the wage rate of each individual, the information needed for the construction of the budget constraints that are crucial for the analysis of behavioural responses to tax changes.

The tax system component of MITTS contains the procedures for applying each type of tax and benefit. Each tax structure has a data file containing the required tax and benefit rates, benefit levels and income thresholds used in means testing. As mentioned before, it is not possible to include within MITTS all the complexity of the tax and transfer system. However, all major social security payments and income taxes are included in MITTS.[4] Pre-reform net incomes at the alternative hours levels are based on the MITTS calculation of entitlements, not the actual receipt. Hence in the calculation of net income it is assumed that take-up rates are 100 per cent.[5]

The various components of the tax and benefit structure are assembled in the required way in order to work out the transformation between hours worked and net income for each individual under each tax system. For example, some benefits are taxable while others are not, so the order in which taxes and transfers are calculated is important.

Changes to the tax and benefit structure, including the introduction of additional taxes, can be modelled by editing the programmes in this component. MITTS stores several previous Australian tax and transfer systems, which can be used as base systems for the analysis of policy changes.

MITTS-A contains the facility to examine each household, income unit and individual in the selected base dataset in turn and generate net incomes, at the given hourly wage rates, for variations in the number of hours worked. Thus the changes in effective marginal tax rates (EMTRs) and labour supply incentives faced by households at various levels of the wage distribution can be compared, in addition to calculating the aggregate costs of different reform packages. Furthermore, distributions of effective marginal tax rates, for a variety of demographic groups, can be produced for pre-reform and post-reform tax systems, as well as distributions of gainers and losers, for various demographic characteristics. Hypothetical households can also be constructed and examined.

4.2 TaxMod

TaxMod is a model of the New Zealand population, based on data from Statistics NZ – the Household Economic Survey. TaxMod provides a detailed picture of the New Zealand population, which allows a variety of questions related to the effect of changes in income tax and social security to be answered

[4] For details of the different payments, see Payment Guides published by the Commonwealth Department of Family and Community Services (of several years), DVA Facts and the annual report published by the Department of Veterans' Affairs (of several years).

[5] Alternatively, it is possible to use a simple rule whereby a benefit is not claimed if it is less than a specified amount.

The two main strengths of TaxMod are that it accurately models the interactions between various policies, and that it allows new policies to be modelled, ranging from simple tweaking of existing parameters to looking at brand new policies – such as for example, looking at universal benefit schemes.

TaxMod works as follows. It reads in one family at a time, calculates market income, adds income from various government programs (benefits, superannuation, Family Support, Accommodation Supplement) according to eligibility, and calculates tax liability. It can provide output at the personal, family and household level, which can then be processed using a statistical software package such as SAS or STATA. Examples of output include disposable income, accommodation supplement, unemployment benefit, low income rebate, total income from all sources, total transfers (tax paid minus benefits received). It also accumulates some figures for the entire population, and these are available directly from TaxMod as standard output.

TaxMod can also analyse a single family, whether extracted from HES or made up by the user. Detailed results of the tax/benefit calculation can be displayed for each member of the family, showing results under two sets of tax/benefit parameters, as well as the differences for each field. This feature is very useful for understanding surprising results.

Another useful feature is that TaxMod allows us to take a family, allow one of the income variables to go through a range of values, and graph a variable of interest. This is useful to understand the effects of a policy change on effective marginal tax rates (EMTRs).

Limitations of TaxMod stem primarily from the data on which it is based. Although HES collects a large amount of data from each household, and surveys a large number of households by New Zealand standards, the data has notable shortcomings. The main purpose of HES is to measure CPI accurately and TaxMod takes advantage of the data gathered for measuring CPI. However, the sample design means that the accuracy of results relating to general questions is not as high as would be ideal.

For example, the numbers of ex-beneficiaries that show up in the HES data are consistently very low relative to administrative data collected by DSW. There are two ways of handling these shortcomings – attempt to compensate for them, or estimate the sampling error. Both techniques have been used with TaxMod. As part of the data preparation, household weights are altered to correct the population totals in various areas, and data for recent years allows estimation of the size of the sampling error for different measures.

There are some definitional problems that are best exemplified by the way in which families are treated in TaxMod. The individuals in a household are grouped into families by the TaxMod preparation code. The HES data records the blood relationships between people in each household, and this provides a starting point for building families. However, some families reported in this manner are broken up by TaxMod. For example, a nineteen year-old son living with his parents may be considered by all in the house to be part of the core family. However, for tax and benefit purposes, he is independent of his parents, so TaxMod separates him out into his own family. There are also households that contain children unrelated to the core-family, and in those cases the children are added to the core family by TaxMod.

Unlike in MITTS, the behavioural and non-behavioural microsimulation models in TaxMod are not integrated. TaxMod is a non-behavioural microsimulation model in which behavioural responses of individuals resulting from a policy change in tax or transfer payments are not accounted for in the modelling process. TaxMod-B is a separate behavioural microsimulation model which can read output data from TaxMod, containing net incomes for each household at a range of predetermined labour supply points. It is designed to provide a tool for additional analysis so that the labour supply effects of the policy changes can be simulated and evaluated. In addition, the effects on government revenue and expenditure while allowing for labour supply responses can also be simulated.

The input for TaxMod-B is based on the HES datasets, but these data need to be run first through TaxMod, the static microsimulation model for New Zealand, before they can be used. TaxMod is needed to calculate net incomes at a range of discrete labour supply levels before and after the reform.[6] TaxMod generates separate files for incomes before the reform and for incomes after the reform and separate files for single persons and couples. In addition to the net incomes, the files contain a range of individual and household characteristics. These files are then passed on to TaxMod-B to be read. TaxMod-B contains no social security or tax system information, but only the labour supply parameters on which the behavioural responses are based and a variety of tabulation and graphic facilities, which means output can be generated directly from the menu. In addition, a Gauss output data file is generated which allows further analysis to be undertaken. The wage and labour supply parameters for New Zealand are reported in Kalb and Scutella (2004, 2003).

The link between TaxMod and TaxMod-B ensures that all simulations that are possible in TaxMod can be followed by a behavioural simulation in TaxMod-B. Therefore, policy changes that cannot be simulated in TaxMod cannot be simulated in TaxMod-B either.

4.3 Using Labour Supply Modelling in MITTS-B and TaxMod-B

The behavioural components of MITTS and TaxMod are called MITTS-B and TaxMod-B respectively. They examine the effects of a specified tax reform, allowing individuals to

[6] TaxMod had to be adapted to enable these net income calculations at the relevant discrete hours points.

adjust their labour supply behaviour where appropriate. Both models use the same approach to obtain behavioural responses of tax policy changes. The behavioural responses generated by MITTS-B and TaxMod-B are based on the use of quadratic preference functions whereby the parameters are allowed to vary with individuals' characteristics. These parameters were estimated for five demographic groups, which include married or partnered men and women, single men and women, and sole parents; see Kalb (2002), and Kalb and Scutella (2003). The joint labour supply of couples is estimated simultaneously, unlike a common approach in which female labour supply is estimated with the spouse's labour supply taken as exogenous.

The framework is one in which individuals are considered as being constrained to select from a discrete set of hours levels, rather than being able to vary labour supply continuously. Other studies using this approach include Van Soest (1995), Duncan, Giles and MacCrae (1999) and Keane and Moffitt (1998).

Some individuals are observed to be working a number of hours such that they are facing very high effective marginal rates. One explanation for this is that in practice people may not be claiming all the benefits to which they are entitled, especially if the benefits are small, so that their actual EMTR is not as large as it seems from the calculations. An alternative explanation is that people are in practice restricted in their labour supply choice. If people are actually at hours levels that give them marginal rates of 100 per cent or more, this cannot be explained in a continuous hours labour supply framework. Such points could not be the optimal points in the model, since the indifference curves cannot be flat. However, in a discrete hours approach such labour supply points can be optimal, because if people are not free to vary their hours continuously they have to pick the best discrete choice available. In MITTS-B and TaxMod-B, individuals are constrained to select from a discrete set of hours levels, rather than being able to vary labour supply continuously.

Different sets of discrete hours points may be used for each demographic group. Different sets of discrete hours points are used for married men and all other groups. Given that the married male's hours distribution is much less spread over part-time and full-time hours than the other distributions, but is mostly divided between nonparticipation and full-time work, men's labour supply is represented by just six points, whereas women's labour supply is divided into 11 discrete points. For couples, labour supply is estimated simultaneously for the two members, contrary to an approach in which female labour supply is estimated with the spouse's labour supply taken as exogenous.

Given the aim of simulating policy changes with regard to the tax and transfer system and assessing its effect on labour supply, priority is given to incorporating all possible detail on taxes and transfers. Utility is maximised conditional on the restricted total amount of time available to each adult and the restricted amount of total household income. It is expected that utility increases with an increase in leisure, or home production time, and income. Usually more income means less leisure time for one of the adults, except when more income is obtained through social security benefits. It is assumed that everyone who is eligible for benefits takes them up. Maximising a household's utility involves balancing the amount of leisure and income. It is assumed that all nonparticipants are voluntarily not working and that participants are at their preferred labour supply points. Wage rates, non-labour income and household composition are exogenous in this model.

Restricting the number of possible working hours to a limited set of discrete values means that complex tax and transfer details can be incorporated. The economic model, assuming there are two adults in the household, is specified as follows. The utility function, $U\left(x,\ell_1,\ell_2\right)$, is maximised subject to a time restriction for each adult. Let ℓ_i and h_i denote the weekly aggregate of leisure and home production time, and hours of work of partner i, with $\ell_1 + h_1 = T$ and $\ell_2 + h_2 = T$. The h s, the time spent in employment, are chosen from discrete hours sets. Let x indicate total net income per week, which is assumed equal to household consumption. The gross wage rates of male and female partners are denoted w_1 and w_2 respectively and y_i are the non-labour incomes. Let C refer to household composition, and $B(\ )$ is the amount of benefit for which a household is eligible, given household composition and household income. The tax function indicating the amount of

$$\begin{aligned} x = {} & w_1h_1 + w_2h_2 + y_1 + y_2 + B(C,w_1h_1 + w_2h_2 + y_1 + y_2) \\ & - \tau(B,w_1h_1 + y_1,w_2h_2 + y_2,C) \end{aligned} \qquad \textbf{(1)}$$

tax to be paid is $\tau(\ )$. The budget constraint is given by:

The discrete hours choices are given by the sets $\left[0,h_{11},h_{12},...,h_{1m}\right]$ and $\left[0,h_{21},h_{22},...,h_{2,k}\right]$ for partners 1 and 2 respectively. Using these sets, net income can be calculated for all $\left(m+1\right)\left(k+1\right)$ combinations of h_1 and h_2. For this limited set of hours, the utility each possible combination of hours would generate, according to the specified utility function, can be computed.

The choice of labour supply is simultaneously determined for both adult members of the household. Depending on the form of the utility function, different interactions between household income and labour supply of both adults can be modelled. For one-adult households, the model is simplified by excluding everything related to the second adult.

Utility is assumed to consist of a deterministic and a random component. Choosing an extreme value specification for the random component results in a multinomial logit model; see Maddala (1983) and Creedy and Kalb (2005).

The utility function used in MITTS and TaxMod-B is a quadratic specification, following Keane and Moffitt (1998), which is simple but flexible in that it allows for the leisure of each person and income to be substitutes or complements. A fixed cost of working parameter, γ, is included in the income variable x to indicate the cost of working versus nonparticipation, following Callan and Van Soest (1996). As a result of the inclusion in x, this cost of working parameter is measured in dollars per week. The deterministic

$$U(x,h_1,h_2) = \beta_x(x-\gamma_1-\gamma_2) + \beta_1 h_1 + \beta_2 h_2 + \alpha_{xx}(x-\gamma_1-\gamma_2)^2 + \alpha_{11}(h_1)^2 \\ + \alpha_{22}(h_2)^2 + \alpha_{x1}(x-\gamma_1-\gamma_2)h_1 + \alpha_{x2}(x-\gamma_1-\gamma_2)h_2 + \alpha_{12}h_1h_2 \quad \textbf{(2)}$$

component of utility is specified as follows:

where the α s and β s are preference parameters and γ_1 and γ_2 are the fixed cost of working parameters to be estimated, where the indices 1 and 2 denote the husband and wife respectively. The fixed cost is zero when the relevant person is not working. For single adult households, all terms related to h_2 drop out of the utility function and γ_2 is set to zero.

Observed heterogeneity is included by allowing β_1, β_2, β_x, γ_1 and γ_2 to depend on personal and household characteristics. Unobserved heterogeneity may be added to β_1, β_2, β_x, and γ_2, in the form of a normally distributed error term with zero mean and unknown variance. In estimation, the unobserved heterogeneity parameters were found to be insignificant while the other parameter values remained unchanged. Parameter estimates for all four demographic groups are in Kalb (2002) and Kalb and Scutella (2003).

For those individuals in the dataset who are not working, and who therefore do not report a wage rate, an imputed wage is obtained. This imputed wage is based on estimated wage functions, which allow for possible selectivity bias, by first estimating probit equations for labour market participation, as described in Kalb and Scutella (2002, 2004). However, some individuals are fixed at their observed labour supply if their imputed wage or their observed wage, obtained by dividing total earnings by the number of hours worked, is unrealistic.[7] Furthermore, some individuals such as the self-employed, the disabled, students and those over 65 have their labour supply fixed at their observed hours.

---

[7] The rejection range is less than 4 and more than 100 dollars per hour for Australia and less than 50 per cent of the relevant minimum wage at the relevant time or greater than 100 dollars per hour for New Zealand.

Simulation is essentially probabilistic, as utility at each discrete hours level is specified as the sum of a deterministic component (depending on the hours worked and net income) and a random component (here, an extreme value type I distribution, which is associated with the multinomial logit model). Hence MITTS and TaxMod-B do not identify a particular level of hours worked for each individual after the policy change, but generates a probability distribution over the discrete hours levels used. Net incomes are calculated at all possible labour supply points. Given a random set of draws from the error term distribution, along with the computed deterministic component of utility at each of the labour supply points, the optimal choice for each draw can be determined conditional on the relevant set of error terms.

A behavioural simulation for each individual begins by setting reported hours equal to the nearest discrete hours level. Then, given the parameter estimates of the quadratic preference function, which vary according to a range of characteristics, a set of random draws is taken from the conditional distribution of the error term for each hours level. The utility-maximising hours level is found by adding the random to the deterministic component of utility for each discrete hours level. A user-specified total number of draws are produced. These are drawings which generate the observed hours as the optimal value under the base system for the individual. This process is described as ‘calibration’.

For the post-reform analysis, the new net incomes cause the deterministic component of utility at each hours level to change, so using the set of draws from the calibration stage, a new set of optimal hours of work is produced. This gives rise to a probability distribution over the set of discrete hours for each individual under the new tax and transfer structure. Some individuals, such as the self-employed, the disabled, students and those over 65 have their labour supply fixed at their observed hours. For the other individuals, transition matrices showing probabilities of movement between hours levels are computed using these transitions.

When examining average hours in MITTS-B or TaxMod-B, the labour supply after the change for each individual is based on the average value over the set of draws. This is equivalent to calculating the expected hours of labour supply after the change, conditional on starting from the observed hours before the change. In computing the tax and revenue levels, an expected value is also obtained after the policy change. That is, the tax and revenue for each of the hours points are computed for each individual, and the average of these is obtained using the computed probability distribution of hours worked.

5. Labour Supply Elasticities

In constructing any microsimulation model it is important to ensure that, using the base system, it can generate revenue and expenditure totals for various categories that are close to independently produced aggregates, for example from administrative data. For a behavioural model, it is also useful to see how summary information about labour supply behaviour compares with results from other studies. Such comparisons are examined in this section, and in particular New Zealand and Australia are compared. Unfortunately, the comparison is limited by what is available from earlier research in which labour supply models were estimated for New Zealand. Therefore the opportunity to generate additional breakdowns of the elasticities by a range of background characteristics of individuals or households is limited for New Zealand.

The possible approaches of calculating wage elasticities is first discussed in Section 5.1, before reporting results for Australia and New Zealand in Sections 5.2 and 5.3, respectively. In Section 5.4, the two countries are compared with each other and with results from other countries.

5.1 The calculation of wage elasticities

It is common in studies of labour supply to provide wage elasticities for various groups, often computed at average values of wages. However, the discrete hours labour supply model used in MITTS and TaxMod-B simulations of behavioural responses to policy changes does not provide straightforward wage elasticities with regard to labour supply. Indeed, for any individual, there are large variations in the elasticity over the range of hours available. However, elasticities can be approximated by comparing the expected labour supply for an individual after an x per cent wage increase with the expected labour supply under the original wage, and expressing the difference as a percentage change divided by x. By doing this for each individual in the sample, the average elasticity across the sample, or population when making use of the weights, can be computed. It should be noted that the change in wage is a change in the gross wage rate and that the change in net wage rate is also affected by the tax and transfer system which is in place.

A range of different concepts are used in the literature. For example, instead of calculating the average elasticity across the sample, an alternative is to calculate the elasticity for a hypothetical person with average values for each of the relevant characteristics. Hence it cannot be expected that the same values will be obtained, but comparisons of orders of magnitude are useful.

In MITTS elasticities are computed in two different ways, whereas for the New Zealand labour supply model only elasticities based on the first approach were computed. First, the wage elasticities are calculated for each individual for whom labour supply responses are simulated. Using expected labour supply, expected labour supply is computed at the observed and imputed wage levels. Expected labour supply is calculated by drawing 100 random error terms for each individual to add to the deterministic utility level. This allows us to determine the optimal utility level and thus the preferred labour supply for each draw. Expected labour supply is calculated as the average over these 100 draws. The next step is to increase all wage rates by 1 per cent in MITTS (10 per cent for New Zealand) and calculate expected labour supply again using the same draws. The percentage difference in labour supply is the wage elasticity. ABS weights are used to calculate the average elasticity across all individuals by demographic group. In MITTS, the average of the individual elasticities is taken whereas for New Zealand the average expected hours across the sample (or subgroup) is computed before and after the wage change and the percentage change between those two values is used to approximate the relevant elasticity.

For the change in participation, rather than expected labour supply the probabilities of being at the different discrete hours points are used. The change in participation is calculated by comparing the average weighted probability of being at 0 hours before and after the wage increase.

Second, using calibrated labour supply, the wage elasticities are calculated for each individual for whom labour supply responses are simulated and who works positive hours.[8] First, expected labour supply is computed at the observed and imputed wage levels. In this case where calibrated labour supply is used, the error terms are drawn conditionally; that is, only error terms that place the individual at their observed hours are used. Again 100 draws from the error terms are used. Due to the calibration, at the original wage, the expected labour supply equals the observed discretised hours point for each individual. The next step is to increase all wage rates by 1 per cent and calculate expected labour supply again using the same draws from the error terms. Again, the percentage difference in labour supply is the wage elasticity. ABS weights are used to calculate the average elasticity across all individuals by demographic group.

For the change in participation, instead of expected labour supply the probabilities of being at the different discrete hours points after the wage change and the observed non-participation before the wage change are used. The change in participation is calculated by comparing the average weighted probability of being at 0 hours before and after the wage increase.

Expected hours are never zero in principle, so the first set of wage elasticities is calculated for a larger sample (including workers and non-workers) than the second set of

[8] At zero hours, the elasticity cannot be calculated.

wage elasticities (only calculated for workers). It is expected that workers and non-workers have different elasticities. In fact, even within the workers or non-workers group values for the elasticities vary widely. Elasticities provide the most information at the disaggregated level, since at the aggregate level a small elasticity can hide a wide variation of responses for subcategories in the population. For all demographic groups, the individual simulated elasticities vary from negative to positive values, with a substantial number being zero. Discretised observed hours are used to calculate the elasticities based on calibrated labour supply. On average, the elasticities for most individuals are quite similar when using observed continuous hours or discretised observed hours. [9]

In interpreting the results, one should also keep in mind that elasticities are relative measures. That is, the same elasticity has different implications for absolute labour supply changes at different levels of labour supply. People working low hours could have a large elasticity if their weekly labour supply increased or decreased by one hour. Therefore, a large elasticity for some individuals does not necessarily imply the labour supply response will be large in absolute terms. This also depends on which individuals have large elasticities. These individuals working few hours who change their labour supply are going to affect the average elasticity to a lesser extent in the approach used for New Zealand compared to the approach used in MITTS for Australia.

5.2 Wage elasticities for Australia

The tables with wage elasticities and cross wage elasticities, for individuals who are part of a couple, are presented below. The elasticities are calculated based on samples excluding people over 65, disabled individuals, full-time students and the self-employed, for whom labour supply is not simulated in MITTS. Elasticities are broken down by a number of individual and household characteristics. When using the calibration approach, wage elasticities can only be calculated for workers. When using the expected labour supply approach without calibration, all observations can be used in calculating wage elasticities, so that the cells are based on the same number of observations as the cells with the change in participation. However, to compare calibrated and non-calibrated wage elasticities for the same group of individuals the latter wage elasticities are also reported separately for the subgroup of workers in MITTS.

With regard to the participation changes, using calibration means that for each individual the starting point is at the extreme probabilities of 0 and 100 per cent of

---

[9] Although for a few groups, large differences were noticed when instead of observed continuous hours the discretised observed hours are used to calculate the elasticities, this was caused by the exclusion from the calculation of a few cases in the second option (where people working 1 or 2 hours are now categorised as not working). Some of these cases had extremely high elasticities, which are now excluded.

participation in the labour force, whereas using expected labour supply means the starting point can be anywhere in the range from 0 to 100 per cent. Therefore, at the individual level the scope for change (both increases and decreases) appears larger when using calibrated labour supply. However, because these larger changes can both be negative or positive, nothing conclusive can be predicted about the resulting participation changes on average. It should be noted that the changes are fairly small in all groups for both approaches, and that for single men, single women, married men and married women without children the calculated changes are similar in both approaches.

Table 1 present own and cross wage elasticities for 7 demographic groups in Australia. Single parents and married/de facto women, particularly those with children, appeared most responsive to wage changes. Cross wage elasticities in couple families are all quite small. The elasticities presented in Table 1 are disaggregated in Tables 2 and 3, by age and education level respectively.

Table 1 Implied average uncompensated wage elasticities by demographic group based on 1994-1998 labour supply estimates (Australia)

	Based on expected labour supply			*Based on calibrated labour supply*	
	Average wage elasticity		Change in participation	Average wage elasticity	Change in participation
Demographic group	All hours	Observed hours >0	Percentage points	At observed discretised positive hours	Percentage points
Single male	0.22	0.21	0.16	0.04	0.17
Single female	0.38	0.22	0.19	0.07	0.16
Sole parent	1.48	1.49	0.41	0.78	0.24
Married male without children	0.33	0.28	0.20	0.09	0.19
Married female without children	0.42	0.36	0.18	0.23	0.18
Married male with children	0.17	0.16	0.11	0.04	0.11
Married female with children	0.66	0.63	0.22	0.49	0.13
Cross Wage elasticities					
Married males without children	0.06	0.06	0.05	-0.02	0.03
Married females without children	0.08	0.05	0.05	-0.06	0.03
Married males with children	0.02	0.02	0.03	-0.03	0.02
Married females with children	0.12	0.05	0.04	-0.12	0.00

The disaggregation by age in Table 2 does not show any regular patterns, whereas the disaggregation by education in Table 3 shows a tendency for higher wage elasticities amongst individuals at the lowest skill level, except for single parents. For the latter group, only the highest education level displays a clearly lower elasticity compared to the three lower levels of education.

This higher elasticity for people with relatively low skills is at least partly due to the lower participation rate and lower hours of work of this subgroup. Similarly, the cross wage elasticities also appear slightly higher for the individuals with low skill levels, even turning negative for those with a diploma or degree. Again this is likely to be due to the level of labour supply in the starting point.

Table 2 Implied average uncompensated wage elasticities by demographic group and age (Australia)

Demographic group by age	*Based on expected labour supply*			*Based on calibrated labour supply*	
	Average wage elasticity		Change in participation	Average wage elasticity	Change in participation
	All hours	Observed hours >0	In percentage points	At observed discretised positive hours	Percentage points
Single male					
16-24	0.21	0.20	0.16	0.07	0.12
25-34	0.14	0.15	0.12	0.03	0.14
35-44	0.26	0.28	0.20	0.01	0.27
45-54	0.33	0.31	0.22	0.01	0.25
55-64	0.34	0.42	0.20	-0.01	0.21
Single female					
16-24	0.18	0.17	0.16	0.15	0.10
25-34	0.07	0.06	0.10	-0.02	0.13
35-44	0.16	0.18	0.17	-0.04	0.24
45-54	0.41	0.33	0.30	0.13	0.27
55-64	1.48	1.10	0.30	0.15	0.22
Sole parent					
16-24	0.75	0.32*	0.07	0.21*	0.09
25-34	1.91	2.09	0.40	0.42	0.23
35-44	1.39	1.31	0.44	0.84	0.23
45-54	1.29	1.30	0.49	1.06	0.30
55-64	1.40*	1.76*	0.38*	0.07*	0.65*
Married male without children					
16-24	0.36	0.36	0.30	0.03	0.05
25-34	0.09	0.09	0.07	0.03	0.04
35-44	0.08	0.07	0.06	0.02	0.11
45-54	0.29	0.25	0.20	0.07	0.23
55-64	0.64	0.65	0.33	0.25	0.33
Married female without children					
16-24	0.34	0.31	0.18	0.17	0.18
25-34	0.21	0.20	0.10	0.35	0.14
35-44	0.29	0.28	0.13	0.24	0.19
45-54	0.52	0.50	0.23	0.06	0.19
55-64	0.61	0.56	0.20	0.38	0.19

Table 2 continued

Demographic group by age	*Based on expected labour supply*			*Based on calibrated labour supply*	
	Average wage elasticity		Change in participation	Average wage elasticity	Change in participation
	All hours	Observed hours >0	In percentage points	At observed discretised positive hours	Percentage points
Married male with children					
16-24	0.39	0.39*	0.19	0.16*	0.27
25-34	0.19	0.19	0.12	0.04	0.07
35-44	0.13	0.13	0.09	0.03	0.09
45-54	0.19	0.18	0.13	0.02	0.13
55-64	0.27	0.17	0.18	0.28	0.33
Married female with children					
16-24	1.40	0.70*	0.20	0.00*	0.09
25-34	0.81	0.70	0.22	0.37	0.12
35-44	0.62	0.67	0.23	0.60	0.12
45-54	0.43	0.46	0.20	0.38	0.15
55-64	0.41*	0.00*	0.13*	0.60*	0.48*
Cross wage elasticities					
Married male without children					
16-24	0.10	0.11	0.10	-0.04	-0.00
25-34	-0.02	-0.02	0.00	-0.05	-0.01
35-44	-0.01	-0.03	0.02	-0.02	0.02
45-54	0.08	0.09	0.07	0.01	0.03
55-64	0.12	0.15	0.07	-0.00	0.07
Married female without children					
16-24	0.08	0.11	0.02	-0.03	0.03
25-34	-0.03	-0.02	0.00	0.02	0.01
35-44	-0.05	-0.00	-0.02	-0.07	0.01
45-54	0.09	0.11	0.09	-0.15	0.00
55-64	0.23	0.10	0.11	0.01	0.11
Married male with children					
16-24	0.09	0.11*	0.04	0.13*	0.07
25-34	0.03	0.03	0.03	-0.02	0.01
35-44	0.01	0.01	0.02	-0.02	0.02
45-54	0.02	0.01	0.02	-0.04	0.01
55-64	0.10	-0.00	0.10	-0.12	0.10
Married female with children					
16-24	1.12	0.42*	0.15	-0.60*	0.05
25-34	0.04	-0.03	0.02	-0.12	-0.01
35-44	0.16	0.14	0.07	-0.08	0.02
45-54	0.01	-0.02	0.01	-0.17	-0.05
55-64	-0.32*	-0.84*	-0.22*	-0.34*	0.20*

*denotes estimate based on a relatively small cell size (n<20) and so should be treated with caution.

Table 3 Implied average uncompensated wage elasticities by demographic group and education level (Australia)

Demographic group by education level	*Based on expected labour supply*			*Based on calibrated labour supply*	
	Average wage elasticity		Change in participation	Average wage elasticity	Change in participation
	All hours	Observed hours >0	Percentage points	At observed discretised positive hours	Percentage points
Single male					
Year 12 or less	0.25	0.26	0.18	0.05	0.16
Vocational qualification	0.23	0.22	0.18	0.03	0.22
Diploma	0.10	0.12	0.09	0.01	0.23
Degree	0.12	0.11	0.12	0.01	0.10
Single female					
Year 12 or less	0.56	0.32	0.21	0.14	0.18
Vocational qualification	0.21	0.20	0.16	0.03	0.11
Diploma	0.25	0.10	0.21	-0.04	0.35
Degree	0.15	0.10	0.14	0.02	0.11
Sole parent					
Year 12 or less	1.55	1.91	0.38	0.79	0.23
Vocational qualification	1.62	1.67	0.45	0.59	0.16
Diploma	1.70	1.23	0.61	1.58	0.48
Degree	0.83	0.61	0.33	0.54	0.27
Married male without children					
Year 12 or less	0.49	0.46	0.27	0.04	0.23
Vocational qualification	0.27	0.22	0.17	0.20	0.16
Diploma	0.21	0.18	0.16	0.03	0.22
Degree	0.14	0.12	0.11	0.05	0.16
Married female without children					
Year 12 or less	0.51	0.52	0.21	0.15	0.20
Vocational qualification	0.33	0.22	0.15	0.46	0.09
Diploma	0.41	0.36	0.21	0.23	0.16
Degree	0.26	0.18	0.10	0.15	0.20
Married male with children					
Year 12 or less	0.24	0.23	0.16	0.04	0.16
Vocational qualification	0.15	0.14	0.10	0.04	0.07
Diploma	0.12	0.09	0.07	0.04	0.09
Degree	0.10	0.10	0.06	0.04	0.09
Married female with children					
Year 12 or less	0.75	0.73	0.21	0.45	0.13
Vocational qualification	0.57	0.55	0.21	0.30	0.08
Diploma	0.57	0.66	0.27	0.70	0.11
Degree	0.58	0.48	0.23	0.67	0.19

Table 3 continued

Demographic group by education level	Based on expected labour supply			Based on calibrated labour supply	
	Average wage elasticity		Change in participation	Average wage elasticity	Change in participation
	All hours	Observed hours >0	Percentage points	At observed discretised positive hours	Percentage points
Cross wage elasticities					
Married male without children					
Year 12 or less	0.12	0.12	0.07	-0.02	0.05
Vocational qualification	0.04	0.04	0.04	-0.01	0.02
Diploma	0.02	0.03	0.04	-0.01	0.01
Degree	0.01	-0.00	0.02	-0.01	0.03
Married female without children					
Year 12 or less	0.13	0.13	0.09	-0.09	0.06
Vocational qualification	0.08	0.02	0.03	-0.10	-0.05
Diploma	-0.05	0.00	0.03	0.06	0.03
Degree	-0.05	-0.05	-0.02	0.02	0.03
Married male with children					
Year 12 or less	0.04	0.04	0.04	-0.02	0.05
Vocational qualification	0.03	0.02	0.03	-0.03	-0.01
Diploma	-0.00	-0.01	0.02	0.02	0.05
Degree	-0.01	-0.01	0.01	-0.05	0.01
Married female with children					
Year 12 or less	0.22	0.14	0.06	-0.07	0.03
Vocational qualification	0.11	0.02	0.06	-0.22	-0.09
Diploma	-0.06	0.06	0.02	-0.10	-0.06
Degree	-0.07	-0.08	-0.02	-0.12	0.06

In Table 4, elasticities based on the most recent set of labour supply parameters for Australia are presented. To allow for easier comparison with the New Zealand elasticities, the same approach as needed to be taken for New Zealand was computed for this table in addition to the approach used in Tables 1 to 3. Although the actual elasticities have changed compared to those based on the earlier parameters, as in Table 1, married/de facto women and single parents are predicted to have the highest wage elasticities. As in Table 1, the cross wage elasticities are small, and only when using calibrated labour supply are negative cross wage elasticities observed.

The elasticities are clearly sensitive to the moment of averaging across the sample, although the general patterns remain roughly the same. When using expected labour supply, using the same approach as was used for New Zealand results in somewhat lower elasticities compared to first computing the individual elasticities before averaging these over the sample. The differences between these two approaches are larger and less predictable when the elasticities are based on the calibrated labour supply. This is at least partly due to the fact that more observations can be used when applying the New Zealand approach since those not working before the wage increase can now be included in the calculation based on calibrated labour supply.

Table 4 Implied average uncompensated wage elasticities[a] by demographic group based on 1999-2004 labour supply estimates (Australia)

	Based on expected labour supply			*Based on calibrated labour supply*	
	Average wage elasticity		Change in participation	Average wage elasticity	Change in participation
Demographic group	All hours	Observed hours >0	Percentage points	At observed discretised positive hours	Percentage points
Single male	0.33 [0.30]	0.33	0.20	0.16 [0.28]	0.19
Single female	0.28 [0.19]	0.24	0.17	0.06 [0.19]	0.17
Sole parent	0.90 [0.70]	0.85	0.29	0.41 [0.59]	0.26
Married male without children	0.49 [0.36]	0.41	0.24	0.31 [0.32]	0.20
Married female without children	0.70 [0.54]	0.58	0.25	0.54 [0.43]	0.19
Married male with children	0.27 [0.25]	0.26	0.15	0.16 [0.16]	0.09
Married female with children	0.86 [0.75]	0.84	0.32	0.90 [0.52]	0.16
Cross Wage elasticities					
Married males without children	0.07 [0.03]	0.04	0.06	-0.03 [-0.01]	0.02
Married females without children	0.07 [-0.02]	-0.00	0.05	-0.12 [-0.07]	0.03
Married males with children	0.03 [0.02]	0.02	0.04	-0.02 [-0.02]	0.01
Married females with children	0.12 [0.01]	0.01	0.06	-0.10 [-0.06]	0.04

Note: a) [..] indicates the elasticity when using the New Zealand approach of computing average hours across the sample before and after the wage change first, before computing elasticities based on these averages.

5.3 Results for New Zealand

Table 5 presents the wage elasticities for New Zealand. The elasticities are calculated based on samples excluding people over 65, disabled individuals, full-time students and the self-employed, for whom labour supply is not simulated in TaxMod-B. The information that is available only allows elasticities to be broken down by age and couple families cannot be further subdivided into those with and without dependent children. In addition, the wage change of 10 per cent is applied across the board which means that the head's and spouse's wages are increased at the same time. The elasticities for couples presented in Table 5 are therefore different from those usually presented in that they combine own and cross wage elasticities. Given the results for Australia, it is expected that the own wage elasticities dominate and that the results are likely to be close to the own wage elasticities.

Table 5 – Expected Labour Supply, Wage Elasticities and Non-participation Rates[a] by age and demographic group (New Zealand)

	Married men[b]	**Married women[b]**	**Single men**	**Single women**	**Sole parents[c]**
			Expected hours per week		
all	34.75	19.75	29.26	25.28	10.55
Wage increase of 10%[d]	35.56	20.50	31.10	27.35	10.91
Implied elasticity	*0.23*	*0.38*	*0.63*	*0.82*	*0.34*
Selection: people <= 30	35.60	20.17	30.16	28.46	
Wage increase of 10%	36.39	20.85	31.83	30.60	
Implied elasticity	*0.22*	*0.34*	*0.55*	*0.75*	
Selection: people 31-50	38.07	21.01	32.19	28.88	
Wage increase of 10%	38.50	21.79	34.28	30.97	
Implied elasticity	*0.11*	*0.37*	*0.65*	*0.72*	
Selection: people > 50	26.46	15.28	17.79	14.30	
Wage increase of 10%	27.53	16.17	19.94	16.22	
Implied elasticity	*0.40*	*0.58*	*1.21*	*1.34*	
Selection: people > 60	13.86	6.50	6.40	6.09	
Wage increase of 10%	14.91	7.04	7.59	7.17	
Implied elasticity	*0.76*	*0.83*	*1.86*	*1.77*	
			Expected non-participation in %		
all	19.2	39.2	30.2	33.3	65.1
Wage increase of 10%	17.5	37.3	26.1	28.8	64.3
Selection: people <= 30	17.1	40.0	27.3	25.7	
Wage increase of 10%	15.4	38.3	23.7	21.4	
Selection: people 31-50	12.2	35.0	24.9	25.6	
Wage increase of 10%	10.7	33.0	20.2	21.0	
Selection: people > 50	36.8	51.2	57.3	58.5	
Wage increase of 10%	34.4	48.9	52.3	53.6	
Selection: people > 60	65.2	75.3	83.5	78.4	
Wage increase of 10%	62.6	73.7	80.6	75.1	

Note a: Expected labour supply is calculated at the sample characteristics. Average unweighted expected hours of work are computed across the samples.

b: Wages increase for both partners in a couple at the same time.

c: The information by age is not available for sole parents.

d: To approximate elasticities, a wage increase of 1 per cent would have been better. It would also have made the results more comparable to the Australian numbers.

The order of magnitude of elasticities in New Zealand are comparable to those in Australia, although single men and women in New Zealand appear more responsive to wage increases than singles in Australia and married/de facto women and single parents appear less responsive.

The elasticities by age have to interpreted cautiously, since no separate labour supply models have been estimated for those close to retirement age. So for example, health and the amount of assets accumulated by the household are not taken into account in the labour supply decision. These two factors are known to play an important role in retirement decisions. However, eligibility for the superannuation payment, another important factor, was taken into account. In the period over which the models were estimated, an important change to the state-provided superannuation was taking place. The age of eligibility for the universal superannuation payment was gradually increased from 60 to 65 in the period from April 1992 to April 2001. This large change in financial incentive clearly affected individuals' labour supply decisions despite that it concerned the older age groups only. It helped us identify the parameters of the models. It would be of interest to examine the effect of this change in the age eligibility while allowing for the effects of other factors such as health as well.

5.4 Comparisons with other countries

The range of elasticities published in the literature is fairly wide, with large differences between studies using different data and approaches; see overviews by Killingsworth (1983), Killingsworth and Heckman (1986), Pencavel (1986) or more recently by Blundell and MaCurdy (1999) or Hotz and Scholz (2003). The implicit labour supply elasticities in MITTS and TaxMod-B are similar to those generally found within the international literature. The results for married and single men and women are well within the range of results usually found.

The elasticity for single parents is often found to be larger than for other groups and this is also found in MITTS for Australia, but not for New Zealand. Compared to other countries the labour force participation of single parents in New Zealand (and Australia to a lesser extent) is low. To understand whether the relatively lower elasticity for single parents in New Zealand is due to differences in behaviour or whether the tax and social security system imposes/imposed disincentives which are/were larger in New Zealand than in Australia, further analysis would be required. For example, a comparison could be made between the marginal effective tax rates of single parents in the two countries, examining how the gross wage rate change translates into a net wage rate change. In addition, more up to date data could be used to check the persistence of the difference in elasticities.

The elasticity for single parents implicit in MITTS is at the higher end of this range internationally, although other evidence of a high labour supply responsiveness for single parents in Australia has been found by Murray (1996), Duncan and Harris (2002) and Doiron (2004). Murray (1996) found values between 0.13 and 1.64, depending on the exact specification, for part-time working single mothers. The elasticities for full-time workers and single parents out of the labour force are much smaller, at most 0.30. Murray used 1986 data, where only 13 per cent of all single mothers worked part time and about 23 per cent worked full time. In the 2001 data used here, around 50 per cent of single parents work, and about half of the workers are employed between 1 and 35 hours per week.

Duncan and Harris (2002) analysed the effect of four hypothetical reforms, using a previous version of the labour supply models underlying the behavioural responses in MITTS. Two of these reforms are close to being a 10 per cent increase and 10 per cent decrease in single parents' wage rates. The first is to decrease the withdrawal rate for single parents by 10 per cent, which increases their marginal wage rate while they are on lower levels of income. Duncan and Harris report that this is expected to increase labour force participation by 2.5 percentage points and increase average hours by 0.55 hours. The second reform increases the lowest income tax rate from 20 to 30 per cent. This is expected to decrease participation by 2.8 percentage points and decrease average hours by 1.2 hours. Comparing this with the effect of a 10 per cent wage increase using recent labour supply parameters and data from 2000/2001, effects of a similar magnitude are found. That is, participation is expected to increase by 2.2 percentage points and the average hours are expected to increase by 1.0 hours.

Finally, Doiron (2004) evaluated a policy reform affecting single parents in the late 1980s and found large labour supply effects. Doiron compared the effect obtained through the natural experiment approach with predicted effects of policy changes from the MITTS model, as found in Duncan and Harris (2002) or Creedy, Kalb and Kew (2003). Based on the results from her evaluation, Doiron argued that observed shifts in labour supply of single parents can equal or even surpass the predictions based on behavioural microsimulation.

These results suggest that single parents' labour supply elasticities may be substantial. This is perhaps not surprising, given the low participation rate of single parents and the tendency to work low part-time hours. An increase in labour supply by one hour is a larger percentage increase compared with the same increase for a married man. For the other demographic groups, elasticities of those working few hours are also generally higher than for those in the same group who work greater hours. The single parent group is the smallest demographic group in the population. Thus, a change in their labour supply responsiveness would have a relatively small effect on the overall result .

Another way of validating results is by comparing the predicted effects of a policy change obtained through a simulation with the estimated effects of the policy change after it has been introduced. The problem with this approach is that it is often difficult to find policy changes that can be evaluated accurately. It can be difficult to find a control group with which to compare a treatment group (those affected by the policy change).

Blundell *et al*. (2004) evaluated a range of labour market reforms in the UK by a difference-in-difference approach at the same time as simulating the effects of these reforms. They found similar results for sole parents and married women, but for married men the estimated effects were opposite. They suggested that this could be due to a number of reasons related to the analyses, such as differences in sample selection rules, not accounting for other changes that occurred at the same time as the reforms or not accounting for general equilibrium effects changing the distribution of wages.

It has been difficult to find policy changes in Australia which could be used to test MITTS in a similar way. Some results comparing, for sole parents, the effect of the Australian New Tax System introduced in July 2000 calculated by MITTS with the effect calculated using a difference-in-difference evaluation approach are available; see Cai *et al.* (2008). The results indicate that, if anything, the simulated effects appear to be smaller than the effect of the policy change as estimated through an evaluation approach.

6. Conclusion

This paper has made a first comparison between the implied elasticities of two sets of labour supply models: one for Australia and the other for New Zealand. Given that I have no longer access to the New Zealand microsimulation model or data, an in-depth comparison has not been possible. Nevertheless, some information from earlier research was still available and has been used to obtain an indication of the similarity of the two sets of labour supply responses.

The order of magnitude of the elasticities is broadly speaking comparable but there appear to be differences in the groups that are most responsive to financial incentives. In New Zealand, single men and women appear most responsive, whereas in Australia single parents and married/de facto women are most responsive.

More analysis would be needed to confirm whether this difference still holds when using more recent New Zealand data and when applying the same approach to approximate elasticities in both countries, such as using a 1 per cent increase in wage instead of a 10 per cent increase. In addition, if the difference holds, more in-depth analysis would be required to determine whether there appear to be differences in behaviour or whether the tax and transfer system imposes/imposed more disincentives for some groups in Australia compared to New Zealand or vice versa.

References

Apps, P. and Savage, E. (1989) Labour supply, welfare rankings and the measurement of inequality. *Journal of Public Economics*, 47, pp. 336-364.

Banks, J., Blundell, R. and Lewbel, A. (1996) Tax reform and welfare measurement: do we need demand system estimation? *Economic Journal*, 106, pp. 1227-1241.

Blundell, R. and MaCurdy, T. (1999) Labor supply: a review of alternative approaches. In *Handbook of Labor Economics*, Vol. 3 (ed. by O.C. Ashenfelter and D. Card), pp. 1559-1695. Amsterdam: North-Holland.

Blundell, R.W., Meghir, C., Symons, E. and Walker, I. (1986) A labour supply model for the simulation of tax and benefit reforms. In *Unemployment, Search and Labour Supply* (ed. by R.W. Blundell and I. Walker), pp. 267-293. Cambridge: Cambridge University Press.

Blundell, R., Brewer, M., Duncan, A., Reed, H. and Shephard, A. (2004) *The Employment Impact of Labour Market Reforms: A Bank of England Report*. London: Institute for Fiscal Studies.

Buddelmeyer, H., Creedy, J. and Kalb, G. (2007), *Tax Policy Design and Behavioural Microsimulation Modelling*. Cheltenham: Edward Elgar.

Buddelmeyer, H., Dawkins, P., Duncan, A., Kalb, G. and Scutella, R. (2004a) An analysis of the Australian Labor Party's tax and family benefits package: using the Melbourne Institute Tax and Transfer Simulator (MITTS). Report to the Australian Labor Party, September 2004.

Buddelmeyer, H., Dawkins, P., Freebairn, J. and Kalb, G. (2004b) Bracket creep, effective marginal tax rates and alternative tax packages. *Mercer–Melbourne Institute Quarterly Bulletin of Economic Trends*, 1.04, pp. 17-28.

Buddelmeyer, H., Dawkins, P. and Kalb, G. (2004) The Melbourne Institute report on the 2004 Federal Budget. *Mercer–Melbourne Institute Quarterly Bulletin of Economic Trends*, 2.04, pp. 19-23.

Cai, L., Kalb, G., Tseng, Y.-P. and Vu, H.H. (2008) "The Effect of Financial Incentives on Labour Supply: Evidence for Sole Parents from Microsimulation and Quasi-Experimental Evaluation", *Fiscal Studies*, 29(2), 285-325.

Callan, T. and Van Soest, A. (1996) Family labour supply and taxes in Ireland. ESRI Working Paper No. 78, Dublin: The Economic & Social Research Institute.

Creedy, J. (1999) *Modelling Indirect Taxes and Tax Reform*. Cheltenham: Edward Elgar.

Creedy, J. and Duncan, A.S. (2002) Behavioural microsimulation with labour supply responses. *Journal of Economic Surveys*, 16, pp. 1-39.

Creedy, J. and Kalb, G. (2005) Discrete hours labour supply modelling: specification, estimation and simulation. *Journal of Economic Surveys*, 19, pp. 697-734.

Creedy, J., Duncan, A.S., Harris, M. and Scutella, R. (2002) Microsimulation Modelling of Taxation and the Labour Market: The Melbourne Institute Tax and Transfer Simulator. Cheltenham: Edward Elgar.

Creedy, J., Kalb, G. and Kew, H. (2003) Flattening the effective marginal tax rate structure in Australia: policy simulations using the Melbourne Institute Tax and Transfer Simulator. *Australian Economic Review*, 36, pp. 156-172.

Doiron, D.J. (2004) Welfare reform and the labour supply of lone parents in Australia: a natural experiment approach. *Economic Record*, 80, pp. 157-176.

Duncan, A.S. (1993) Labour supply decisions and non-convex budget sets: the case of National Insurance contributions in the UK. In *Empirical Approaches to Fiscal Policy* (ed. by A. Heimler and D. Meulders), pp. 137-162. London: Chapman & Hall.

Duncan, A.S. and Giles, C. (1996) Labour supply incentives and recent family credit reforms. *Economic Journal*, 106, pp. 142-155.

Duncan, A. and Harris, M.N. (2002) Simulating the behavioural effects of welfare reforms among sole parents in Australia. *Economic Record*, 78, pp. 264-276.

Duncan, A., Giles, C. and MacCrae, J. (1999) Household labour supply, childcare costs and in-work benefits: modelling the impact of the working families tax credit in the UK. Unpublished paper, Institute for Fiscal Studies, London.

Hotz, V.J. and Scholz, J.K. (2003) The earned income tax credit. In *Means-Tested Transfer Programs in the United States* (ed. by R. Moffitt), pp. 141-197. Chicago: The University of Chicago Press.

Kalb, G. (2002) Estimation of labour supply models for four separate groups in the Australian population. *Melbourne Institute Working Paper*, no. 24/02.

Kalb, G. and Scutella, R. (2002) Estimation of wage equations in Australia: allowing for censored observations of labour supply. *Melbourne Institute Working Paper*, no. 8/2002.

Kalb, G. and Scutella, R. (2003) New Zealand labour supply from 1991-2001: an analysis based on a discrete choice structural utility model. *New Zealand Treasury Working Paper*, no. 03/23.

Kalb, G. and Scutella, R. (2004) Wage and employment rates in New Zealand from 1991 to 2001. *New Zealand Economic Papers*, 38, pp. 21-47.

Keane, M. and Moffitt, R. (1998) A structural model of multiple welfare program participation and labor supply. *International Economic Review*, 39(3), pp. 553-589.

Killingsworth, M.R. (1983) *Labor Supply*. New York: Cambridge University Press.

Killingsworth, M.R. and Heckman, J.J. (1986) Female labor supply. In *Handbook of Labor Economics*, Vol. 1 (ed. by O.C. Ashenfelter and R. Layard), pp. 103-204. Amsterdam: North-Holland.

Klevmarken, N.A. (1997) Modelling behavioural response in EUROMOD. University of Cambridge *Department of Applied Economics Working Paper*, no. 9720.

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

Moffitt, R. (2000) Simulating transfer programmes and labour supply. In *Taxes, Transfers and Labour Market Responses: What Can Microsimulation Tell Us?* (ed. by T. Callan), pp. 1-22. Dublin: The Economic and Social Research Institute.

Murray, J. (1996) Modelling the labour supply behaviour of sole parents in Australia. In *Proceedings of the Econometric Society Australasian Meeting 1996, Volume 4: Microeconometrics* (ed. by M. McAleer, P. Miller and C. Ong), pp. 507-546. Perth: Uniprint, University of Western Australia.

Pencavel, J. (1986) Labor supply of men. In *Handbook of Labor Economics*, Vol. 1 (ed. by O.C. Ashenfelter and R. Layard), pp. 3-102. Amsterdam: North-Holland.

Stern, N.H. (1986) On the specification of labour supply functions. In *Unemployment, Search and Labour Supply* (ed. by R.W. Blundell and I. Walker), pp. 143-189. Cambridge: Cambridge University Press.

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