New Advances in Microsimulation Modelling: Improving Social and Economic Policy

A. Harding

National Centre for Social and Economic Modelling (NATSEM), University of Canberra
(ann.harding@natsem.canberra.edu.au)

Abstract: This paper describes recent developments in microsimulation modelling at NATSEM at the University of Canberra. Microsimulation models provide exceptionally detailed answers to questions about the distributional impact of government policy changes. The paper describes new initiatives at NATSEM in tax/transfer, health, regional and superannuation modelling.

Keywords: Microsimulation; Modelling; Distributional impact

1. INTRODUCTION

The idea of analysing the impact of social and economic policies by simulating the behaviour and characteristics of individual decision-making units was pioneered by Guy Orcutt in the United States in the 1950s [Orcutt, 1957; Orcutt et al, 1961]. Such models start with microdata – typically the records of individuals from a national sample survey conducted by Bureaus of Statistics. In the past two decades microsimulation models have become very powerful tools in many countries, being used routinely within government to analyse the distributional impact of policy changes to tax and cash transfer programs (such as age pension). Such models have frequently played a decisive role in determining whether or not particular policies are implemented.

Yet, despite having made a major contribution to the development of tax/transfer policies during the past decade or two, there are many important areas of public policy to which microsimulation has not yet been applied. Only slow progress has been made in moving beyond simulating the immediate impact of tax/transfer policies to include, for example, the use of services such as health, the behavioural responses of consumers to policy changes, and the distributional impact of such economic changes as variations in protection or interest rates. Similarly, while the use of models estimating the *current* immediate distributional impact of tax/transfer policy change has become routine, microsimulation models

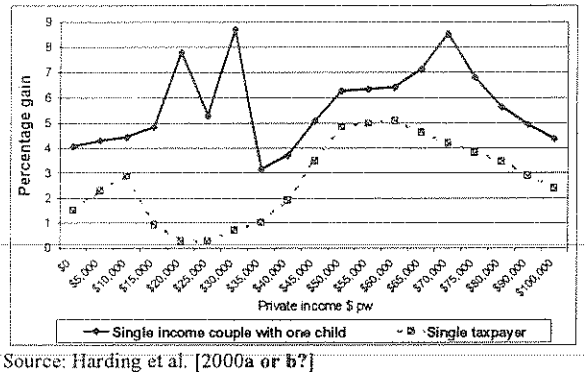
simulating the future impact of policy changes or the future structure of the population have not yet become widely used by policy makers. This paper describes recent microsimulation modelling developments at NATSEM, and how they are being used to inform social and economic policy.

2. TAX AND TRANSFER POLICY

Throughout the industrialised world, the key use of microsimulation models has been to illuminate the immediate revenue and distributional impacts of changes in tax and social security policy. In Australia, NATSEM's publicly available STINMOD model simulates payment of income tax and receipt of social security cash transfers against a representative population sample from a national ABS survey. The STINMOD model provides estimates of the immediate distributional impact of a proposed policy change, such as a liberalisation of the age pension income test or a tax cut -- showing who wins and who loses from the policy change and how great the gains and losses of particular types of families are. It also shows the impact on the spending of government departments and on revenue collected by the Australian Tax Office. The STINMOD model has now been used for more than five years by Federal government departments - such as Family and Community Services and the Treasury – to look at the impact of policy change.

In the late 1990s the STINMOD model was joined with Professor Neil Warren's STATAX model of indirect taxes. The resulting STINMOD-STATAX model was used to assess the likely distributional impact of the government's GST tax reform package for the Senate Committee on a New Tax System [Warren et al., 1999]. Results from the model were one of the factors leading to the Government delivering more generous compensation to social security recipients and reducing the proposed income tax cuts to high income earners.

After all of the changes, NATSEM reassessed the impact of the final tax reform package and found that it provided the greatest benefits to single income couples with children and sole parents [Harding et al., 2000]. This is illustrated in Figure 1, which shows that the estimated average percentage gains in after-tax income from the tax reform package were much lower for a single taxpayer than for a single income couple with one child.



Source: Harding et al. [2000a or b?]

Figure 1. Estimated Percentage Gain in Disposable Income from the Final GST Tax Reform Package

3. HEALTH MODELS

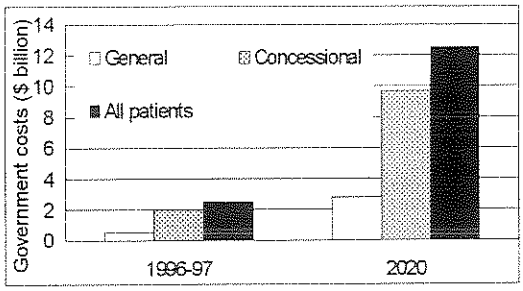
In the last five years NATSEM has begun to apply microsimulation techniques to health policy issues. In 1997-98 the first Pharmaceutical Benefits Scheme (PBS) Model was developed, which used STINMOD as a base and then added data from the National Health Survey about usage of prescribed pharmaceuticals by age, gender and so on. The model simulated spending on pharmaceuticals by different types of households; the resultant government outlays under the PBS; and the remaining out-of-pocket costs to different classes of consumers. Under the PBS scheme, low income families are eligible for very heavily subsidised pharmaceuticals (Concessional category), while other families are eligible for more lightly subsidised pharmaceuticals (General category).

The PBS is an uncapped scheme whose costs have been increasing rapidly in recent years, so that the likely future growth in outlays by government is a cause for concern. NATSEM projected the population to 2020 and found that government outlays on the PBS were likely to increase five-fold by 2020 (Figure 2). This increase was partly driven by population ageing but more importantly, was the result of forecast increases in drug prices.

During the past year NATSEM has been working with the Australian Pharmaceutical Manufacturers Association to build a sophisticated PBS modelling and forecasting capacity. The goal is to be able to simulate the widest possible variety of changes - in the drugs listed under the PBS, in their prices, and in the rules of the PBS (such as the amount that consumers have to pay before becoming eligible for government subsidy). We hope to extend this model next year to begin looking at the benefits, as well as the costs, of new drugs (for example, in reduced hospital costs).

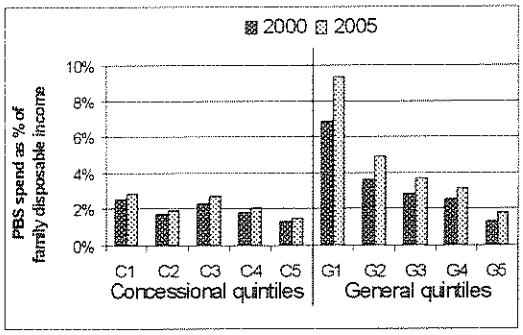
The prototype model is already producing very interesting results, as shown in Figure 3, which illustrates the estimated proportion of family disposable (after-income-tax) income being devoted to pharmaceuticals. The families eligible for concessional pharmaceuticals have been divided into five equally sized groups, called quintiles. As the figure shows, pharmaceuticals take only about two per cent of the disposable income of all such families. However, the poorest 20 per cent of *general* category pharmaceutical users are estimated to spend about seven per cent of their after-tax income on pharmaceuticals. This is projected to increase to over nine per cent by 2005, which suggests that spending on pharmaceuticals is likely to become an important financial pressure on those on low incomes outside the social security safety net. Included within this group are working poor singles and couples without children, who are not receiving social security payments.

The PBS scheme is under great pressure, due to population ageing, rising drug prices and the extension of very costly pharmaceutical subsidies to self-funded retirees. The new PBS model is intended to increase Australia's capacity for making informed decisions about the rules of the scheme.



Source: Walker et al. [1998, p. 23].

Figure 2. Estimated cost to government of the Pharmaceutical Benefits Scheme, 1996-97 and 2020 (1996-97 $).



Source: APMA-NATSEM PBS model. The families within the 'concessional' and 'general' categories have been divided into five equally sized groups (called 'quintiles') on the basis of their income.

Figure 3. Estimated spending on pharmaceuticals as a percentage of family disposable income, 2000 and 2005.

There has also been very little information in the past about the income and socio-economic characteristics of the users of health services. This has meant, for example, that State governments have not known about the distributional impact of their hospital outlays, while the Federal government has not had a clear picture of who benefits from Medicare. In a project with the Department of Health and Aged Care, NATSEM has imputed socio-economic characteristics onto Medicare data so that, for example, the Department can look at whether there is a regional divide in the provision of Medicare services. In another long-term project with NSW Health, the Health Insurance Commission and the Productivity Commission, NATSEM is imputing socio-economic information onto the records of users of NSW hospitals. This will mean, for example, that all three of these agencies can gain a clearer picture of whether those from affluent suburbs are relatively more likely to use hospitals or certain types of services. In the future a policy modelling capacity will be added, so that the impact of changes in health insurance policy upon public hospital usage can be estimated.

4. REGIONAL MODELS

Another particularly exciting development during the past three years has been the creation of regional microsimulation models. Regional issues have recently assumed much greater importance in Australia. There is a growing realisation that the gains from economic growth have not been equally distributed amongst different regions in Australia. For example, the overall stability in national poverty rates since the early 1980s appears to have disguised increasing poverty and inequality in many areas of regional and rural Australia [Vinson, 1999; Gregory and Hunter, 1995; Harding and Szukalska, 2000].

The life experiences of all Australians — and the economic opportunities available to them — are profoundly affected by the region in which they live. Those who live in areas that are developing rapidly are more likely to experience abundant job opportunities and increasing wealth (with rising house prices). In contrast, those who live in highly depressed areas may face a constellation of problems, including greater difficulties with crime and personal safety and poorer health [Walker and Abello, 2000].

The new NATSEM regional microsimulation models combine data from the Population Census and the ABS sample surveys (such as the Household Expenditure Surveys and the Income Surveys). The crucial advantage of the Population Census, the importance of which cannot be over-emphasised, is that it contains *detailed regional* socio-demographic information. However, although the CDATA Census product from the ABS is regarded as being among the best in the world, it has important limitations that have constrained regional analysis in Australia until now. One limitation, for example, is that detailed data on expenditures and incomes are not available in the Census. A second important problem is that output for the whole Census file is only available as a pre-defined series of tables for each Census Collectors District (rather than being in the form of records for each family, which is what is required for a microsimulation model). This means, for example, that relationships between characteristics of interest cannot be fully explored (such as age by income by educational qualifications).

On the other hand, the ABS sample surveys such as the Household Expenditure Survey (HES) contain exceptionally detailed expenditure and income data

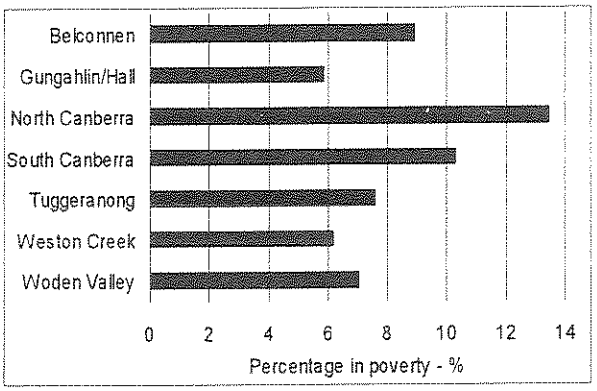
at the individual and household level, but *lack any detailed geographic information*. In part, this is to protect the confidentiality of respondents to the survey. Often the most detailed geographic classification available in the publicly released data is 'State'.

The new regional microsimulation modelling techniques developed at NATSEM blend the Census and sample survey data together to create a synthetic unit record file for every Census Collectors District. The first model to be constructed by NATSEM using these new techniques was the Marketinfo model, which provides detailed regional expenditure and income estimates. The model first recodes the Household Expenditure Survey (HES) and Census variables to be comparable, and then reweights the HES, utilising detailed sociodemographic profiles from the Census. This is done for each Collectors District separately, and a reweighted HES unit record file is generated for each District.

To date, the output from this model has principally been used by private sector clients - to determine where to put new shopping centres; to examine what percentage of total spend in an area is received by their shops; to maximise the efficiency of direct marketing efforts, or to examine the estimated incomes and assets of consumers living within each Collectors District.

However, the modelling techniques are now starting to be used to address the concerns of public policy makers. For example, last year NATSEM looked at estimated poverty rates by statistical subdivision in the ACT [Harding et al, 2000a]. This study indicated that just over 13 per cent of all residents living in the North Canberra area were in poverty, with this being due to the high concentration of students and public housing tenants in this area (Figure 4). This year we have used the new model to examine postcodes with the highest and lowest poverty rates within each state [Lloyd et al., 2001].

NATSEM is also engaged in a long-term project to develop a small area model of the characteristics and access channel usage of Centrelink clients, both now and in five years time. The model will help Centrelink with its property management strategies, as well as providing forecasts of the likely demand for each of the various methods of accessing Centrelink services.



Source: Harding et al [2000a, p. 20].

Figure 4. Estimated poverty rates in the ACT, 1999

5. FORECASTING WITH DYNAMIC MODELS

All of the modelling efforts described above fall within the province of *static* microsimulation modelling [see Harding, 1993 for an overview of the various types of models]. Static models are most frequently used to provide estimates of the *immediate* distributional impact of policy changes. Static ageing techniques are typically used to either age a microdata file so that it more accurately represents the current world or to provide forward estimates of the impact of policy change during the next few years. Dynamically ageing microsimulation models, on the other hand, involves updating each attribute for each micro-unit for each time interval.

Dynamic models often start from exactly the same cross-section sample surveys as static models. However, the individuals within the original microdata are then progressively moved forward through time. This is achieved by making major life events - such as death, marriage, divorce, fertility, education, labour force participation etc - happen to each individual, in accord with the probabilities of such events happening to real people within a particular country. Thus, within a *dynamic* microsimulation model, the characteristics of each individual are recalculated for each time period.

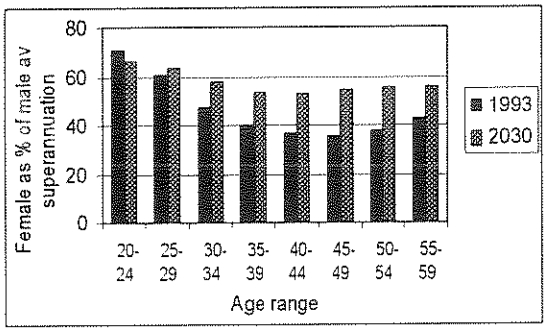
Dynamic microsimulation models are generally much more complex and expensive to build. NATSEM's dynamic model, DYNAMOD, has been under construction for the past nine years [King et al., 1999]. The model starts with the 1986 Census one per cent sample (about 160,000 individuals). It then ages each of those individuals, month by month, for up to about 60 years.

Dynamic models are particularly useful for looking at the likely future or long-range impacts of

government policy or current social and economic trends. During the past year NATSEM has been adding assets and superannuation to the DYNAMOD model, with the aim of throwing light on the likely future retirement incomes of Australians.

The level of superannuation coverage for both men and women has increased dramatically since the introduction of the three percent industrial award superannuation and then the Superannuation Guarantee in 1992. The latter of these, with its compulsory eight per cent employer contributions for every employee earning more than $450 per month, is having a dramatic impact on the coverage of superannuation. In 1993 only half of all employees aged 15 to 74 years were covered by superannuation. The NATSEM simulations suggest that this proportion has now increased sharply, to about 85 per cent of all such employees [Kelly et al., 2001].

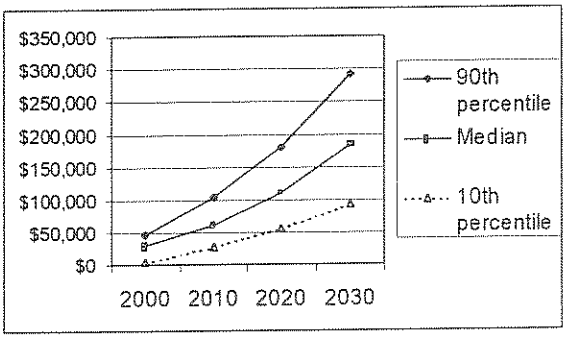
The introduction of compulsory superannuation is making a particularly dramatic difference for women, who were less likely than men to be covered by superannuation at the beginning of the 1990s. Figure 5 shows forecast female average superannuation assets as a percentage of male average superannuation assets in 1993 and 2030. In 1993 female superannuation assets were worth 43 per cent of average male assets. In other words, in 1993 the average woman had accrued less than half the amount that the average man had. By 2030 the average woman's superannuation is forecast to have increased to 70 per cent of the average man's. (Women still lag behind because they remain more likely to take time out of the labour force for parenting and, when in the labour force, earn less than men.) Figure 5 suggests that compulsory superannuation will particularly benefit women in their 40s and early 50s.



Source: Derived from Kelly et al, 2001

Figure 5. Female Superannuation Assets as a Percentage of Male Superannuation Assets, by Age Range, 1993 and 2030.

The DYNAMOD forecasts indicate that in the near future almost all Australians will be retiring with at least some superannuation entitlement. However, for many Australians, accumulated superannuation is expected to be relatively low. Even by 2030, about 10 per cent of women of retirement age are forecast to have superannuation assets of less than $100,000 (Figure 6). The middle (median) amount of superannuation for such women of retirement age is forecast to be just under $200,000 by 2030, up from less than $50,000 in 2000. If a government decided that this was an inadequate level of superannuation coverage, DYNAMOD could then be used to simulate a world where the Superannuation Guarantee was raised to, say, 15 per cent of earnings.



Source: Kelly et al. [2001, p. 23].

Figure 6. Forecast Superannuation Assets for Women Aged 55 to 64 Years, 2000 to 2030.

6. CONCLUSIONS

Microsimulation models are now used extensively throughout the industrialised world, most often for predicting the immediate distributional impacts of government policy change. Such models are unusual in the degree of detail they provide about distributional impact, and are regarded as one of the more useful modelling approaches available to those interested in the likely future impacts of population ageing and retirement incomes [Citro and Hanushek, 1991; OECD, 1996].

NATSEM is a specialist microsimulation modelling centre, established at the University of Canberra in 1993. The NATSEM models and results are used by a wide range of Federal and State Government departments to answer questions about the distributional and revenue impacts of possible policy changes. The models have played an important role in public policy debate being used, for example:

- by the Senate during the GST tax reform debate,

- by State governments for the assessment of changes in public housing policy [Percival et al., 1997]; and
- by academics for examining the implications of reforming the tax and social security systems [Keating and Lambert, 1998; Dawkins et al., 1998].

This paper has described some recent modelling developments at NATSEM, including the development of complex health and regional microsimulation models. These new models lie at the frontiers of current knowledge, with microsimulation techniques only now being applied to the analysis of health and regional issues, both in Australia and internationally. It is expected that ultimately these new models will extend to the health and regional analysis fields the same sophisticated decision-support capacity as microsimulation models currently provide to policy makers in the tax and social security arenas.

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