AN INTRODUCTION TO MICROSIMULATION MODELS OF TAX REFORM

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Abstract

This paper describes the steps involved in the construction of a static microsimulation model for assessing the revenue and distributional impact of tax reform options. It identifies the areas where methodological differences may exist and examines the methodology underlying the 'cameos' published in the Government's recent *Tax Reform* document. It also identifies possible areas for further questions or action by the Senate Committee.

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1 Introduction

1.1 Modelling tax reform: overview

A model's output is only as good as its input. However, it is important to recognise that models cannot be expected to tell the absolute "truth". After all, they are only simplified representations of reality, which have as their primary purpose the highlighting of relationships and issues that are important.

What models do is discipline the economist and policy adviser in their thinking and working through particular issues. A healthy respect for the limitations of economic models is an important prerequisite to appreciating the benefits to be gained from such models. Generally, there are two different types of approaches to modelling the impact of tax reforms. These are *Economy Wide Models* and *Sector Specific Models*. This report is not concerned with the former although some brief insight is provided into these models in Attachment A.

While the economy wide models are synonymous with macroeconomic models, sector specific models are like microeconomic models which focus on just one element of the macroeconomy. Microeconomic models have taken two forms - those that seek to model households and those that model businesses. Our concern here will be with the former and in particular, with those models designed to examine how taxes come to be borne by different types of households. Such models are used to examine, for example, how tax changes impact on specific groups such as working households with two adults and two children or how a very specific tax change impacts on the tax revenue from very precisely defined tax packages.

1.2 Australian tax reform microsimulation models

This paper provides an introduction to microsimulation models of the household sector used for evaluating the revenue and distributional implications of tax reform packages. There are four main such models in use in Australia. These are:

- the PRISMOD model developed by the Federal Treasury;

- the STINMOD-STATAX model developed by NATSEM and Professor Neil Warren;
- the Melbourne Institute model, and
- the ABS fiscal incidence study model.

1.3 PRISMOD

PRISMOD stands for the **P**rice **R**evenue **I**ncidence **S**imulation **MOD**el, developed by the Federal Treasury. PRISMOD has had a number of phases in its evolution. It was initially called TAXIO (**TAX** and **I**nput **O**utput Model) and was used by the Federal Treasury in their analysis for the 1985 *Draft White Paper* on indirect tax reform. In particular, it was used to model the impact on households of the proposed changes to indirect taxes which centred around the introduction of a 12.5 per cent retail sales tax (called a Broad Based Consumption Tax). A paper on this model was presented at the 1986 *Conference of Economists* (Wright and Henry, 1986). When the Liberal Opposition party began its work on the Fightback! tax reform package in 1990, the then Labor government responded by funding the setting up in 1991 of a Microeconomic Modelling Unit within the Treasury. TAXIO subsequently evolved into PRISMOD. PRISMOD was subsequently used to simulate the impact of the Fightback! tax reform proposals. The basic details of this model were detailed in a *Treasury Press Release* on 11 March 1992. The model was more fully explained at an *Australasian Economic Modelling Conference* later in 1992 (Henry and Wright, 1992).

PRISMOD has been further refined since its use in analysing the Fightback! tax reform proposals and was used in the recently released government report on *Tax Reform* (Treasurer, 1998).

PRISMOD is a comprehensive model embracing reforms to the direct and indirect tax system and to cash transfers. However, the part of PRISMOD which examines the distributional impact of reforms and estimates the impact of changes to the personal income tax schedule and the social welfare system, has been derived from a version of NATSEM's STINMOD model. The ultimate output from the other key part of PRISMOD – the indirect tax side - is estimates of business costs and consumer price vectors, of the type presented in the *Tax Reform* document (1998, p. 167-172).

1.4 STINMOD-STATAX

STATAX is a model designed to undertake a **ST**atic **A**nalysis of **TAX**es and was originally developed by Neil Warren on a six month secondment to EPAC from January to June 1985. It was primarily used to evaluate submissions to the 1985 National Tax Summit. The model originally comprised three modules: a personal income tax module, indirect tax module and a social welfare module. The indirect tax module was developed at the same time as TAXIO was being developed by the Federal Treasury. In fact, STATAX owes much to joint work undertaken between EPAC and the Federal Treasury in early 1985. Results from STATAX in relation to a number of submissions to EPAC were tabled at the Tax Summit as part of EPAC's submission to the Summit.

STATAX has gone through a number of evolutions the first of which was reported in Warren(1987), which factored in a number of the enhancements raised in the Henry and Wright(1986) paper where TAXIO evolved into PRISMOD It was this form of STATAX that was used in the distributional analysis undertaken in Fightback!.

With the increasing complexity of the social welfare system and the trend towards specialisation in model building, a decision was made in 1997 to incorporate the STATAX Indirect Tax (IT) module into the STINMOD model (developed by NATSEM). The STINMOD model is the most comprehensive model available in Australia of the distributional impact of income taxes and cash transfers, and it is used by the major Federal Government departments, including Family and Community Services and the Treasury.

The STINMOD-STATAX model is now operational and has been used to estimate the distributional impact of current tax and social welfare programs (Harding and Warren, 1998). It has also been used to examine the distributional implications of a number of tax and welfare reform packages. STATAX models all Federal, State and local taxes, which is not the case with PRISMOD. In recent years PRISMODs coverage has been extended but it is not comprehensive.

1.5 Melbourne Institute

The Melbourne Institute has recently developed a model capable of simulating the distributional impact of indirect taxes. The particular model developed to

examine tax incidence on households is a minor revision of that developed by Chisholm(1993). This model was subsequently updated by Scutella (1997 – see also Johnson *et al*, 1998a and 1998b).

The model is not as sophisticated as PRISMOD nor STATAX, nor as comprehensive in its treatment of indirect taxes. In addition, the model does not simulate the cash transfer or income tax systems. This means that it is not capable of analysing the impact of tax reform packages which embrace reforms to direct and indirect taxes and cash transfers. For example, the results from the Institute's own modelling of the indirect tax system are blended with the Treasury's estimates of the change in income taxes and social welfare payments in order to produce estimates of the overall distributional impact of the *Tax Reform* package (Johnson et al, 1998b).

1.6 ABS fiscal incidence studies

The ABS fiscal incidence studies use similar data sources to the three models outlined above (ABS, 1996). The modelling approach adopted is relatively simple and builds on the methodology developed by the UK Central Statistical Office, who undertake a conceptually similar study.

There are a number of major limitations to the ABS model. One is that it is concerned with the status quo and is not designed to examine tax reforms. It is thus not capable of simulating the distributional impact of tax reforms.

Another is that the ABS allocates to households only those taxes that can be directly attributed to households through their final consumption expenditure. Indirect taxes that fall on investment goods for example, are ignored in the ABS study. (In contrast, the wholesale sales tax paid on computer equipment when it is purchased by an airline is assumed in STINMOD–STATAX to be subsequently borne by consumers when they purchase airline tickets.) As a result, less than half of all indirect taxes are allocated in the ABS study. In addition, company tax is excluded. The ABS study is therefore *not* reporting the effect of *all* taxes on households.

In summary, only the PRISMOD model and STINMOD-STATAX are capable of assessing the distributional impact of tax reforms involving changes in direct and indirect taxes and cash transfers.

1.7 Structure of this paper

The goal of this paper is to describe the main steps involved in the construction of microsimulation models of tax reform; to identify where methodological differences may exist; and to briefly examine the recent results presented using the PRISMOD model in the *Tax Reform* document published by the Treasurer in August 1998.

Sections 2 to 5 of this paper describe the steps involved in the construction of such microsimulation models. Section 6 looks at how we measure whether or not households are winners or losers from a tax reform. Section 7 examines the methodology underlying the cameos presented in the *Tax Reform* document.

2 Selecting the base data

To simulate the full distributional impact of the current tax system and possible alternative tax systems upon households a representative sample of the Australian population is required. This base data needs to include information about the demographic, labour force and income characteristics of households, as well as details about their expenditure patterns. Details about income and family structure are required so that the current income tax and government cash transfer programs (such as age pension) can be simulated. Details about expenditure are required so that the current indirect tax system can be simulated.

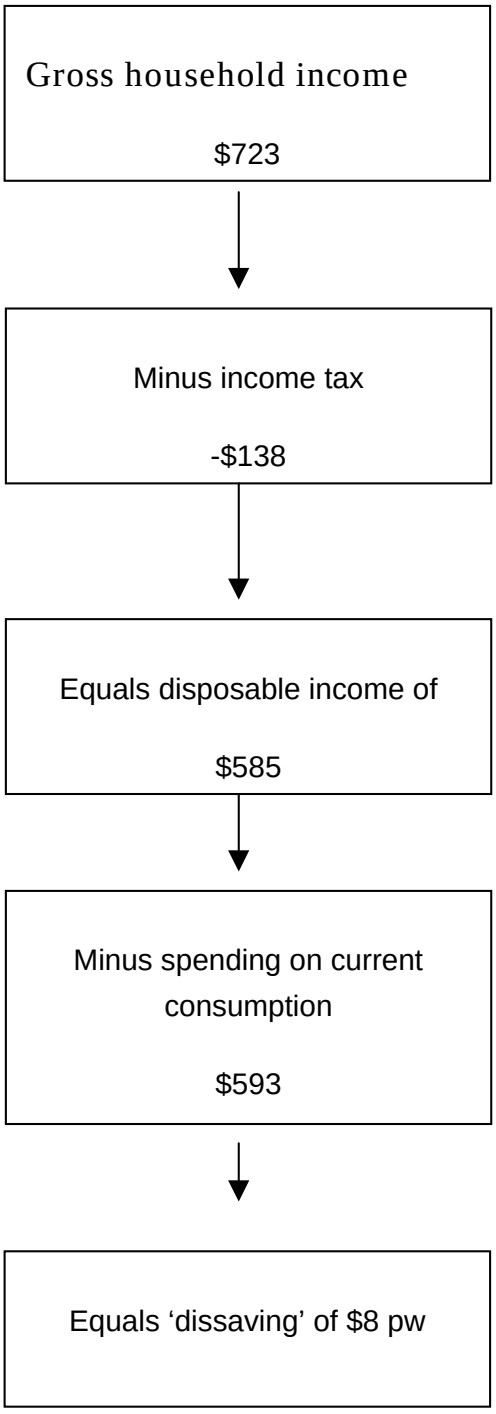
There is only one possible such data source in Australia, which is the Household Expenditure Survey microdata tape produced by the Australian Bureau of Statistics. This survey is produced every four years or so. The latest available data is for 1993-94, which covers about 8,400 households. The data are provided by the ABS with a set of weights, to allow estimates to be 'grossed up' from this representative sample to estimates for the entire Australian population. For example, if the first household in the microdata tape has a weight of 300, it means that the ABS estimates that there are 300 similar such households living in Australia, and the results for this household are thus multiplied by 300 when deriving estimates for the entire population. Only the population living in private dwellings is included (ie. those living in prisons or nursing homes, for example, are excluded from the sample).

The HES is not, however, a perfect data source for undertaking tax reform analysis, as has been pointed out by a number of authors (Wright and Henry, 1985; Harding, 1992; Treasury, 1992;Carnahan, 1998). The results for the average household in the 1993-94 HES clearly illustrate the core of the problem. According to the ABS, average household income in 1993-94 was $723. Out of this, the average household paid $138 in income tax, leaving $585 to either spend on goods and services or to save (Figure 1). Expenditure on goods and services for current consumption was $593, which means that, if the figures are taken at face value, then the average household was 'dissaving' to the tune of $8 a week. And this does not include all items of expenditure. The ABS also records three other types of expenditure - on repaying mortgage principals, on other capital housing costs (such as extensions) and on superannuation and life insurance. It is not clear to what extent these payments should be regarded as 'spending', as in many ways they could also be regarded as 'savings'. However, expenditure on these items was about $72 a week for the average household, raising the possible extent of 'dissaving' to about $80 a week.

Clearly, no one believes that the average Australian household is spending $80 a week more than it earns. The ABS itself notes that, for a range of reasons, 'HES income and expenditure estimates therefore do not balance for individual households or for groups of households and the difference between income and expenditure cannot be considered to be a measure of saving' (ABS, 1995, p. 27).

Why is there this mismatch between the income and expenditure estimates in the HES? One problem is that the definition of income used in the HES is 'usual cash receipts that were regular and recurring'. Thus, receipts which were excluded from the measure of income because they were not 'cash', 'regular' or 'recurring' included inheritances and legacies, non-recurring gifts from other households, maturity payments on life insurance policies, lump sum compensation for injuries, capital gains, and receipts from loans or credit obtained. In other words, many of the sources of income from which households might finance their expenditure were not included within the income measure. Thus, if a household financed this month's spending on an overseas holiday from last month's inheritance from Uncle Bob, the spending was recorded in the HES survey but not the income.

Figure 1 Income and expenditure of average household in 1993-94



Source: ABS (1995, p. 5)

Another issue is that income can be measured over different time periods. Collecting usual income from wage and salary households is relatively simple. But collecting usual income from self-employed households or those living on their investments is often much more difficult. In many such cases, the ABS takes taxable income from self-employment or investments in the preceding financial year and divides it by 52 to derive an estimate of current weekly income for use in the HES. This means that the value of 'current weekly income' given to a household may not reflect their real income at that point in time. Comparison with the National Accounts also suggests that receipt of investment and self-employment income is substantially understated in the HES.

Another important issue relates to the purchase of consumer durables. Households in the HES sample are asked to keep a two week diary to record their expenditure of frequently purchased goods and services. But many important items are purchased only infrequently, such as houses or consumer durables such as televisions or cars. For such irregular or infrequent expenditures, the ABS administers a special questionnaire with a longer recall period. As Carnahan explains:

> 'the sample is so designed that the inclusion of lumpy expenditures incurred in a relatively short reporting period provides a reasonable proxy for the cost of the ongoing service flows associated with those durable expenditures – *provided one is concerned with the average expenditure of the full sample.* For example, the purchase of a house by one household is balanced by sales by other households and the lack of such expenditure for many other households during the relatively short reporting period of the HES. When the sample average is calculated, the average expenditure on housing services is believed to be representative on an ongoing or weekly basis." (1998, p. 8 – emphasis in original).

Carnahan argues that because of this infrequent nature of purchase of consumer durables, the results for small sub-groups of the population using the HES are suspect. (For example, the results for sole parents with three children can be distorted if one such sole parent in the HES sample purchased or sold a car – even though the results might be reliable if the entire population was examined.)

Finally, comparisons between the HES and the National Accounts indicate that spending on 'sin goods' is understated in the HES, particularly alcohol and tobacco. As a result, the shares of household expenditure for typical households do not match either those suggested by the National Accounts or those used in the construction of the Consumer Price Index (CPI).

Clearly the HES data do not provide a perfect guide to the real income and expenditure patterns of Australians. Treasury recently argued that these problems were of sufficient magnitude that distributional analysis of tax reform using microsimulation models and the HES data should not be undertaken (Carnahan, 1998, p. 2).

2.1 The dissaving issue

Why do the above issues create such difficulties for assessing tax reform packages? There are two key issues – the dissaving issue and the price effects. One problem created by the dissaving issue is that it potentially increases the difficulties for governments trying to introduce large tax mix shifts. The central idea of tax mix shifts is that the new indirect taxes paid by consumers following the introduction of a goods and services tax will be offset by either income tax cuts or increases in government cash transfers or tax credits. Initially, the idea of compensation appears simple. A distributionally neutral shift apparently requires returning to individuals, or at least to poor ones, by one or other means the extra consumption tax that they would pay. For example, if a single person with an after-tax income of $400 a week spends $300 of this income on goods and services, a GST which raised prices by 10 per cent would require spending $330 to buy the same basket of goods and services. A $30 income tax cut would allow this person to buy the same consumption bundle, and at first glance this would appear to provide adequate compensation for the effects of a new GST (Table 1).

However, in the longer term this taxpayer would be disadvantaged because the general increase in prices caused by the GST would reduce the real purchasing power of their savings. Maintaining the real disposable income of this taxpayer would require a $40, rather than a $30, income tax cut. As Table 1 illustrates, the 'maintenance of real disposable income' approach to compensation implies a different pattern of income tax cuts or cash transfer increases to that inherent in the 'maintenance of consumption' or ‘net cash gain’ approach. Both political parties have always adopted the maintenance of real disposable income approach to compensation when proposing large tax mix shifts in the 1980s and 1990s.

However, as the final column in Table 1 shows, the ‘maintenance of disposable incomes’ approach does not provide dissavers with sufficient in income tax cuts or transfer increases to compensate them for their new indirect tax burden. In the absence of other measures, the ‘maintenance of disposable

incomes' approach to compensation effectively transfers consumption from dissavers to savers - that is, usually from lower to higher income individuals. To offset this effect, cash transfer increases need to exceed the anticipated GST-caused increases in prices facing cash transfer recipients. Alternatively, compensation might be delivered via tax credits or via new cash transfer programs.

It is the apparent need to spend extra money on compensation caused by the presence of dissaving that explains why the degree of dissaving contained within the HES causes such difficulties for government. The real extent of dissaving is thus a critical issue for tax reforms which involve shifts in the tax mix towards consumption taxes. Much dissaving is the product of lifecycle factors - for example, the aged may run down financial savings or other assets acquired earlier while in the workforce. Other dissaving is due to (possibly temporary) misfortune or circumstances, such as when the unemployed spend severance payouts or students spend money earned during previous years. Similarly, students financing their current consumption out of student loans would appear to be dissaving in the HES. Some component of the apparent dissaving within the HES is due to the failure to include all income sources and, for self-employed households in particular, due to the possible failure of reported cash income to accurately reflect the real economic well-being of such households (Bradbury, 1996).

Because it only captures a snapshot of the circumstances of a family during the two weeks that they are in the ABS sample, the HES inevitably captures some families in transition- such as those moving between employment and unemployment or those leaving their marital home. But it also appears that the HES methodology overstates the extent of dissaving in Australia. What is at issue is how widespread such dissaving really is and to what extent is it a permanent rather than a transitory feature.

Table 1 Examples of alternative approaches to compensation

	Single Taxpayer		
	Saver	Exp = Income	Dissaver
Weekly disposable income	$400	$400	$400
Weekly expenditure	$300	$400	$500
Effect of GST[a]	$30	$40	$50
Tax cut or cash payment increase required to:			
- maintain consumption	$30	$40	$50
- maintain disposable income	$40	$40	$40

(a) For illustrative purposes, the GST is assumed to increase prices by 10 per cent.

Source: Harding (1998)

2.2 The price effects issue

The second critical problem created by the deficiencies of the HES data for the assessment of tax reform packages is the measurement of the increase in the prices facing each household as a result of the tax changes. Thus, after the entire model is finally completed and a tax reform shock is run, one of the outputs will be an estimate of how much more or less each household will have to pay to purchase the same bundle of goods and services as they did prior to the tax reform.

For particular types of tax reforms, some groups in the community can be expected to face higher price increases than others. For example, if a new tax upon food was introduced, low income groups could be expected to experience a greater percentage increase in the cost of their total consumption, because they spend a greater proportion of their income upon food than high income groups.

With a wide ranging tax reform, such as that recently suggested in the *Tax Reform* package, the ultimate price and distributional effects are not immediately obvious. Thus, while the proposed new tax upon food might hit the poor harder, the proposed new tax on services might hit higher income groups harder and the proposed abolition of some existing regressive indirect taxes such as FID might benefit the poor more.

For the reasons outlined above, the Treasury recently argued that the HES could not be reliably used to calculate household-specific price effects (1998). They thus advocated using the CPI change as the estimate of the price change facing all groups in the community. All those using the HES would acknowledge the difficulties identified by the Treasury: at issue, again, is the magnitude of the problems with the HES and whether these are sufficiently great to invalidate distributional analysis.

Possible questions/action

- Ask the ABS to appear before the Committee, and ask them whether they agree with the Carnahan conclusion that the HES cannot be used to calculate household specific price effects
- Ask the ABS for their views about why dissaving is so high in the HES and about whether estimates for particular groups (such as pensioners) might be more reliable than for others (such as the self-employed)
- Ask Treasury to present any analysis that they did about the extent of and characteristics of those dissaving

3 Ageing the base data

By the time the HES microdata file is released by the ABS, it is already out of date. For most tax reform analyses, it thus has to be aged to a recent financial year or the current financial year. For tax reform packages intended to occur in the near future, the base data may be aged to some years in the future. For the assessment of the Government's *Tax Reform* package, it appears that the PRISMOD base data were aged to 2000-01.

The aging of the base data in static microsimulation models usually involves two key steps – reweighting and uprating.

3.1 Reweighting the dataset

Because the HES is only a representative sample survey of the population, the results have to be weighted so that they can be 'grossed up' to estimates for the entire population in private dwellings. If the dataset is to be aged to a year in the recent past, the task is somewhat easier because the ABS Labour Force Survey can be used to provide estimates of the population by age, gender, labour force status and so on. If the dataset is to be aged to a future year, then projections of the future characteristics of the population must be used to provide the benchmark numbers to which the HES data are to be reweighted. The ABS provide population projections, but adjustments to these are required because the projections deal with the entire population, not just those living in private dwellings. The Department of Employment and the ABS both publish labour force projections, but these projections often differ from each other.

The mechanics of reweighting are not entirely straightforward. In the STINMOD-STATAX model, a two step reweighting procedure is followed. First, the weights are adjusted to match ABS labour force statistics by state, age, sex, labour force status, family status and study status, using the reweighting procedures described in detail in Landt et al (1994). While the weights calculated by the above method provide a good match between STINMOD and the ABS Labour Force Survey benchmarks, they do not always generate a good match with some of the benchmark data for the cash transfer programs modelled in STINMOD. The second step in the calculation of weights in STINMOD-STATAX is thus the adjustment of the weights calculated from the LFS matrix to give better results for administrative benchmarks. Using the CALMAR software developed by the Institut National de la Statistique et des Etudes Economiques (INSEE) in France, the weights are adjusted to administrative benchmarks for veterans' payments (by major payment categories); New Start allowance (by sex, age and marital status); Disability Support pension (by sex and marital status); and sole parents (by receipt of pension and sex).

It is not known how the weights in PRISMOD were calculated.

Possible questions/action

- Ask Treasury to provide details of the reweighting matrix that they used for 2000-2001 and the methodology that they used to reweight the HES.

3.2 Uprating

The next step in the ageing process is to adjust the incomes and expenditures of each of the 8,400 households, so that they better reflect either current or forecast future incomes and expenditures. The uprating procedures followed in different microsimulation models can vary greatly in the degree of sophistication. For example, when uprating earnings, a single earnings inflator might be used (such as the change in average weekly earnings) or disaggregated earnings data might be used to capture increasing dispersion in the distribution of earnings.

Uprating incomes

The HES data contain income amounts for a large number of private income sources in 1993-94. Adjustment factors are applied in STINMOD-STATAX to all the private income sources, with different factors applied to different income sources (Warren and Lambert, 1999). Typically, the factor is the average growth in an income source from the time of the HES survey to the relevant financial year. This average approach is taken because there are no suitable data to undertake a more disaggregated updating. The one exception to this is wage and salary income. This is an important exception as there is clear evidence of a widening in the distribution of wage and salary in recent years, and wage and salary income dominates private income (eg in the 1995/96 SIHC wage and salary income was 86 percent of total private income). In this case, disaggregated data from the *ABS Weekly Earnings of Employees Distribution Survey* (WEEDS) are used to adjust wage and salary income, with inflation factors being calculated by quintile of income and full or part-time status.

The method used to uprate incomes in PRISMOD is not known. It is likely that similar methods to those for STINMOD-STATAX were used to update the data to a recent financial year, and then estimates of the likely change between that year and 2000-01 were then applied.

Uprating expenditures

The HES data show the expenditure by each household on each of 424 different expenditure groups (such as 'kitchen furniture'). Again, the sophistication of the updating process varies from model to model. In STINMOD-STATAX each individual expenditure item is inflated or deflated by the movement in the relevant detailed CPI category between 1993-94 and the financial year in question.

This means that the uprating process takes account of changes in the price of the relevant good or service but not shifts in demand since 1993-94. For example, if there has been strong growth in purchases of mobile phones since 1993-94, this would not be captured in this uprating process.

The expenditure uprating process used in PRISMOD is not known. It is likely to be similar to that to STINMOD-STATAX for ageing to a recent financial year, with possibly more simplistic assumptions about likely price movements after that point.

Possible questions/action

- Ask Treasury to provide details of the inflation factors used for each income component in the HES to age the incomes to 2000-01.
- Ask Treasury to provide details of how expenditures were aged to 2000-01.
- Ask Treasury to describe any other adjustments made to the base data

4 Simulating the pre-change world

Once the base data has been satisfactorily aged to the correct year, the rules of government programs are simulated, so that the amount of direct and indirect tax paid and the value of government cash transfers received by households before any tax reforms can be calculated. Once again, the simulation is not straightforward and microsimulation models can vary greatly in the degree of program complexity that they capture.

4.1 Cash transfers and income tax

STINMOD-STATAX aims to cover as many government programs as the microdata permit (see Table 2). There are two main reasons for this breadth of scope. First, it provides a comprehensive picture of the way government programs interact for individuals and families. Second, it provides the model with the ability to capture interactions between government programs.

Microsimulation models contain many thousands of lines of computer code replicating the rules of government programs. Once again, this is not a straightforward task. Sometimes characteristics which determine eligibility or the amount of payment due under a scheme are not contained in the HES base data and have to be imputed. In some cases no imputation is possible (eg. the assets tests for government cash transfers cannot be replicated because the HES does not contain details of the value of assets owned).

Once potential eligibility is established, entitlement is assessed by following the rules for that particular cash transfer. This is easier when simulating a recent financial year, as the payment rates and income tests applying at that time are already known. When simulating a future financial year, new payment rates and income test parameters have to be specified for every cash transfer and income tax program included in the model.

When simulating income taxes, it is assumed that individuals pay the taxes that they are legally liable to pay.

It is not known exactly how PRISMOD simulated cash transfers and income taxes. However, as this component of the PRISMOD model was based on the STINMOD source code, the methodology and results can be expected to be very similar.

Table 2 Government programs covered by STINMOD

Pensions	Allowances and benefits	Family payments	Tax rebates	Tax
Service	Newstart	Basic	Dependent spouse	Income tax
War disability	Sickness	Additional	Low income	Medicare levy
War widows	Special	Guardians	Pension	
Income support supplement	Mature age	Family tax	Beneficiary	
Age		Rent assistance	Dividend	
Disability support	Parenting		Family tax	
Wives	Partner			
Widows	Pharmaceutical			
Carers				
Sole parent				

Source: Warren and Lambert (1999)

4.2 Indirect taxes

Indirect and company taxes have been imputed to households in the STINMOD-STATAX model using the STATAX model. The taxes allocated in STATAX, along with the assumed proportions borne by domestic consumers, are detailed in the following table. In total in 1996-97 almost $84 billion of indirect and company taxes have been imputed to households within the household expenditure survey.

STATAX uses four data sources in deriving its results. The 1993-94 input–output data are used to identify the indirect tax component in final consumer prices in 1993-94. National accounts and taxation revenue data are then used to age the 1993-94 input–output data to 1996-97. The result of this process is estimates of the indirect tax component in the price of goods and services consumed by households (through household final consumption expenditure), firms (gross fixed capital expenditure and stocks), governments (final consumption and gross fixed capital expenditure) and non-resident consumers (by consuming Australia's exports and investing in Australia).

Table 3 Indirect and company taxes collected in Australia: 1996-97

	Total tax burden	Estimated domestic burden	Domestic burden as % of total
	$m	$m	%
Federal			
Company tax*	18 770	15 123	80.6
Wholesale sales tax	13 293	12 385	93.2
Excise			
Petrol (incl. PRRT)	11 935	10 135	84.9
Tobacco	1 687	1 682	99.7
Beer	542	536	98.8
Other alcohol	887	887	100.0
Primary production	603	525	87.0
Customs duty	2 854	2 617	91.7
Fringe benefits tax	3 062	2 858	93.3
Other indirect taxes	1 819	1 667	91.7
Subtotal	55 453	48 414	86.7
State			
Land lax	1 988	1 878	94.4
Motor vehicles	3 592	3 501	97.5
Stamp duties	5 805	5 488	94.6
Payroll tax	7 632	6 558	85.9
Gambling taxes	3 497	3 497	100.0
Franchise taxes	5 221	4 988	95.5
Other indirect taxes	4 440	4 192	94.4
Subtotal	32 175	30 102	93.6
Local			
Rates	5 704	5 374	94.2
Total	**93 332**	**83 890**	**89.9**

* Adjusted for imputation credits claimed through the personal income tax.

This information is then combined with a series of assumptions about how the various taxes are borne by households. The most fundamental underlying assumption in STATAX is that, ultimately, all taxes are incident on households, whether they are resident or non-resident households. As noted earlier, this is different from, for example, the modelling approach used in the ABS (1996) report, *The Effects of Government Benefits and Taxes on Household Income*. The ABS allocates to households only those taxes that can be directly attributed to households through their final consumption expenditure. Indirect taxes that fall on investment goods, for example, are ignored in the ABS study. As a result, less than half of all indirect taxes are allocated in the ABS study.

As already noted, after aging the survey data to the base year using disaggregated consumer price indexes, the different indirect taxes are distributed to households on the assumption that their shares of the particular goods reported in survey are in line with their shares of the aggregate reported in the national accounts. What this means is that *all* taxes are allocated to households, even if the survey indicates a level of under-reporting of specific consumption goods. This is most important in the case of alcohol consumption — the household expenditure survey appears to significantly under-report the consumption of alcohol. The STATAX modelling assumption becomes an issue only if the distribution of this under-reporting is not consistent with the under-reporting in the survey.

This is again different from the assumptions made in the ABS study, where no adjustments are made to allow for the under-reporting of expenditure, particularly on alcohol and tobacco (ABS 1996, p. 68). This is also different to the assumptions made in PRISMOD, where the Treasury works with effective tax rates while STATAX works with nominal tax liabilities. What this means is that the STATAX estimates of, say, total indirect taxes collected from tobacco match the National Accounts estimates, while the PRISMOD estimates are much lower than the National Accounts estimates. Where the Treasury has sought to estimate the price impact on different households, its has responded to this concern by scaling the households expenditure on the basis of HES under-reporting of National Accounts aggregates (Treasury 1992 p 17 para 29). The Melbourne Institute (Johnson, Cowling and Harding 1998) adopts a similar procedure when estimating the impact of indirect tax change on different groups. The advantage of the approach adopted in STATAX is that all indirect taxes allocate directly to households are directly allocated to those households. In contrast, if tax rates (even when adjusted for expenditure under-reporting by each household) are applied to the disposable income of these households, what is being allocated is not necessarily the households ultimate tax burden. This is what leads to the apparently different outcomes for the same indirect burdens in Table 1 of Johnson, Cowling and Harding (1998, p 12).

The actual tax modelling assumptions adopted in STATAX are described in detail in Warren (1987) and in Lambert and Warren (1999). Probably the most controversial incidence assumption is that 50 per cent of the company income tax is borne by shareholders (via lower dividends) and 50 per cent by consumers of products produced by these companies (via higher prices). While various other assumptions could be adopted, the stance taken is

designed to reflect a somewhat inconclusive literature on the incidence of capital taxes. While there is a growing case for the assumption that in an internationally competitive environment these taxes are like consumption taxes, there are other arguments that suggest that capital taxes are borne by capital owners. Generally speaking, all of the other indirect taxes are assumed to be 100 per cent shifted to consumers.

PRISMOD differs here from STATAX in its modelling of taxes on investment goods. The PRISMOD approach is to treat those taxes on investment goods (such as cars and machinery) as intermediate inputs into production. Both STATAX and the long run version of the Melbourne Institute indirect tax model undertakes a similar reallocation but each in different ways. Given that PRISMOD and the Melbourne Institute allocate taxes on the basis of the effective tax rates on commodities consumed by households, while STATAX allocates these on the basis of the tax revenue collected from each good consumed, the final outcomes are not be too different. A version of STATAX is currently being developed to examine its sensitivity to a different approach to modelling taxes on investment goods.

Another area of different between PRISMOD and STATAX is in relation to the modelling of price markup ratios. STATAX assumes ad valorem markup ratio which is a reasonable long term approach. PRISMOD adopts a combination of ad valorem and fixed margins.

Possible questions/action

- How is the Input-Output 1993-94 data used and aged?
- What level of Input-Output disaggregation is modelled?
- What taxation data is used and how is it aged (in the PRISMOD case to 2002-2003)?
- What is the coverage of the taxation data - Federal, State, Local?
- What markup margin assumptions? Fixed / Ad valorem / or some combination?

- How are taxes on capital investment goods treated and how do they impact on output prices? Does the approach taken assume all capital good prices fall as takes are taken of new capital goods?
- What tax shifting assumptions are made?
- What is the assumed level of avoidance and evasion of income and expenditure based taxes?

5 Simulating a tax reform

To simulate reforms in the income tax and cash transfer systems, new computer code is written capturing the desired new rules and payment levels for each individual government program. This sounds relatively simple, but many months of work may be involved in writing the computer code to simulate the new rules, particularly if major structural changes are proposed (such as the introduction of entirely new cash transfer programs or income tax rebates).

To simulate indirect tax reforms involves specifying a range of parameters which indicate the nature of some proposed indirect tax reform package. The resulting parameter file is then accessed by STATAX and this determines just what tax reforms are to be modelled. Any number of possible reforms to indirect taxes can potentially be modelled in STATAX. As a result, STATAX can model taxes as diverse as excise duties, stamp duties, payroll taxes, and the Wholesale Sales Tax.

A series of new tax and welfare variables are then generated for each of the households in the HES. Those variables most commonly used include the change for each household in:

- income tax paid (net of any rebates, deductions or Medicare levy);
- government cash transfer payments received; and
- indirect tax paid.

In the vast majority of cases, these results do not take account of behavioural changes by consumers or economy-wide changes (eg. in employment). However, it is possible to incorporate into STINMOD-STATAX as exogenous shocks, changes in employment or the price of imports. The Treasury has done just this with PRISMOD in the case of the expected revaluation of the Australian dollar following the introduction of the proposed indirect tax reforms.

Possible questions/action

- Ask Treasury if all these indirect taxes are removed from foreign consumers and the exchange rate revalues, how have they modelled the benefits to local consumers?
- What time period is being assumed for consumer prices to change as a result of the proposed indirect tax reforms?

5.1 Incorporating economy-wide responses

The methodology for linking results from economy-wide models to microsimulation models is still in its infancy. It is likely that a major tax reform shock will have impacts upon a wide range of macro-economic variables, such as employment or unemployment, the balance of payments and so on. NATSEM has been working with the Centre of Policy Studies at Monash University for the past three years on trying to link their applied general equilibrium models with NATSEM's microsimulation models. A methodology has been developed to develop some linkages, so that the microsimulation model could potentially capture forecast changes from the

MONASH model in employment by industry and occupation and in returns to factors of production (ie. in wages, dividends, self employment income etc).

A recent example demonstrating this type of linkage is Harding and Robinson (1998). However, to date there are no existing examples that we know of where the economy-wide changes due to a tax reform shock have been fed into a microsimulation model in any sophisticated way. We are aware that the Melbourne Institute has incorporated into their distributional impact model the price effects coming from the ORANI-G (Johnson *et al*, 1998b, *p25*) in relation to producer responses. However, this is done in a very aggregate way since ORANI-G only models one consumer and therefore the response of this one consumer. Moreover, the specification of ORANI-G (as with most of these macroeconomic models) is that the reforms do not generate employment growth but that any pressure in the labour market results in increased wages. In the Melbourne Institute distributional results, they ultimately concentrate only on the implications of the price effects and not those on household income.

We understand that the PRISMOD model has not been integrated with any macroeconomic models except to the extent that the model is subject to external shocks such as the impact of a revaluation of the Australian currency.

5.2 Incorporating behavioural response

Consumers could be expected to respond in two major ways to a tax reform shock. First, they might change their expenditure patterns, so that they purchase less of those goods and services that are now more highly taxed and more of those goods and services that are now relatively more lightly taxed. In this sense, as Carnahan observes, the initial incidence results provided by standard microsimulation models overstate the negative impact of tax changes on households (1998, p. 4). Once again, there have been some preliminary attempts to take account of such responses of consumers in microsimulation models (Symons and Warren, 1996). However, these studies seem to suggest that taking account of such behavioural responses has only a small impact on the pattern of gains and losses.

Neither STINMOD-STATAX, PRISMOD or the Melbourne Institute model currently take any account of different consumers changing their purchasing behaviour as a result of a tax reform.

The other type of behavioural response which might conceivably be important is changing labour supply decisions as a result of the tax change. For example, if marginal income tax rates are cut substantially, workers might decide to work more hours or enter the labour force. Once again, there are some examples of this type of microsimulation modelling, but such efforts are still in their infancy (See Symons and Warren, 1996).

Neither STINMOD-STATAX nor PRISMOD currently take any account of changing labour supply as a result of a tax reform.

Possible questions/action

- Ask Treasury what consideration is given to macroeconomic variable changes? For example, what if the A$ revalues? Are any other macroeconomic factors considered and incorporated into PRISMOD? Why stop at A$ revaluation?
- What behavioural responses by consumers to relative price changes are assumed?

6 Evaluating the distributional results

Once the change in direct and indirect taxes and in cash transfers received has been calculated for each household, how does one evaluate the distributional impact? There is usually community concern that the poor should not lose as a result of a tax reform package. But defining whom is poor and who is not is not straightforward. Generally, we use cash income to measure the standard of living of different households, while acknowledging that cash income does not always provide a good measure of economic resources. (For example, the self-employed may have a higher standard of living than their cash income would indicate – Bradbury, 1996).

There are two key ways of assessing the distributional impact of a package. Treasury has called these two measures the change in 'real disposable income' and the 'net cash gain' (1992). Figure 2 illustrates the difference between the two concepts. Suppose that we have a person that, before the tax reform,

received social security income of $200 and paid no income taxes. A tax mix switch is planned which will increase the prices of the goods and services bought by this person by 3 per cent (with 3 per cent of the disposable income of $200 being $6 a week). To compensate such social security recipients for the new indirect tax, the government plans a $7 a week pension increase. Using the 'change in disposable income' measure of gain or loss, this person is $1 a week ahead after the tax change.

But suppose that this person is dissaving, spending $440 a week on goods and services. When the prices facing them increase by 3 per cent, they will pay an extra $7.20 a week in indirect tax. In this case, their $1 a week gain turns into a 20 cents a week loss. The difference between the two outcomes is essentially driven by the extra $40 a week that this person is dissaving. And it is for this reason that the real extent of dissaving becomes such an important issue. As the Treasury criticism indicates – and as the ABS state – the HES figures cannot be used as a reliable guide to the extent of dissaving. But if and where dissaving does exist, it may turn apparent gains into real losses. It is also true, however, that where the CPI effects are expected to be reasonably small – as those in the *Tax Reform* package arguably are – then very high levels of dissaving are required before gains turn into losses.

Figure 2 **Illustration of difference between 'real change in disposable income' and 'net cash gain' measures**

Suppose James receives $200 a week in social security income, pays zero income tax, and spends $240 a week on goods and services.
The estimated effect of a tax reform package is to increase prices on the goods and services that James buys by 3 per cent.
James will receive a $7 a week pension increase at the same time as the new indirect tax increases the prices by 3 per cent.

Change in *real disposable income* equals:

$$\frac{\text{Post-change disposable income}}{1 + \text{household specific CPI effect}} - \text{pre-change disposable income}$$

$$= \frac{\$207}{1.03} - \$200$$

equals 97 cents gain

Change in *net cash gain* equals:

(post-change disposable income – pre-change disposable income) -
household specific CPI effect *(1-s) * pre-change disposable income

where s = the household savings ratio (ie. the proportion of household disposable income which is saved)

= ($207 - $200) - 0.03 * (1.2) * $200
= 20 cents loss

7 The *Tax Reform* cameos

In the 1998 *Tax Reform* document, the Treasurer presented a list of 25 'cameos' to illustrate the effect of the proposed tax reform package upon different types of families (1998, p. 178-202). These cameos represent a conceptually distinct form of distributional analysis. When the full STINMOD-STATAX or PRISMOD HES-based sample is analysed, it allows estimates to be prepared of the total number of winners or losers – or the total number of households in a particular population sub-group. In contrast, the cameos represent the results for *hypothetical* or *typical* families. This type of analysis allows one to show the estimated impact of the tax reform package upon a single income couple with two children aged less than 13 and earning, say, $40,000. However, it does not allow one to say *how many* such couples there are who are affected in this way. Nonetheless, this type of analysis can be a very useful guide to the pattern of gains and losses, and STINMOD-STATAX can also be run in this 'hypothetical families' mode, rather than in the full 'distributional' mode.

Two types of output have gone into the compilation of the cameos presented in the *Tax Reform* document, which was most likely constructed in Excel. First, typical families were probably run through the PRISMOD source code, in order to produce the estimates of current tax liability, the value of tax cuts, the combined value of tax cuts and any increases in Family Package Benefits, and the increases in social security payments applicable to that particular type of family at each specified level of private income. When added together, the change in income taxes, family payments and social security then gave the results for 'change in disposable income'.

At this point, however, the cameos depart from the household specific analysis. Thus, the PRISMOD model, presumably after some adjustments, has apparently indicated that the general increase in the population wide CPI due to the tax reform package will be 1.9 per cent. It is therefore assumed in the cameos that the prices facing each of the hypothetical family types will rise by 1.9 per cent. The column headed 'cost of living adjustment from GST', presented in each of the cameos, therefore equals the disposable (after-income tax income) of each hypothetical family multiplied by 1.9 per cent. The final column in each of the cameos, headed 'What is the total package worth to me?' therefore represents the change in real disposable income measure, explained above in Figure 2. Figure 3, which is taken from one of the cameos and whose figures we have been able to replicate, illustrates how the figure in the 'worth of the total package' column in the cameos is derived.

Figure 3 Derivation of the 'worth of the total package' in the cameos

Take single person on $50,000 a year.

Divide by 52 to get weekly private income of $961.53

Subtract weekly pre-change income tax liability of $284.85

Disposable income thus equals $676.69

Assumed effect on prices for this person is 1.9 per cent

$676.69 multiplied by 1.9 per cent and divided by 1.019 (to account for the change in general prices) equals $12.61, which is the amount given in the 'cost of living adjustment from GST column'

This person receives a $52.21 cut in personal income tax from the tax package. When the 'cost of living adjustment' of $12.61 is subtracted, this person is $39.60 'ahead'.

Source: Original figures provided in Treasurer (1998, p. 178).

Two critical assumptions thus underlie the estimates of net gains presented in the cameos. The first is that it is fair to assume that the prices facing each of the hypothetical families will rise by 1.9 per cent, which is the average change for the entire population. The second is effectively that dissaving does not occur or, if it does, it is not a problem which requires addressing. This assumption is implicit in the calculation that the impact of the new indirect

taxes will be limited to 1.9 per cent of current disposable income, rather than 1.9 per cent of current expenditure in cases where expenditure exceeds income.

7.1 A different price effect for low income groups?

Why might the price increases facing low income groups as a result of the tax reforms differ from those facing the population generally? Low income people spend their income in different ways to those on high incomes. For example, most food and clothing items are currently not taxed under wholesale sales tax, but will be taxed under the GST. Analysis using the STINMOD-STATAX model for 1996-97 suggests that the average Australian household spends 18 per cent of its total current expenditure upon food. However, the picture does differ significantly by income level. Thus, households with incomes below $450 a week spend 22.5 per cent of their total current expenditure upon food, while those with incomes above $450 a week spend 17.7 per cent of their total expenditure upon food.

The government has published estimates of the price effects upon different industries of its tax reform package. Excluding confectionery, food products are forecast to rise in price by 2.1 to 6.6 per cent, while clothing and footwear are both forecast to rise in price by 6.8 per cent (Treasurer, 1998, p. 170). Such price increases are well above the expected general population CPI increase of 1.9 per cent forecast by the Government. On the other hand, the prices of many other goods and services are expected to fall as a result of the indirect tax changes, so that the net price impact is not intuitively obvious.

A recent Treasury press release containing some estimates from the full distributional mode of PRISMOD has suggested that for most population groups the population-wide CPI increase will provide an adequate measure of the change in the prices affecting different types of households. However, although the Treasury cautioned that in its view the HES data should not be used to produce these types of estimates, the estimates also indicated that the price impact for pensioner couples and singles would be about 2.4 per cent –– ie. about half a per cent more than the average population-wide impact (1998, p. 6). This is of some concern, because age pensioners were among those groups to gain very little from the tax package.

The *Tax Reform* document indicated that pensions would be increased by four per cent, or by $7.75 a week in July 2000 (1998, p. 164). However, there appeared to be some intent to reduce the extent of this increase in future years, with the government stating that it 'will ensure that over time the increase is maintained at 1 ½ percentage points above the actual impact of the tax reform package on the CPI' (1998, p. 164). In the cameo for single age pensioners with no private income, the increase in age pension presented was $6.48 a week, representing a 3.4 per cent increase in age pensions rather than the previously indicated 4 per cent (Treasurer, 1998, p. 199). This 3.4 per cent increase appeared to reflect the government's intent of ensuring that pensioners were only 1.5 per cent better off in the long run (as the 3.4% is apparently represented the sum of the 1.9 per cent CPI movement and a 1.5 per cent 'gain'). If, however, the prices facing age pensioners increase by 2.4 per cent in the long term rather than the general CPI increase of 1.9 per cent, then the extent of the maximum potential gain for single pensioners is presumably reduced to only $1.87 a week - or 1 per cent of their pre-tax change income.

Some questions have also been raised about the accuracy of the 1.9 per cent general price increase. According to Johnson et al (1998b), the Treasury excluded the impact of increases in tobacco prices from the estimated 1.9 per cent CPI increase. Given that lower income groups smoke more than higher income groups (Harding and Percival, 1997), inclusion of tobacco price rises might be expected to disproportionately raise the prices facing lower income groups. A second issue is that the Treasury imputed the value of the proposed new first home owners' rebate as an offset to the price of houses, rather than as an increase in the income of new home owners. This again had the effect of reducing the price impact of the package on the CPI. The Melbourne Institute estimates that if these two factors were included in the CPI, then the net effect would be a 2.4 per cent CPI increase due to the tax package, rather than a 1.9 per cent increase (Johnson et al, 1998).

The Melbourne Institute has also disputed the notion that the population-wide CPI increase adequately measures the change in prices likely to face many groups in the community. They point out that the construction of the CPI uses expenditure weights of employee households in Australian capital cities from the HES: This excludes about 70 per cent of the population and, in particular,

excludes all households dependent on government cash benefits and those living outside the capital cities (Johnson et al, 1998, p. 8). However, this is probably less of a problem with the recently released revisions to the CPI coverage which will see the CPI base include all population groups in the 8 capital cities.

It is true that the movement in the general CPI is used as the basis for indexing welfare benefits. Australian studies have suggested that while a 'low income' CPI might have diverged on occasion from the general CPI, over time the two have tended to move in much the same way. However, this does not necessarily mean that at the time of a major indirect tax shock that the change in prices for the general population will provide an accurate indicator of the change in prices for low income groups. This is because over time, relative prices change only marginally but this is not the case with the major indirect tax reforms proposed by the government (See the relative price shifts in *Tax Reform* 1998, p170-72). If low income groups consume more of those good whose price is increasing fastest and the higher income groups, more of those whose price is decreasing, then the price impact on these different groups can vary widely.

There is also an issue about the timing of price rises. It appears that the expected price increase in 2000-01 is greater than that expected in 2001-02, and that the latter has been used in the construction of the cameos.

7.2 The dissaving question

The second key assumption implicit in the cameos is that no additional protection is required for households that are dissaving.

The 1996-97 STINMOD-STATAX model suggests that about two-fifths of age pensioner couples who live in a household by themselves have less than $5 a week of private income and are therefore essentially wholly reliant on their pension. Four-fifths of all such pensioner couples have private incomes below $5,000 a year. The model suggests that, on average, those with less than $5000 a year of private income are spending $327 a week on current goods and services, $13 more than their disposable income of $314 per week. This is 4.1 per cent more than their disposable income. If this ratio was continued in July 2000, then on average such pensioners would be spending $334 a week, somewhat more than their pension in July 2000, which is forecast by the Government to be $321. If the 1.9 per cent change in general prices predicted

by the Government did turn out to be correct for this group, then their additional indirect tax burdens would be $6.23 a week, reducing their anticipated gain to $4.59 or 1.4 per cent. If, on the other hand, the price increases facing this group turned out to be 2.4 per cent, then their additional indirect tax burdens would be $7.82 a week, reducing their anticipated gain to $2.99 a week or less than one per cent.

7.3 General distributional outcomes

Generally speaking, the Government's figures in the cameos suggest higher percentage gains for those on high incomes than those on low incomes. For example, the estimated percentage gain for a single person with no private income and fully dependent on social security is 1.5 per cent, while that for a single person earning $70,000 a year is 7.3 per cent (Treasurer, 1998: p. 178 and Table 2). Similarly, the Government's estimated gain for a single income couple with no dependent children and with no private income and receiving social security is 1.5 per cent, while that for a similar couple with an income of $70,000 is 6.8 per cent (1998, p. 181). In general, the gains for those fully dependent on social security but without young children range between 1.5 and 2 per cent. The gains for those fully dependent on social security but with children aged less than five years are somewhat higher, at 3.3 per cent.

Another group that does relatively poorly is two income couples with family incomes between about $35,000 and $60,000. However, two income couples on incomes above this fare much better, with real percentage gains of some 5 to 6 per cent for those two income families on incomes of $100,000 a year. Sole parents with younger children also do well out of the Package, with significant gains of about 5 to 10 per cent. This is particularly welcome, given that research has consistently suggested that sole parents have higher poverty rates than many other groups in the community (Landt and King, 1996).

Table 3 Government's Estimates of the Distributional Impact of the Tax Reform Package

	Net change in social security payments and income tax	Extra indirect tax due to GST	Overall gain	
			$ pw	%
Single person				
$0 private income	5.71	3.17	2.54	1.5
$70,000 private income	79.06	16.3	62.76	7.1
Single income couple, no children				
$0 private income	10.31	5.72	4.59	1.5
$70,000 private income	79.06	16.78	62.27	6.8
Single income couple, 1 child aged 5 to 13				
$0 private income	13.00	6.73	6.27	1.7
$70,000 private income	95.12	17.01	78.11	8.4
Dual income couple (67%:33% income split), 1 child aged 5 to 13				
$0 private income	13.00	6.73	6.27	1.7
$70,000 private income	69.71	18.85	50.86	5.0
Sole parent pensioner, no private income, 1 child aged under 5	31.11	5.14	25.97	9.3
Single age pensioner, no private income	6.48	3.60	2.89	1.5
Age pensioner couple, no private income	10.82	6.00	4.81	1.5

Source Treasurer (1998, pp. 178-200).

Possible questions/action

- Ask Treasury whether they have undertaken any analysis of the characteristics of dissaving households on low incomes (eg. to what extent are they self-employed, working poor, dependent on social security incomes, by age etc).
- Ask Treasury how great the price increase actually facing pensioner households would have to be before they incurred a loss from the tax reform package.
- Ask Treasury what the expected increase in the CPI would be if tobacco price changes were included and if the home savings rebate was not assumed to result in decreased housing prices.
- Ask Treasury how should we model the wealth effects of the reforms on the retired and those with substantial assets?
- What point in time is modelled? Treasury models CPI on 2001-2002. What happens in July 2000?
- Ask the ABS whether they feel the forecast CPI change provides the best measure of the impact of tax reform upon households not included in the CPI coverage (eg. pensioner households).

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Attachment A Economy wide models

Economy-wide models are often also called macroeconomy models. There are a limited number of such models maintained in Australia. These include MONASH (formerly ORANI), TRYM (Federal Treasury), SALTER, MURPHY, MSG-2, G-Cubed, and IMP (National Institute). Providing a brief description of these quite complex models is obviously not easy but there is now extensive literature on each of these models and their application to a number of problem areas. The most comprehensive discussion of these models is discussed and each model compared and contrasted in Colin Hargeaves "A Comparison of Economy-Wide Models of Australia", Commission Paper No 2, EPAC (1994). Some of the key areas where there are real differences are identified in the table below.

Table 1 Economy wide modelling assumptions

MODEL	COVERAGE	ESTIMATION	TYPE	INDUSTRY AGGREGATION	ELASTICITY OF SUBSTITUTION [1]
MONASH (formerly ORANI) (Monash University)	National	Input-Output etc	Computational General Equilibrium Models	Disaggregated	0.5
MURPHY-macro (Econtech)	National	Econometrically	Macroeconomic Models		0.75
MURPHY-Sectoral (Econtech)	National	Input-Output etc	Computational General Equilibrium Models		0.75
TRYM (Federal Treasury)	National	Econometrically	Macroeconomic Models		0.755
SALTER (Productivity Commission)	Multi-country	Input-Output etc	Computational General Equilibrium Models		1.6-2.4
MSG2 (McKibbin)	Multi-country	Input-Output etc	Dynamic General Equilibrium Models	Disaggregated	1.0
G-Cubed (McKibbin)	Multi-country	Input-Output etc	Dynamic General Equilibrium Models	Disaggregated	0.8-1.0

1. (Note: a value of 1 means a 5% fall in the factor price ratio of wages to cost of capital (w/r) will result in a 5% rise in the labour to capital ratio (L/K))

Source: Colin Hargeaves "A Comparison of Economy-Wide Models of Australia", Commission Paper No 2, EPAC (1994)

Some questions to ask economy wide modellers

Question 1 What is the assumed elasticity of substitution between capital and labour?

Why is this assumption important? The greater the substitutability, the greater the scope for labour to benefit from productivity improvements. For example, no substitutability implies no gains from increased labour productivity *ie* inputs used in fixed proportions implies elasticity of substitution equals zero. The more flexible the economy, the more it can gain from increased efficiency in the long term

Hargreaves(1994) indicates that in these models assumed elasticities of substitution of 0.5 in MONASH (and short term ORANI), 1.28 in the long term ORANI; MURPHY assumed 0.75; TRYM 0.755; G-cubed 0.8 to 1.0; MSG2 1.0; and SALTER 1.6 to 1.8 in manufacturing and 1.8 to 2.4 in services

Question 2 Flow through of efficiency gains to labour

Why is this important? The more of the benefits from efficiency improvements due to increased labour productivity that flow through to labour, the less the chance for improved employment and reduced unemployment. Therefore, the greater the ability to substitute labour for capital and the lower the labour productivity pass through, the greater will be the employment effects.

Question 3 Are there other ways of introducing the shock?

Why? Different approaches to introducing a shock may have very different impact using the same model? For example, the assumption about the flow through of a payroll tax to the various sectors of the economy will determine how it impacts on various sectors and in turn on households. For example, is it assumed that a payroll tax is a tax on wages, a tax on profits or a tax on consumer prices. The initial assumption about where the impact begins will determine what is the impact of this tax.

Question 4 What is assumed to happen to employment and wages?

Why? Different approaches will result again in different outcomes. If for example, it is assumed that employment levels are assumed constant, then all pressure on the labour market will manifest itself as pressure on real wages. Is this reasonable if one of the objectives is to investigate what impact a particular reform has on employment.

Question 5 How does the model handle the short, medium and long term?

Why? While knowing the final outcome in 2005 may be interesting but what is more interesting is what does it mean for the economy in 3 months, 6 months, 1 year, 2 years and 5 years. After all, the transition to the new general equilibrium may be as important as the ultimate general equilibrium itself.

In working with and understanding the economy wide models and their results, it is critical to know the assumptions made and the modelling approach adopted. Also, sectoral (economy-wide) models are the most interesting and those which can complement their comparative static models with models that explain the path to the new equilibrium are most important. The later recognised that the long run results seem to vary little…but the short run results do.