The New Frontier of Health And Aged Care: Using Microsimulation to Assess Policy Options

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About NATSEM

The National Centre for Social and Economic Modelling was established on 1 January 1993, and supports its activities through research grants, commissioned research and longer term contracts for model maintenance and development with the federal departments of Family and Community Services, Employment and Workplace Relations, Treasury, and Education, Science and Training.

NATSEM aims to be a key contributor to social and economic policy debate and analysis by developing models of the highest quality, undertaking independent and impartial research, and supplying valued consultancy services.

Policy changes often have to be made without sufficient information about either the current environment or the consequences of change. NATSEM specialises in analysing data and producing models so that decision makers have the best possible quantitative information on which to base their decisions.

NATSEM has an international reputation as a centre of excellence for analysing microdata and constructing microsimulation models. Such data and models commence with the records of real (but unidentifiable) Australians. Analysis typically begins by looking at either the characteristics or the impact of a policy change on an individual household, building up to the bigger picture by looking at many individual cases through the use of large datasets.

It must be emphasised that NATSEM does not have views on policy. All opinions are the authors’ own and are not necessarily shared by NATSEM.

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Abstract

This paper provides a brief overview of microsimulation modelling, and in particular, a general introduction to and insight into the potential role and usefulness of microsimulation in analysing public policy. Microsimulation has made a major contribution over the past decade to the evaluation of the distributional effects of tax and social security policy reform in Australia. More recently, NATSEM has extended the benefits of these sophisticated quantitative decision support tools to the health and aged care arenas. The paper provides two examples of the innovative use of microsimulation for the analysis of health and aged care policy at both a national and small area level. These are first, MediSim, a model of the Pharmaceutical Benefits Scheme and, second, CareMod, a spatial microsimulation model of the need for aged care services in NSW. Various technical aspects are highlighted to illustrate how these socio-economic models are constructed and implemented to help inform and assist with possible responses to increasingly pressing policy issues.

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General caveat

NATSEM research findings are generally based on estimated characteristics of the population. Such estimates are usually derived from the application of microsimulation modelling techniques to microdata based on sample survey. These estimates may be different from the actual characteristics of the population because of sampling and nonsampling errors in the microdata and because of the assumptions underlying the modelling techniques. The microdata do not contain any information that enables identification of the individuals or families to which they refer.
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1 Introduction

This paper provides a brief overview of microsimulation modelling, and in particular, a general introduction to and insight into the potential role and usefulness of microsimulation in not only analysing public policy outcomes but assisting in public policy agenda setting. The economic, social and political landscape of Australia has shifted significantly over the last few decades. The issues and events that are currently affecting Australians, and those that will become increasingly pressing in coming decades, are highlighting the need to link accurate, innovative research to policy-making. Research organisations such as the National Centre for Social and Economic Modelling (NATSEM) at the University of Canberra, the Melbourne Institute of Applied Economic and Social Research at the University of Melbourne, and the Social Policy Research Centre at the University of NSW can help inform public discussion by providing careful analysis of the issues and trends that affect public policy and the likely outcomes of changes in policy. Such organisations are well positioned to provide policy-makers with the objective research and non-partisan advice that is critical to developing innovative solutions in increasingly unfamiliar and daunting national and global political-economic environments.

Public ‘economic’ policy questions have typically involved the analysis of the cost and (re-) distributional impacts of changes in policy – what are the costs (or savings) to government versus the community? Who are the winners and who are the losers? Econometric models can be used to examine the nature of policy and the detailed effects of structural changes. These models have been applied most often to government policy in the taxation, social security and labour market fields, including growth in productivity. A more recent phenomenon has been the emerging demand for econometric models from the private sector, for informed analysis of changes in company policies and structural and fiscal arrangements with respect to client services – for example the likely implications of wealth accumulation and participation in private superannuation schemes.

In the past two decades, microsimulation models have become very powerful quantitative decision-support tools used routinely within government, in many countries including Australia, to analyse the distributional impact of policy changes. Such models have often focused on tax and cash transfer programs (such as age pensions, unemployment allowances or disability support pensions). An example of this traditional microsimulation modelling is NATSEM's STINMOD model. The first version of this was released in 1994 with new versions being released each year.

STINMOD simulates the payment of personal income taxes and the receipt of social security cash transfers and is used to estimate the impact of these systems on Australian families. In essence, the eligibility and entitlement policy rules of the
income tax and government cash transfer programs are applied to a population database comprising income units\(^1\), the individuals of which are a representative sample of the Australian population (Bremner et al., 2002). STINMOD’s basefile includes a wide range of demographic and economic indicators as well as income unit, family and household structure. In this way, the impact of policy changes can be investigated with respect to not only narrowly defined groups of individuals but also types of families (Bremner et al., 2002). STINMOD provides estimates of the immediate ‘morning-after’ 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 are the gains and losses for particular types of families. 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 about 10 years by Federal government departments - such as FaCS 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 STATA TAX model of indirect taxes. The resulting STINMOD-STATA X 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). After all of the changes, NATSEM found that final tax reform package provided the greatest benefits to single income couples with children and sole parents. 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.

Models such as STINMOD 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, there are many important areas of public policy to which microsimulation has only recently, or not yet, been applied. In Australia, Canada and the UK, this technology is now rapidly being adopted and expanded into the health, disability and aged care fields. In addition, the focus of the modelling is moving beyond simply simulating the immediate impact of policies to include, for example, modelling the future structure of the population and their likely need for services and ability to pay for care, the behavioural responses of individuals and households to policy changes, and generating synthetic small area estimates through the use of spatial microsimulation - a very recent development which is attracting substantial interest from policy makers. Microsimulation models are unusual in the degree of detail they provide about distributional impact, and are regarded as one of the more useful modelling

\(^1\) The Australian Bureau of Statistics defines an income unit as ‘one person or a group of related persons within a household, whose command over income is assumed to be shared. Income sharing is assumed to take place within married (registered or de facto) couples, and between parents and dependent children’ (ABS 2001).
approaches available to those interested in the likely future impacts of population ageing (Citro and Hanushek, 1991; OECD, 1996).

This paper provides two examples of the innovative use of microsimulation for the analysis of Australian health and aged care policy – one operating at the national level and the other at a small area level. The approach taken is somewhat instrumental in that policy is conceptualised more as a theory of choice and a study of costs (and benefits) (March and Olsen, 1989). The origins of the policies that are referred to in the paper, the processes and decisions generating the policies, the bigger social and political questions surrounding these policies, for example, are not discussed.

A brief overview of microsimulation as a quantitative modelling technique is given in the following section. The paper then describes two recent microsimulation modelling developments at NATSEM – MediSim, a microsimulation model of the Pharmaceutical Benefits Scheme, and CareMod, a spatial microsimulation model of the need for aged care services in NSW. Various technical aspects are highlighted to illustrate how these socio-economic models are constructed and are being used to inform health and aged care policy in Australia and assist with possible responses to increasingly pressing policy issues.

2 Overview of microsimulation modelling

Econometric modelling is basically the representation of economic phenomena and/or the simulation of economic processes either at macro or micro scale. As Dee (2004) comments, econometric modelling is often used to construct a representation of the counterfactual from which likely real world outcomes of a policy change can be compared with the existing state of no policy change i.e. to the factual. Microsimulation can be regarded as a structural modelling technique informed by econometric and other processes. Microsimulation is

- a means of modelling real life events by simulating the actions of the individual units that make up the system where the events occur.

Microsimulation models are large-scale complex quantitative models. They are constructed using either deterministic or stochastic algorithms, or both. If a model is deterministic then it is rule-based - if A then B. For example, if an individual meets certain income criteria then they are eligible for a government pension. Taxation models such as STINMOD are good examples of deterministic rules based models. Stochastic modelling, in contrast, is based on conditional probabilities that certain economic or social conditions or processes will exist or occur - for example, the likelihood that a low income widowed 88 year old female living by herself in her own home and who has mild restriction in her activities of daily living will be receiving some formal support through Home and Community Care (HACC)
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services. This approach is being used in NATSEM’s new ‘CareMod’ model (see section 3.2).

Microsimulation models are based on microdata i.e. “low-level” population data — typically the records of individuals from either a national sample survey conducted by a national Bureau of Statistics or large administrative databases. In other words, microsimulation models begin with a dataset that contains detailed information about the characteristics of each person and family (income unit) or household within a sample survey or an administrative database (Brown and Harding, 2002). This is one of the most important advantages of these types of models. Being based on unit records, it is possible to examine the effects of policy changes for narrowly defined ranges of individuals or demographic groups (Creedy, 2001). Further, the models’ databases can mirror the heterogeneity in the population as revealed in the large household surveys.

Group (cell) models provide details of the average experience for each of the groups specified within the model. This approach has the disadvantage of potentially underestimating key variables. The use of average values within the various cells reduces the variance in the factors seen in the real world (e.g. hours worked). It also obscures the relationship, for example, between the actual labour force participation levels and the socio-demographic characteristics of interest. Since microsimulation modelling is based on unit record files, then the variance in key variables can be examined directly. Microsimulation models take the individual as the unit of analysis, with average results for particular sub-groups of the population then being achieved by adding together the results for each of the relevant individuals. It is precisely because of the inherent drawbacks of the group modelling approach that microsimulation modelling is becoming a preferred option whenever it is necessary to capture responses and outcomes that must differ across population groups.

Microsimulation techniques bring a range of benefits, including the ability to change a greater variety of parameters independently and the capacity to provide considerably more accurate estimates and detailed projections of the distributional effects of changes. Two key strengths of microsimulation models are that: 1) they can replicate the complexity of the policy structures, transfers, and settings; and 2) they can be used to forecast the outcomes of policy changes and ‘what if’ scenarios i.e. the counterfactual where the results describe what, under specified conditions, may happen to particular individuals and groups (Brown and Harding, 2002).

Most microsimulation models are static in that there is usually no attempt to model a time sequence of changes (Creedy, 2001). These models are commonly referred to as measuring the effects of policy changes on the ‘morning after’ the change. Static models assess what each individual would, counterfactually, have under a new system or set of policy rules. 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
Dynamic microsimulation models represent the current world or to provide forward estimates of the impact of policy change during the next few years (Harding, 1996).

Dynamically ageing microsimulation models, on the other hand, are more complicated, in that a temporal element is introduced into the modelling. Dynamic models involve updating each attribute for each micro-unit for each time interval under consideration. Individuals are aged and stochastically undergo transitions, as well as being subject to modified policy regimes (Halpin, 1999). Dynamic models often start from exactly the same cross-sectional datasets as static models. However, the individuals within the original microdata (the model’s cohort) are then progressively moved forward through time. This is achieved by making major life events - such as education and training, labour force participation, family formation and dissolution (marriage, children, separation, divorce), migration, retirement, death etc - happen to each individual, in accordance 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. This involves the use of large transition matrices or econometric techniques to determine the various year-to-year shifts. Hence, dynamic microsimulation models are generally much more complex and expensive to build than static models (Brown and Harding, 2002).

To date, the majority of models have been non-behavioural in that no allowance is made for changes in individuals' behaviour in response to policy changes. This has been a standard practice in microsimulation modelling. It is often reasonable to make this assumption in the absence of any real world data as to how people would react to changes in their circumstances. A challenge is to incorporate behavioural elements and responses (e.g. consumer preferences, labour supply responses, elasticities of demand) into econometric models. This adds complexity to the model and increases the technical difficulty in its construction and maintenance. However, some policies are designed to impact on behaviour — such as altering the consumption of certain goods and services, changing individuals’ participation in the labour market or increasing compulsory savings through superannuation. Increasing patient copayments for prescribed medicines subsidised on the pharmaceuticals benefit scheme (PBS) is not only a method for government to raise revenue to help pay for the pharmaceutical bill but is also supposed to act as a price signal to consumers to encourage more appropriate patterns of consumption of PBS-listed pharmaceuticals (Brown and Harding, 2002). In such situations, behavioural models would significantly value-add to the contribution microeconomic quantitative modelling can make to policy assessment. The Melbourne Institute's MITTS model is one example where labour supply behavioural responses have been incorporated into the modelling.

Until recently, most econometric based microsimulation models have been non-spatial – the concern being for ‘who is affected’ not ‘where do these people live’. As a consequence, results have only been available at the national level or, at best, at a
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State or Territory level. This is because the existing models have been constructed on top of ABS sample survey data, which do not by themselves allow estimates at small geographic levels. Thus, in the past, it has not been possible using most models to predict the spatial impact of possible policy changes upon the household sector. However, regional models are now being developed through the construction of synthetic small area populations (see section 3.2) that will allow policy analysts to investigate the local area impacts of national policy changes or assist with the development of specific regional policies.

Further information on what is microsimulation, the various types of models, some of the technical characteristics and considerations, and examples of model applications can be found in Harding (1996) and Gupta and Kapur (2000). Although, the idea of analysing the impact of social and economic policies by simulating the behaviour and characteristics of individual decision-making units was pioneered in the US in the 1950s (Orcutt 1957; Orcutt et al 1961), microsimulation models were only introduced into Australia in the mid-1980s, and only in the late 1990s applied to health and ageing.

There are few examples internationally where microsimulation has been used to model health and aged care policy effects (e.g. Merz, 1991, van Hout et al, 1993; Merz 1994). Health Canada established a Microsimulation Modelling and Data Analysis Division in 2000 with emphasis on modelling both demand and supply-side health workforce issues, and health care expenditures and tax entitlements, particularly in relationship to pharmaceutical insurance coverage. In December 2003, an International Microsimulation Conference on Population, Ageing and Health was held in Canberra and a number of papers were presented on a range of health applications – these papers can be found at the following website: http://www.natsem.canberra.edu.au/conference/papers/index.html

3 Modelling Health and Aged Care Policy Options

Over the last few years, NATSEM has extended the benefits of its traditional microsimulation modelling to the health and aged care arenas, including the Pharmaceutical Benefits Scheme, private health insurance, hospital and medical services usage and costs, and the need for aged care services. In the following sections, two examples of the use of microsimulation for the analysis of health and aged care policy options are provided – MediSim, which is a new model of the pharmaceuticals benefit scheme and CareMod, which is a spatial microsimulation of aged care needs in NSW. Various technical aspects are highlighted to illustrate how these socio-economic models are constructed and implemented to help inform and assist with analysing public policy outcomes and public policy agenda setting.
3.1 MediSim – A Model of the Pharmaceutical Benefits Scheme

Policy Relevance

Australians have enjoyed access to ‘cheap’ medicines for over fifty years via the Commonwealth Government’s Pharmaceutical Benefits Scheme (PBS) (Productivity Commission, 2001). The PBS was designed originally in 1948 to provide access for all Australians to a 'free-list' of life-saving medicines. It now aims to provide Australians with timely, reliable and affordable access to necessary and cost-effective prescription medicines. The PBS currently covers over 2,500 different drug products (brands). This is a comprehensive range of medicines, with the majority of prescription medicine sales being covered by the scheme (DHA, 2003).

However, the fiscal sustainability of the PBS, and in particular, the continued funding of increasing government outlays on subsidised prescribed medicines, is being keenly discussed within federal health and financial public policy circles. Over the past few years, government expenditure on the PBS has grown by more than 10 percent per annum (Figure 1). The PBS has been one of the fastest growing areas of government outlays over the past decade - well above growth in GDP (4 percent) or in the total health budget (6 percent). By 2003-04, total government expenditure on the PBS had reached $5.1bn, with some 165m scripts being subsidised. Meanwhile PBS settings – patient copayments and safety net thresholds - have generally increased only in line with inflation. On average, the government subsidises patients to the extent of 84% of total PBS drug costs. Nearly 80% of total government PBS benefits accrue to government concession cardholders. There is, however, evidence that consumers are also beginning to feel the financial pressure in purchasing prescription medicines. Modelling work by NATSEM has indicated that patient contributions to the purchase of PBS subsidised drugs amount to a considerable proportion of the income of the working poor who are not eligible for concessional status under the PBS (Walker, 2000; Harding et al, 2004).

The PBS is an uncapped scheme. It has been estimated that if current trends and rules governing the PBS remain unchanged, then the cost of the Scheme to government could increase five fold by 2020 (Walker et al, 2000; Commonwealth of Australia, 2002). Finding ways of curbing government expenditure on the PBS, while maintaining social equity and access to ‘essential’ medicines, is at the centre of an ongoing and often emotionally charged public debate.

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2 For details see the following website <www.health.gov.au/pbs/general/aboutus.htm>.

3 Concession cardholders are individuals and/or families eligible for certain Commonwealth Government (Centrelink) pensions and allowances.
This debate has been brought into sharp focus in the last couple of years with greater than expected growth in PBS expenditures combined with the entry, or imminent entry, into the pharmaceutical market of new high cost biotechnology drugs and other innovative targeted therapies. While these new drugs have the potential to deliver significant health benefits, often to those with previously unmanageable conditions, they present new challenges to the existing PBS. The PBS is already under financial pressure and these new ‘era’ drugs are likely to add considerably to the growth rates of PBS costs (Lofgren 2001; Brown et al, 2002). The issue of who will have access to such drugs, under what conditions and at what cost to the patient and to government, will need to be resolved in a way that is acceptable to consumers, the industry and government. Microsimulation modelling can assist in these deliberations.

Since the late 1990s, individual drugs being listed on the PBS have had to demonstrate their cost-effectiveness. However, there is very little research that reports the health benefits that accrue to particular population subgroups that use a particular class of drugs (e.g. antihypertensive agents or cholesterol lowering drugs). Unfortunately, it is often this group level analysis that is required to inform policy debates on health expenditures. This is particularly so for the Australian Pharmaceutical Benefits Scheme. Measuring health outcomes at a subpopulation level and then incorporating these outcomes into policy debates on health
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expenditure and resource allocation remain a major challenge for health service researchers in general and health economists in particular. On the one hand, there is a significant body of literature that examines health outcomes at the macro or aggregate level, this work typically focussing on international differences in measures of population health and health system performance. On the other hand, clinical outcomes research has produced substantial literature on the outcomes of specific treatments at the micro-level (i.e. at the level of the individual patient). What appears to be missing in health outcomes research is the middle or group-level analysis. Differences in the health status of different countries, as measured by mortality rates, for example, have been investigated in terms of national expenditures on ethical (prescribed) pharmaceuticals. Random control trials document the clinical gains to study subjects from using a particular drug. But there are virtually no middle-level health outcomes data available to assist policy-makers to decide, for example, if a greater share of the overall health budget should be directed towards paying for the PBS in the future. Is the Australian public getting good value for their taxpayer dollars being spent on the PBS?

Under an ARC linkage grant NATSEM, in partnership with Medicines Australia, has built a microsimulation model of the Pharmaceutical Benefits Scheme known as ‘MediSim’. Up until now, NATSEM’s modelling of the PBS has focussed solely on issues of expenditure. Current and future use and costs of PBS medicines, under existing PBS and different policy settings, have been simulated and the distributional effects of policy changes estimated (see for example Abello et al, 2003; Brown et al, 2004; Harding et al, 2004). Thus to date, the primary utility of the modelling has derived from its capability to generate PBS government outlays and consumer costs based on various script volume, drug price and patient copayment assumptions, as well as to estimate the corresponding effects on families belonging to various income and household groups.

This modelling has provided valuable insights into the effects of various policies on PBS medicines and equity, but it does not have the capability to quantify the value that such pharmaceutical spending delivers. To present a more comprehensive picture of the contribution of pharmaceuticals to the Australian economy, and to advance the debate on PBS sustainability (i.e. move the discussion beyond the prevailing cost containment mentality), not only do the costs of pharmaceutical use but also the benefits that result from the use of these medicines - in the form of improved health outcomes - need to be modelled. MediSim extends the current expenditure and distributional microsimulation model of the PBS to incorporate health outcomes. As such, MediSim builds upon a prototype model of the PBS originally developed by NATSEM in the late 1990s (Schofield, 1998; Schofield, 1999). Over the past few years, this model has been extensively revised and upgraded in successive stages and the model significantly enhanced with respect to both technical aspects of the modelling and its application to policy and research (Abello et al, 2003; Brown et al, 2004; Harding et al, 2004; Brown et al, 2004a). Modelling health
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outcomes to be able to assess cost-effectiveness and the value the PBS delivers to the
Australian economy presents a range of significant theoretical and practical
challenges, particularly at the level of aggregation at which MediSim operates.
Adding health outcomes will be a significant advancement but this is a more
complex and demanding modelling task than the modelling attempted to date.

Model Description

The basic conceptual and technical constructs of the earlier model and the new
MediSim model have been described in detail elsewhere (Abello et al, 2003; Brown et
al, 2004; Brown et al, 2004a; Harding et al, 2004;). Fundamentally, MediSim is
composed of two parts - an input dataset (base file) and a forecasting component.
The main input dataset is at the person-level (i.e. each record pertains to an
individual with a family identifier to link family members) with individual
demographic, socio-economic and health characteristics, as well as data on drug
usage and costs across 19 aggregated drug classes broken down by sex, age and
government concessional cardholder status. The unit of analysis can be the
individual, the family, or aggregate levels (e.g. by groupings of income ranges
and/or drug classes). In the forecasting mode, the base population is ‘aged’ and the
script and cost data in the person-level dataset revised each year to provide five out-
years.

The base data set for MediSim has been constructed using a combination of the
following data sources:

a) an expanded basefile constructed by statistically matching the ABS National
Health Survey (2001) Basic CURF with NATSEM’s STINMOD 01A (which is
based on the ABS Household Expenditure Survey (1998-99) Basic CURF);
and then imputing short-term health conditions and drug usage for non-
priority health conditions using information from the 1995 NHS and HIC
data on distribution of scripts per person; and

b) three Health Insurance Commission (HIC) aggregated data sets used for
imputation and benchmarking purposes:

1. HIC frequency table on scripts: distribution of scripts per person by
concession card status, sex, age group, and drug class (2003);

2. HIC data by Pharmaceutical Benefits Scheme (PBS) item: monthly data
on PBS scripts and government costs (1992-2003); and

3. HIC data on PBS copayments and safety net thresholds, used to estimate
patient costs.

The introduction of health conditions into the existing model’s dataset was the
necessary first step to developing a facility in the model to measure health outcomes.
Adding variables on disease patterns and health status to the model complement the variables already available on drug usage and cost patterns. This additional information enables the examination of, for example, policy options that raise copayment thresholds for patients with short-term non-life threatening conditions but simultaneously protecting the chronically or seriously ill through safety net provisions.

It was thought initially that the best way to add diseases into the model’s dataset was to replace the existing database (which was derived from STINMOD01A model dataset) with the 2001 National Health Survey (2001 NHS). The 2001 NHS dataset contains the latest person-level information on long-term health conditions, drug usage for priority conditions, and health risk factors. However, the 2001 NHS has a number of limitations when applied to microsimulation modelling. It does not provide information relating to drug usage for non-priority health conditions and does not include information on people’s short-term health conditions. Further, and significantly, the survey structure does not allow for the modelling of the PBS safety net as it provides most information at the person level and only limited details regarding family composition and inter-relations.

In February 2004, NATSEM was given approval by the ABS to statistically match (i.e. record link) the 2001 NHS to a modified HES file. This was the first time in Australia that record linkage of two ABS national surveys had been embarked upon. Our goal was to bring together microdata that were not available from a single data source. As stated above, the 2001 NHS does not have complete health information about whole families/households and their interrelations, as the survey structure was to gain person level information only. To model safety nets for the PBS, information about families, their use of PBS medicines and expenditure, and their income is required. The statistical matching of the NHS01 and HES allows the retention of the health information available on NHS01 whilst borrowing the family structure from HES and potentially adding detailed information about family income and health expenditure.

The methodology and results of the statistical matching work are detailed in a joint NATSEM-ABS publication (ABS NATSEM Technical Working Group, 2004) and a paper on MediSim presented at the 2004 Health Economists Conference (Brown et al, 2004a). The work undertaken in collaboration with the ABS has provided a better understanding of the theoretical and practical issues involved in statistical matching and how to evaluate the accuracy of the matched dataset. The current version of the statistically matched file is of a sufficient high quality for modelling the PBS so long as the use of variables from the HES-based STINMOD dataset are restricted to the matching variables. The matching of the HES and 2001 NHS has been simplified to a significant degree by the fact that most of the variables required to do the PBS modelling are available on the 2001 NHS. The key input from the HES is family structure. That is, the NHS person records were re-organised using information from
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the HES dataset to create synthetic families - a complete record for every individual in each family.

In addition, since the 2001 NHS contains no detail on short-term health conditions and non-priority health disorders as well as prescribed drugs for these conditions, records from the 1995 NHS have been used to impute this additional information. The 1995 NHS provides the most comprehensive data available on short-term conditions.

Prescribed medicines fall into one of three categories: drugs that attract a government subsidy under the PBS (known as PBS benefit drugs); PBS listed prescribed medicines that do not attract a government subsidy i.e. scripts with a total cost (or price) below the PBS copayment level (below copayment drugs); and prescribed drugs not listed on the PBS (private medicines). MediSim models PBS benefit drugs only. Total fortnightly drug usage is imputed initially and once the aggregate numbers are correct, the majority of scripts are then designated as being PBS benefit scripts and the remainder designated as non-PBS scripts (i.e. below copay and private medicines).

Once the main person-based dataset has been prepared, the PBS is modelled by applying the rules of the scheme to each individual and family in the dataset over an 18-month period on a two-weekly basis starting on 1 January (that is when each family’s safety net threshold is reset to zero). The safety net operates on a calendar year basis and therefore needs to be modelled over this period. To reconcile this with the need to generate statistics on a financial year basis, statistics are produced on scripts and costs for both the first and last 12 months of the 18-month simulation period. Briefly, the steps carried out in running the model involve: 1) allowing users of the model to specify the policy settings of the scheme (copayment levels and safety net thresholds over the simulation period for concessional and general patients); 2) simulating the scheme by computing the costs associated with the scripts imputed to individuals and identifying below and above safety net patient expenditures for concessional and general patients; 3) computing government contributions as total costs less patient contributions; and 4) creating detailed output datasets for both concessional and general patients.

Model Application

MediSim is able to simulate a wide variety of changes - in the drugs listed on the PBS, in their prices, in the rules (policy settings) of the PBS, in government versus consumer outlays, and in the distributional impacts. Results of scenarios (counterfactuals) simulated using MediSim are compared to the ‘base case’ outcomes and changes in script volumes, government and patient costs, and distributional impacts assessed. The ‘base case’ represents the situation when no policy changes occur except CPI indexed increases in PBS settings. By altering the drugs included in
the model, their assigned prices and script volumes, MediSim is capable, for example, of simulating the impact of the inclusion of new drugs on the list; restriction on the drugs listed on the scheme or on the pricing of drugs; increased restrictions on drugs by indication; increased use of generics at more competitive prices; or an increased emphasis on the quality use of medicines as reflected in changes in doctor prescribing behaviour; as well as changes to copayment and safety net arrangements.

The distributional impacts of the PBS and a number of possible policy options have been investigated using MediSim (or its forerunner). The results of this modelling work indicate that the PBS is highly progressive with two-fifths of all Government outlays on the PBS being directed towards the poorest one-fifth of Australians. There are also pronounced distributional effects by age and gender, family type and lifecycle group, with older Australians receiving far greater PBS benefits than younger Australians and women receiving on average a higher share of government outlays than men. Couples without children receive nearly 50 per cent of total government PBS subsidies, reflecting the significance of older retiree couples. Almost 11 per cent of total government outlays on the PBS are directed towards women aged 75 years and over (Harding et al, 2004). These results reveal one of the main policy dilemmas facing government with the PBS - reducing or restraining government outlays on the PBS in any substantial way necessarily involves affecting low income Australians, given that they are overwhelmingly the beneficiaries of the current scheme. It is these very groups of individuals that the PBS is designed to help access ‘essential’ medicines at affordable prices.

The key concern for government is rising and uncapped public expenditure on the PBS. One recent policy solution has been the 2002 federal government budget measures to introduce a near-28% increase in PBS copayments and safety net thresholds. With the Labour Party recently supporting these changes, the increased PBS policy settings will come into effect on 1 January 2005. The impact of the proposed increases in copayments and safety net thresholds were modelled by NATSEM (Brown et al, 2003). When the budget measures were announced in May 2002, co-payments for concession cardholders such as pensioners were to rise by $1 to $4.60 and co-payments for others i.e. general patients by $6.20 to $28.60 per prescription. Consistent with existing PBS arrangements, once concession cardholders had paid for 52 PBS prescriptions in a year, they would receive further PBS medicines free of out-of-pocket cost for the rest of the year. Non-concession cardholders who reached $874.90 in out-of-pocket payments in a year would be eligible for further PBS medicines at the concessional rate for the rest of the year. The Treasurer argued that the proposed measures would ensure that consumers, industry, doctors and pharmacists all contributed to containing the rate of increase in the PBS and that, by making the PBS more sustainable, the Government could continue to fund the listing of new, highly effective, but expensive medicines (Commonwealth of Australia, 2002).
Using microsimulation to assess policy options

The modelling of these proposed changes showed that the increases in patient out-of-pocket contributions would generate an extra $233 million to government in its first year of implementation. This represented a 5 percent savings in government outlays from around $4.85 billion to $4.62 billion. Concessional patients were estimated to pay an additional $100 million, representing 43% of the cost shifting, or a net increase in their expenditure of 25% (noting that the base case incorporates the standard CPI increase of 2.5% in patient contributions) while general patients would pay an extra $133 million. For many general patients, the price of their medicines would fall below the increased co-payment level of $28.60. Some 3.4 million scripts, representing 13% of all PBS subsidised medicines prescribed for general patients, were estimated to ‘drop-out’ of the scheme as their price fell below the higher general patient co-payment. Of the $133m saving to government from general patients, the cost of these ‘new below copay’ medicines was estimated to represent $95 million - the costs of these medicines now to be borne in full by general patients.

The modelling also indicated that concessional cardholding families would on average pay an extra 75 cents a week (or $39 a year) for their medicines, while those families without a card would on average have to pay an extra 40 cents ($20.80 a year). The poorest 20% of concession cardholders would pay an extra 45 cents a week for medicines, bringing their weekly family spending on PBS medicines to 1.1% of their after-tax income, while those at the other end of the income scale (highest 20% of income) would pay an extra 95 cents, increasing their family expenditure to 0.8% of their family disposable income.

Raising copayments is a mechanism for cost-shifting. Various commentators suggest that simply raising copayments does not address the reasons the PBS is growing, and is likely to produce negative consequences for those who use medicines the most. PBS costs are the outcome of an array of influences, for example, the strategic negotiation between government and the pharmaceutical industry over the listing, pricing and indications for particular drugs, doctor-prescribing behaviour, and consumer need and demand.

The Government in considering its policy options needs to address the impacts of population ageing alongside the non-demographic drivers of the growth in PBS costs. The Government’s aim is to achieve fiscal sustainability of the PBS but there are a number of ‘structural’ impediments to this, especially within the context of an ageing population (Brown et al, 2003). The Government remains the major funder of PBS medicines – even with the implementation of the proposed budget measures, consumer out-of-pocket contributions were estimated to still represent only 18.4 per cent of the total costs of PBS benefit medicines. Factors cited for the growth of PBS expenditures include; the listing of new and effective, but more expensive drugs on the PBS; the growth in the numbers of people eligible for concession cards; the growth of preventive medicine and increasing rates of diagnosis and treatment of chronic illness particularly asthma, diabetes, heart disease and mental illness; population ageing; cost shifting between the Commonwealth uncapped PBS and the
states (with capped health budgets); increasing community awareness of the new drug treatments; doctors prescribing larger volumes of newer, more expensive medication compared to older, cheaper drugs (Donovan, 2002; Harvey, 2002; Rickard, 2002).

The ‘price’ elasticity effects of changing patient copayments on script volumes has been investigated using MediSim. It was found that a 25% increase in patient copayments is likely to reduce demand for PBS scripts over 12 months by nearly 10%. While the intention of increased copayments is to send a price signal to consumers in order to reduce their use of unnecessary medicines, if increasing costs of medicines to patients restricts their access to affordable medicines and they do not fill their scripts then, ultimately, the policy could cost the community much more money than it saves (Harvey, 2002; Donovan 2002).

As indicated, the major PBS user group is older Australians, nearly all of whom access PBS medicines at the concessional rate. Growth in numbers of age pensioners, ceteris paribus, will be reflected in increased script volumes and costs, and unless the eligibility criteria for concession cardholder status are changed, most of the rise in costs will be borne by government. The impact of changing eligibility of individuals to access PBS medicines at concessional rates, such as changing the Government’s policy on self-funded retirees and their access to the Commonwealth Seniors Health Care Card, can be easily investigated using MediSim.

Fundamentally though, if the benefits that accrue from private and public spending on subsidised prescribed medicines are to be assessed fully then the key health outcomes that are achieved from this expenditure need to be identified, a way of measuring these achievements needs to be found, and changes in performance over time tracked. Unless GDP growth accelerates significantly, or PBS expenditures grow well below historical rates in the future, difficult political decisions will have to be made about priorities in health funding. If Australia is to enjoy ongoing access to new medicines then the debate on funding pharmaceuticals must be broadened to consider the benefits that these medicines may bring. Quantitative econometric models such as MediSim will increase Australia's capacity for making such informed decisions.

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4 State funded hospitals are limiting the supply of drugs to discharged patients and privatising outpatient clinics and pharmacies, so the PBS now pays for drugs previously dispensed from hospitals and in-house pharmacies.
3.2 CareMod – A spatial microsimulation model of the need for and costs of aged care

The second example is a spatial microsimulation model that is currently in development to generate detailed regional projections to 2020 of the need for and costs of aged care in NSW under existing and counterfactual settings.

*Policy Relevance*

As the Intergenerational Report published by the Federal Treasury (Commonwealth of Australia, 2002a) makes clear, Government is starting to face the policy challenges associated with population ageing and the future needs of the ageing baby boomers. At the moment, Australia does not have adequate strategic planning and decision-support tools for forecasting the future demand for care services by older Australians; the likely cost of such services; and the financial capacity of older Australians to bear a greater share of those costs. In addition, such forecasts have not been available at a detailed small area or regional level. Geographical and financial access to and equity in care services are key political considerations (AIHW, 2002; Allen Consulting Group, 2002).

There is intense and widespread interest in the future socio-economic profile of the older population and the likely economic resources available to the ageing baby boomers (see, for example, the Myer Foundation Report on aged care to 2020 -Allen Consulting Group, 2002). A key question for public policy is the extent to which older Australians are likely to be able to draw on their own resources to help fund their needs in retirement and later life. Researchers differ in their assessment of the likely budgetary impact of population ageing (Productivity Commission, 2004). However, it is already clear that population ageing will place increased pressure upon the social security and health and aged care budgets. Older Australians will require access to services that support them in their later life and help alleviate or retard the health and disabling effects of ageing. The likely incomes of the baby boomers in retirement will thus become increasingly important, as Australia looks at possible changes in its health and aged care programs to help shift more of the costs from government to consumers (Brown et al, 2002).

Despite the significance of the high costs of residential care, the majority of older Australians live within the community. Projecting likely care costs must therefore also involve projecting the likely family structures of the baby boomers, as in many cases, informal care by relatives will substitute for formal care (Percival and Kelly, 2004). In 2001, for example, it was estimated that some 1.1m older Australians lived as a couple without children; some 690,000 lived alone; and over 360,000 lived with a family member (AIHW, 2002). Which baby boomers are likely to have spouses and children will be a very important issue – as will the projected health, labour force status and incomes of these possible potential informal carers. In the face of projected
longer life spans - but life years not necessarily free from disability - two key questions currently remain unanswered: who will pay for the care and support that will be demanded; and who will provide it? These issues will become critical over the next few years.

The issue of unequal distribution of care needs and funding of services across geographical areas has been a policy concern for some decades (Gibson et al, 2000). There is no doubt that access to care in regional Australia will continue to be one of the most important areas of social policy, as there are already major concerns about difficulties in attracting medical and allied health professional staff to rural/remote areas and about lower service standards. Issues of spatial equity are likely to become even more prominent in the next two decades — given current trends in the internal migration of older Australians to ‘sunbelt’ and coastal ‘retirement’ regional centres and as the health impacts of the ‘baby boomers’ reaching retirement age start emerging. But the pressures placed on the overall health and aged care budgets by ever-increasing costs will limit the extent to which special regional needs can be met in the future. These issues underline the need for much more sophisticated databases and analytical tools that can be used to project the future need for services in rural/remote areas, as well as within urban Australia.

NATSEM in partnership with the Office for an Ageing Australia and NSW Department of Disability, Ageing and Home Care, via an ARC linkage grant, is developing a spatial microsimulation model – known as CareMod - to assist in addressing these policy issues. The research is set within the framework of a ‘National Strategy for an Ageing Australia’ (Andrews, 2001). As such, it addresses some of the key challenges to and possible responses from all levels of Government, individuals, their families and communities in meeting the needs of Australians as they age. In particular, this research focuses on the key issues identified by the government of financial security, independence and self-provision, mature age employment, housing for seniors, and the provision of ‘world class’ high quality affordable care (Bishop, 1999a-c; 2000).

**Model Description**

CareMod is based on the unit records from the ABS 1998 Survey of Disability, Ageing and Carers (SDAC). But who should be included in CareMod’s basefile? Who are Australia’s ‘aged’? One of the key reasons for using the SDAC as CareMod’s base file rather than an alternative ABS national survey was that its top-coding of age is 85 years and above. This allows the ‘older ‘old age groups to be examined in more detail. Being able to categorise older Australians into narrower aged groups, such as ‘75 to 79’, ‘80-84’ and ‘85+’ years enables far more accurate modelling of the likely aged care needs of Australians by region. However, the question remained ‘what should be the lower age limit’ for this modelling? A review of the literature suggested several possible age cut-offs. In order to provide a ‘margin’ that would
ensure ‘full-capture’ of an appropriate target population as well as adequate numbers for modelling purposes, the base population for CareMod was defined as all persons living in households in which there is at least one person aged at least 55 years. Based on the disability survey, if 55 years is used as the age cut-off, then the number of records available for analysis is 12,754, which represents a weighted population of 3,872,905 persons.

Importantly, the SDAC includes both persons living in private dwellings and non-private dwellings (NPDs) i.e. institutions. Non-private dwellings can be divided into two categories – cared accommodation and other non-private dwellings. Cared accommodation consists of hospitals, homes for the aged (nursing homes and aged care hostels) and cared accommodation component of retirement villages. Other non-private dwellings include for example self-care accommodation for the retired or aged, hostels for the homeless, night shelters, refuges, guests and boarding houses, hotels, motels, caravan parks, camping grounds, religious and educational institutions, staff quarters, and aboriginal settlements. From the SDAC among those aged 55 years and over, a total of 3,633,717 (94%) individuals reported they lived in private dwellings and 239,188 (6%) lived in non-private dwellings. For the very old (aged 85+ years), however, the proportion living in institutional accommodation (i.e. NPDs) increases to 39%. Most of those living in non-private dwellings, reside in residential aged care facilities.

The person, income unit, family and household structures within the SDAC are retained within the model’s base file. Data on socio-demographic variables, economic factors, functional status, availability of informal carers etc will be either retained from the SDAC records or imputed. The records will be ‘aged’ over time (i.e. the data up-rated to provide projections over the model’s 20 year forecast period.)

In CareMod, the aim is to map individuals’ functional status to the need for different ‘modalities’ of care and then, using current expenditure data, to cost the likely use of these modalities of care. While these modalities of care may map to current aged care services and programs, the intention is to avoid defining the type of care required in terms of the services currently available. Rather, the type of care needed has been defined using a sliding scale ranging from no or minimal assistance required through to high dependency (Figure 2):

Care Modality 1 = no (or very minimal) assistance;

Care Modality 2 = low level of need which could be met within the family/community from a low level of support from informal carers for example;
Care Modality 3 = low medium level of need which maps to higher demand on either informal or formal care providers within the home or community setting;

Care Modality 4 = high medium level of need which translates to high demand on either informal or formal care providers within the home or community, or lower dependency institutional (residential) type services; and

Care Modality 5 = high levels of need requiring high dependency institutional type care and support.

This approach aims to separate the need for care from the existing organisational structure of age care support and supply of services. It therefore provides the opportunity of mapping the need for care to new forms of service delivery and support that may be developed in the future. Thus, the needs of elderly Australians may be met by a very different looking age care sector in 10 to 20 years time, depending upon future public policy options and community preferences and demands.

Need for the five care modalities will be modelled stochastically as a function of population characteristics, principally via an imputed ‘Index of Need’ based on conditional probabilities of the need for assistance with key activities of daily living (ADLs). The need index would be used with other characteristics (e.g. living arrangements) to predict the probability of an individual’s need for a particular
modality of care. This builds on the work previously undertaken by NATSEM for the Department of Health and Aged Care - which used the ABS’s 1993 SDAC to impute whether assistance was needed with seven ADLs (Percival and Lloyd 2000) - and work by AIHW on disability, functioning and dependency levels of older Australians analysing data from the 1998 SDAC as well as various administrative datasets (e.g. AIHW, 2001; AIHW, 2002).

Literature on aged care was reviewed to identify key drivers of the need for aged care — i.e. variables that predict the need for care (or more typically, the use of aged care services). These variables may not be direct determinants of the need for care but rather are good predictors acting through simple or complex relationships with functional status. For example, the fact that an individual is elderly does not mean that that particular individual will need aged care services, but age is a key predictor of the need for age care, since physical and mental impairment increases exponentially with age. Hence, the need for and rates of utilisation of aged care services are strongly predicted by age through its relationship with functional status.

In theory, the demand for aged care then could be modelled as a function of need, supply effects and care preferences. A person’s usage of care could be determined by existing information on its historic probability, informed by AIHW’s extensive research in this area (see for example AIHW 2001 and 2002), and conditioned by changes in the supply and type of available services. In establishing the demand for care, the model could also account for care preferences, as they relate to an ability to buy services, including the use of insurance products. However, it should be kept in mind that the initial intent is to model the need for care, with the later possibility of modelling the demand for and use of specific aged care services.

Perhaps the key innovative element of CareMod is that it is being built as a spatial microsimulation model. As stated in the introduction, NATSEM is developing a regional methodology to produce small area estimates. This involves the reweighting of an ABS national (or another) survey confidentialised unit record file (CURF) to create a ‘synthetic’ dataset for each small area of interest. In CareMod, small areas estimates are generated by reweighting the SDAC CURF to create ‘synthetic’ datasets for each statistical local area (SLA) in NSW. A national weight is provided by the ABS in the SDAC CURF for each person level record. A weight represents the likelihood of finding persons with a similar set of characteristics in the Australian population. Conceptually, the SDAC national weight for each record is turned into a ‘synthetic’ SLA weight, so that the new weight now represents the likelihood of finding persons with a similar set of characteristics in the local area population. After reweighting, the weighted characteristics of the survey records should mirror those of the SLA population as revealed by the 2001 census. In other words, to provide the model’s regional estimates, a set of record weights is generated for each statistical local area (SLA).
The SDAC is reweighted against a range of ‘benchmarks’, using data from the census. Benchmarks are based on a selection of ‘linkage’ variables that are common to both the SDAC and census. It is important that these linkage variables adequately represent the socio-demographic attributes of each SLA population and address the main issues of concern — in the case of CareMod, the drivers of the need for aged care and the income and assets of older Australians.

The reweighting process trialled to date has involved five major steps:

1. identification and specification of desirable benchmarks and target variables i.e. selection and definition of relevant linking variables and their classes;
2. data pre-processing and preparation
   a. obtaining customised census tables from the ABS against which SDAC data are reweighted (i.e. data was requested to be made available in finer age groups for people 55 years and over). The census counts for persons in these tables are based on usual resident persons;
   b. preparation of census data, which largely involved the ‘balancing’ or reconciliation of the census tables.
   c. preparation of SDAC data involving recoding and up-rating data;
3. mapping of SDAC98 variables to the census benchmark variables;
4. use an optimisation algorithm to generate new weights for each SLA to create the synthetic small area populations; and
5. validation of the small area estimates produced through the regionalisation process.

These steps are outlined in more detail in another publication (Brown et al, 2004b). The literature indicates that a number of socio-demographic factors are important drivers for the need for care: age, sex, and ethnic background; income and wealth; family composition and household type; home ownership and accommodation arrangements; mobility and transport (e.g. car ownership). Age is the predominant determinant of the need for care - the relative importance of other variables is not clear. Although a number of factors drive the need for care, only those proxy variables that exist in both the Census and survey can be incorporated in the reweighting as benchmarks. To date, variables such as age, sex, relationship in household, individual income, tenure type and level of education have been trialled as benchmark variables. Because of the importance of age to predicting the functional status of individuals, every person-based benchmark has been cross-tabulated against four broad age groups (0-54, 55-64, 65-84, 85+ years).
Model Application

The rationale for building CareMod is to be able to provide much more detailed answers to possible policy questions about the likely future need for, affordability of, and private and public capacity to fund aged care for older Australians. CareMod will provide forward projections to answer basic questions such as:

- how many elderly persons will live in different regions of NSW in 5, 10, 15 or 20 years time;
- what will be their functional status (disability/health status) and need for care;
- what will be their family status, living arrangements and availability of informal care;
- what income from both government (e.g. age pension) and private sources (e.g. superannuation, returns on investment) and assets including housing will they have at their disposal to contribute to their costs of care?

In addition, the model is being built such that key parameters will be able to be changed so that the distributional consequences of possible policy changes and the significance of key assumptions to the projection outcomes can be assessed.

Because microsimulation models operate at the level of individuals and their households, it is possible to model complex policy options and to assess their distributional and revenue consequences. Given that governments are likely to be under significant budgetary pressure in other policy areas, greater attention will be devoted to the financial costs to government of providing care services and the possibility of greater independence and self-provision by older Australians. Therefore, a key element of CareMod will be its functionality to simulate the distributional impact of changes in the public and private distribution of care costs — that is, what will be the likely costs of the different care modalities and how will these costs be divided between private contributions compared with government outlays under different policy settings?

If the opportunities offered by the reweighting methodology being trialled in CareMod are realised, then CareMod should be able to make a significant contribution to the strategic planning and decision-making and improved targeting of aged care services for older Australians at a regional level. It is anticipated that the model outcomes will provide important input into resource allocation-location decisions, whilst also contributing to policy debates on the affordability and funding of aged care services.
4 Conclusions

This paper has described two of the recent modelling developments at NATSEM, including the development of a complex health and a regional microsimulation model. NATSEM has also modelled private health insurance (Walker et al, 2003) and hospital usage (Thurecht et al, 2003) and is developing a health system-wide model integrating person and family use of prescribed medicines, medical and hospital services.

Microsimulation models have been criticised for embodying more technical knowledge than theory (Halpin 1999). In practical terms, these models are relatively complex, have significant data handling and computing requirements, are costly to build and maintain, and usually require a team of developers with a wide range of expertise and skills. Models can be limited by their design, their assumptions and algorithms, and data quality and coverage.

If quantitative models such as the two described above are used for the purposes for which they are built and are used in an objective and professional manner, then the potential of microsimulation models in the health and ageing fields is very significant. Models need to be accepted by policy makers to be useful. This is clearly illustrated by Dee’s (2004) account of the views of one Senator during the Senate Select Committee hearing on the Free Trade Agreement between Australia and the US stating that ‘The Senator suggested that modelling evidence could be discounted, because it was inconsistent – different modellers came up with different answers – and it was not based on fact, but rather a projection of what might happen in the future’. The acceptance of modelling outcomes as valid evidence necessitates model validation and allowing the modelling to be open to peer review and public scrutiny. To this end, documentation and explanation of models is critical.

Policy simulations are carried out in order to contribute to a more rational analysis and informed debate. In this context, microsimulation models can make a significant contribution to the evaluation of health and aged care policy. While the challenge is to develop models that will perform well and be accepted and used by policy-makers, the future prospects are very exciting, particularly if privacy issues can be resolved and survey and administrative data can be blended on top of which such models can be constructed.
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