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Abstract

With the rapid ageing of the Australian population and the growth in the number of older persons and years likely to be lived with disability, the need for and provision of aged care have become one of the central themes of the public policy debate. This paper discusses the construction of a dedicated Aged Care Module built within the large dynamic microsimulation model APPSIM (Australian Population and Policy Simulator). APPSIM is based on the one per cent sample of the 2001 Australian population census and allows simulation of various life cycle events at individual and household levels through to 2051. The Aged Care Module was designed to specifically simulate low and high care needs and the use and costs of informal and formal home and community and residential age care services, building on information on a range of variables including age, gender, disability level, living arrangements and socio-economic status. The methods for imputing baseline data and transition equations for projecting future care needs will be outlined. The number of older Australians likely to need the different types of aged care will be compared with the projected supply of corresponding care places to estimate unmet need for aged care services at the national level over the next 40 years.

Key words
Aged care, Dynamic microsimulation modelling, APPSIM

Acknowledgements

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1 INTRODUCTION

1.1 AGEING AND AGED CARE IN AUSTRALIA TODAY

1.1.1 Population ageing

Population ageing is a well established phenomenon in developed countries such as Australia. All demographic projections show that the proportion of older persons in the population will continue to increase over the coming decades (Booth and Tickle 2004; ABS 2008; United Nations Population Division 2009; The Treasury 2010). However, there is a considerable degree of uncertainty regarding the extent of ageing as future scenarios depend on various assumptions about fertility, mortality and immigration. According to the official projections produced by the Australian Bureau of Statistics (ABS 2008), the proportion of the population aged 65 years and over is projected to increase from 13 per cent in 2007 to 23 per cent (Series B) in 2056. The rapid growth of the population aged 85 years and over has become a matter of increased concern as this group is likely to require intensive care services owing to higher levels of severe or profound disability. According to ABS (2008) projections, the proportion of people aged 85-plus will increase from 1.6 per cent of the total population in 2007 to between 4.9 per cent (Series B) and 7.3 per cent (Series A) by 2056. In absolute numbers, people aged 85-plus are projected to increase from 344,100 in 2007 to between 1.7 million and 3.1 million by 2056. Life expectancy at birth is projected to climb to 85 years for men and 88 years for women by 2056 (Series B)¹ and it has been argued that the longevity assumptions of the official projections may be exceeded and thus Australia may have more than the expected number of aged people in the future (Booth and Tickle 2004). In the context of the inevitability of population ageing and growth in the number of aged people, the need for aged care will grow in the future. Debates on statistical precision of projected aged population are likely to continue but there is a general consensus that the numbers as well as the proportion of elderly people will grow substantially. As such, modelling of the effects of this growth and possible policy options to manage it will be very useful.

1.1.2 Disability in old ages

Disability prevalence rises rapidly after the age of 65 years. According to the 2003 ABS Survey of Disability, Ageing and Carers (SDAC), about 10 per cent of people aged 65-69 years were identified as having profound or severe core activity limitation. The prevalence of profound or severe disability was as high as 74 per cent for individuals aged 90 years

¹ Series A represent lower assumptions and Series C higher assumptions regarding fertility, mortality and migration. These projections were produced prior to the 2008-2009 economic recession which prompted a reduction in the immigration quota at the end of 2008 and early 2009.
and over (ABS 2004). Age specific prevalence of disability appears to increase about 1.5 times every five years after the age of 65-69 years.

A high prevalence of disability at older ages and a rising number of older people means the number of people with a disability, and demand for care, will rise rapidly into the future. One study anticipates a 70 per cent increase in the number of people with disabilities over the 30 years between 2006 and 2031 (Giles et al. 2003). In addition, care needs will change since the type and severity of disability is age related. For example, chronic health conditions such as dementia will become increasingly common as dementia prevalence rates are currently doubling every five years after the age of 65 years, reaching around 50 per cent in those aged in their 90s (Jorm et al. 1987)(Nepal et al. 2008a).

While the historic rise in longevity is expected to continue into the future, an important issue is how much of the life gained at older ages will be shadowed by disability. This is a contentious issue and the evidence is mixed (Jagger 2000). In Australia, an analysis by the Australian Institute of Health and Welfare (AIHW 2006) indicated that between 1988 and 2003 the gain in life expectancy was accompanied by an increase in years of life lived with disability. According to AIHW, in the period 1998-2003, 67 per cent of gains in life expectancy of men at age 65 (1.5 years over that period) were years with disability (1 year), while for women over 90 per cent of their gains in life expectancy age 65 (1.2 years) were years with disability (1.1 years). While analysis based on longitudinal data would provide better estimates of this trend, what is certain is that each additional year of life gained is unlikely to be free from disability and the arguments are over its extent rather than its absence.

Development of disability may often be a gradual process and the person with a disability may need different forms of care over time. Hence, a person’s lifetime care needs depend on what fraction of their life is lived with disabilities that require normal care and what fraction needs intensive or high care. It is often assumed that care intensity and associated care expenditure increases with age. However, there are other views such as that put forward in the ‘red herring hypothesis’ which suggests that it is the closeness to death rather than age that is more important in determining health care expenditure (Zweifel et al. 1999; Werblow et al. 2007). How this applies to Australia, particularly at the population level and in terms of high-care need, is unknown. If the closeness of death is more important than age in the Australian context, the demand for care, especially high level care, is likely to be delayed rather than reduced as people live longer.

1.1.3 Provision of aged care services

Broadly, aged care can be understood as the collection of services which are delivered primarily to fulfil the special needs of disabled or frail older people, and at present, Australia has two major aged care service sectors: residential care and community care. Residential services are provided to frail older persons and is divided into high-care (24-hour nursing) and low-care (previously known as hostel care). In 2006, around 6 percent of Australians aged 65 or more years lived in residential aged care facilities although over 25 percent of those aged 85 or more years lived in residential aged care facilities (AIHW,
Community care is defined in the Aged Care Act 1997 as ‘care consisting of a package of personal care services and other personal assistance provided to a person who is not being provided with residential care’ (p 205). Community care is also partitioned into high and low care depending on the level of support provided.

In developing a model of aged care, understanding the demand for aged care is clearly crucial. However, current projections on future demand for aged care are based largely on the projected age profile of the Australian population, with little or no consideration of the economic circumstances of the coming generations who will need the services nor, for example, the effect that changes in expectations or living arrangements might have on demand. An important issue to consider is the influence of socioeconomic differences in the use of aged care service. A NATSEM analysis of longitudinal data suggested that people in higher income bands were more likely to enter hostels (low care residential aged care facilities) while those in lower income bands were more likely to enter nursing homes (high care residential aged care facilities) (Percival and Kelly 2003). The authors speculated that income could have worked as a proxy for other factors such as underlying health conditions.

In addition, a number of studies have shown that demand for aged care is increasing with the rising number of oldest old people but the pool of carers is diminishing with the shrinking of the working age population (AIHW 2004; Percival and Kelly 2004; Productivity Commission 2008). The caretaker ratio is projected to decline from 2.5 potential carers per person aged 80 years or older in 2004 to less than 1.0 in 2044 (Productivity Commission 2008, p. 157). This trend is confirmed by studies that used more detailed analysis of aged care needs. For example, using a group-based model, Percival and Kelly (2004) estimated a 160 per cent increase in older persons with severe or profound disability between 2001 and 2031 compared to an increase of just 57 per cent in potential informal carers over the same period. It is also important to note that carers tend to be less healthy than non-carers (Nepal et al. 2008b) and thus may also have greater health care needs. This is compounded by the fact that the pool of potential carers is also ageing. Percival and Kelly (2004) projected that the population of carers aged less than 65 years would rise by 19 per cent compared to an increase of 110 per cent for carers aged 65 years or older between 2001 and 2031. As such, the share of older carers would increase from 42 per cent of all carers in 2001 to 56 per cent in 2031 (Percival and Kelly 2004).

1.2 Dynamic Microsimulation Modelling

1.2.1 Dynamic Microsimulation Modelling, Disability and Aged Care

During the past two decades, microsimulation models (MSM) have revolutionised the quality of information available to policy-makers about the distributional characteristics of a system and the likely behaviour of, and the social and economic impacts of policy change upon the system’s micro-units such as persons, households or firms (Gupta and Harding
MSMs are being used increasingly to forecast the impact of public policy change in the areas of health and ageing.

Microsimulation models are based on microdata (that is, “low-level” population data) - within the model, each micro-unit is represented by a record containing a unique identifier and a set of associated attributes. These unit records may be weighted so as to represent the full population of the system being modelled. The unit records may be sourced from a survey, census or from administrative data. MSMs typically comprise thousands of micro-units and a host of variables. The model’s base of individual records provides significant flexibility. A set of deterministic or stochastic rules, or transition probabilities, can be applied to the units to simulate changes and various counterfactual shocks within the system. Results can then be assessed for individuals, small subgroups of the population or for all of the population represented within the model.

Microsimulation models can be ‘static’ or ‘dynamic’ in structure. APPSIM (and the Aged Care Module) is a dynamic microsimulation model. Dynamic microsimulation models update each attribute for each micro-unit for each time interval over an entire simulation period (Caldwell, 1990), and thus have an intuitive appeal due to the broader temporal dynamics that they can capture. They are more complex, have much greater resource implications, involve additional development time and carry an associated elevated development risk than a static MSM. A static MSM replicates a given system with its participants and rules of operation and considers the immediate impact of a change to the system - referred to as the "morning after impact". In contrast to dynamic MSMs, a static MSM captures changes over time by updating the model’s cross-sectional microdata using static ageing techniques - essentially involving applying a new set of weights to the unit record basefile to reflect the changing profile of the population over the forward looking period (Brown and Harding 2002; Gupta and Harding 2007).

The only dynamic MSM of disability and ageing developed in Australia prior to the APPSIM Aged Care Module (ACM) was DYNAMOD, the first dynamic microsimulation model of the Australian population (Kelly 2003). While disability status was an important component of DYNAMOD, the initial model only dichotomised disability status. Percival and Lloyd (2000) investigated the feasibility of simulating detailed Activity of Daily Living (ADL) categories in DYNAMOD to assess the need for and use of aged care services in Australia. Although they concluded that a longitudinal model of ADLs could be possible, they only tested a static simulation, owing to the lack of longitudinal data available at that time. In another extension of DYNAMOD, Walker (2007) used information on disability status and long-term health conditions from the 1998 SDAC to model four states of health status: has no long-term health condition; has a long-term health condition and disability with no impact on core activities; mild/moderate impact on core activities; and severe/profound impact on core activities. However, this module was designed to look at the impact of health status on the ability of older Australians aged 65 to 70 years to stay in the workforce rather than aged care needs.

Many countries are facing the challenges of a rapidly ageing population and the increased need for aged care and, thus, aged care has also been a component of several dynamic
microsimulation models outside Australia. Cornell Microsimulation Model (COSRIM) is an example of such a model developed at Cornell University beginning in 1987 (Spielauer 2007). Disability status and institutionalisation are modelled throughout the life of the individuals. CORSIM maintains kinship network links between parents and children, spouses and ex-spouses and siblings and uses this information in order to study the supply of informal care in the future (Spielauer 2007). Another example is LifePaths, a dynamic model developed by the Canadian Statistical Office (Statistics Canada 2002). It is different to many other dynamic MSMs in that it operates in continuous time, is an open model (meaning that new ‘people’ are created when they are needed to form a partnership as the model is based around ‘dominant individuals’) and its initial database is synthetic, drawing together a range of sources of micro data to create ‘representative life histories from birth to death for all birth cohorts since 1872’ (Spielauer 2007, p. 38). Disability was added to the model specifically for the purpose of modelling future home care services (Spielauer 2007). LifePaths models both institutionalisation, and the need for informal and formal home care services (Statistics Canada 2002). MOSART is a dynamic MSM of the Norwegian population developed by Statistics Norway (Fredriksen and Stolen 2007). It is based on administrative data that covers around twelve per cent of the population of Norway, and allows for the creation of a longitudinal database of detailed retrospective information (Spielauer 2007). The current and most detailed version of MOZART models demographic behaviour, labour force and educational participation, pensions, household formation and disability. Among other events, institutionalisation is modelled using time-invariant transition tables. Notably MOSART does model moving in and out of aged-care institutions, disability and rehabilitation. NCCSU Long-term Care Model (the Nuffield Community Care Studies Unit - now Leicester Nuffield Research Unit) at the University of Leicester was developed as a dedicated model of the financing of long-term care for elderly people (Hancock 2000; Hancock et al. 2007). The model’s population is limited to those over 65 and focuses on their income and assets. Elderly peoples’ need for care is then modelled by linking it to the PSSRU (Personal Social Services Research Unit) group-based long-term care macro model, which projects the size and age distribution of the population 65 and over who are dependent on care (Speilauer 2007).

1.2.2 APPSIM

APPSIM, or the Australian Population and Policy Simulation Model, is a dynamic microsimulation model, is being developed to simulate demographic, social and economic attributes of the Australian population. Built on a confidentialised one per cent sample of the 2001 Census of Population and Housing, APPSIM provides a snapshot of Australian population as at 30 June each year, from 2001 through to 2051. The model is written in C# (C-sharp), base microdata files are stored as CSV files and parameters are stored in Excel spreadsheets.

The primary aim of APPSIM is to provide the Australian Government with a modelling capacity to assess the social and fiscal implications of Australia’s ageing population, including the future distributional and revenue consequences of government tax and expenditure programs. Within the simulation cycle (which is annual) are a set of functions
or tables of probabilities for calculating the chance of various events occurring. APPSIM has 12 modules that cover most major events that can occur at various stages of an individual’s life (Figure 1). After each simulation cycle is completed, APPSIM generates summary statistics as well as outfiles consisting of individual level records. The outfiles can be used for cross-sectional as well as longitudinal analysis.

APPSIM has individual level information on age and gender, as well as detailed information on social, economic, and now health circumstances (Figure 1). Events are modelled annually using discrete time functions and transition probabilities derived from longitudinal data such as the Household Income and Labour Dynamics in Australia survey (HILDA). Being a dynamic model, APPSIM is able to project over time the impact of policy change, taking into consideration changes in a range of socio-demographic and economic characteristics such as household and family structure, retirement income, assets, superannuation, debt levels and health status, including disability status. The Aged Care Module is integrated within APPSIM and so it is able to draw upon the individual level information available in APPSIM’s other modules.

Figure 1    APPSIM diagram showing simulation cycle and modules.
2 METHODOLOGICAL APPROACH

2.1 MODULE DESIGN AND COMPONENTS

The Aged Care Module is a specific purpose built module that has been added to and works in concert with existing APPSIM modules. Accordingly, it makes use of the common APPSIM basefile and information generated by the other modules. Figure 2 shows the components of the ACM and their relationships. Individuals who are 65 years or older are modelled in this module.

The ACM has two main components:

1. The need for aged care services; and
2. The use of aged care services.

The need for aged care services are modelled endogenously. The use of aged care services is constrained by the supply side information, which is an exogenous input. The estimated need and use of aged care services are brought together to quantify both met need (use) and unmet need. Need is modelled on the basis of individual’s disability level and potential family assistance (informal care). The ACM uses the Demographic Module (which models fertility, mortality and migration (Pennec and Bacon, 2007; Pennec and Keegan, 2007) and the Family Formation and Dissolution Modules in APPSIM (Bacon and Pennec, 2007) to estimate the number of older persons in the future and their family-household structure - a key influence on the availability of informal care. The ACM builds on a disability variable which had been imputed as part of the APPSIM basefile (because of the influence of disability on labour force participation and earnings).

The underlying need for aged care services arises from limitations in physical, medical, social or psychological circumstances which may develop gradually (natural ageing process) or suddenly (accidents or medical emergencies such as heart attack). These four dimensions of need are combined into the term disability. As established in the Aged Care Act 1997, a person is eligible to receive formal aged care services if they have any of these four forms of limitation that require the provision of care. The choice of a specific type of care then depends on how the care needs can be met. The ACM adopts this categorisation of disability and the associated need for aged care, using a measurement of disability as an indicator of the need for care.
Figure 2  Aged Care Module: A diagram showing components and their relationships

Person enters aged care module (aged 65+)
Disability level is already defined [0-5]

Is assistance needed?
No (if disability =0,1)  Yes (if disability >=2)

Level of care needed 1 – 4  [low - high]

Is informal care available?
No  Yes

Is likely to seek formal care?
No  Yes

Is community care adequate?
No  Yes

What level of residential care is needed?

What level of community care is needed?

Residential high care
Residential low care
Community high care
Community low care

Is residential high care available?
Yes  No

Is residential low care available?
Yes  No

Is community high care available?
Yes  No

Is community low care available?
Yes  No

Unmet need for residential high care
Unmet need for residential low care
Unmet need for community high care
Unmet need for community low care

Total need for care places is compared to supply of such care places to determine unmet need
Unmet need = total need – supply

Disability level  Care level
0 none  none
1 low  none
2 mild  low
3 moderate  medium
4 severe  high
5 profound  high

Select records with disability and model availability of informal care without identifying individual carers. Explanatory variables: age, sex, living arrangement (presence of spouse, presence of other adult member).

Filer: do not seek formal care if:
Informal care is available and
Disability level is 2 - 3

Community care availability

Community care:
disab <=3 then low care
disab 4,5 then high care
provided the places are available.

Residential care level probability based on disability level

Unmet need for residential high care
Unmet need for residential low care
Unmet need for community high care
Unmet need for community low care

Age, informal care availability

Level of care needed 1 – 4  [low - high]
In keeping with the most detailed data source on disability in Australia – the ABS Survey of Disability, Ageing and Carers (SDAC) - APPSIM imputes disability status with six levels of disability using the definitions adopted by the ABS in this survey:

0. No disability (i.e. able bodied);
1. Some restriction;
2. Mild disability;
3. Moderate disability;
4. Severe disability; and
5. Profound disability.

The data source used to allocate levels of disability in APPSIM was the 2003 SDAC (ABS 2004). The SDAC surveys assign a disability status according to the presence or absence of any disability and, if present, its impact on core activities of daily living in the areas of self-care (bathing or showering, dressing, eating, toileting and bladder or bowel control), mobility (moving about the usual place of residence, getting into or out of a bed or chair, going to or getting around a place away from the usual residence) and communication (understanding and being understood by others: strangers, family and friends). Core activity limitation is in turn assigned to one of four levels: profound (unable to do, or always needs help with, a core activity task); severe (sometimes needing assistance to perform a core activity, has difficulty understanding or being understood by family or friends, can communicate more easily using sign language or other non-spoken forms of communication); moderate (not needing assistance, but having difficulty performing a core activity); or mild needing no assistance and having no difficulty performing a core activity but needing assistance in performing other tasks) (ABS 2005).

In the modelling, it is assumed that if an individual has a disability then they may need some form of assistance. The availability of informal care moderates the need for and use of formal aged care services. If informal care is available then an individual may not use formal care services; use community based services when otherwise they may have moved into residential care; or they may access a lower level of care. Broadly, informal care in the ACM is calculated on the basis of disability level and available family support using information from the SDAC on the relationship between disability levels and caring arrangements. Thus, modelling the need for both community and residential aged care is calculated taking into account the possible impact of the availability of informal care. The ACM allows modellers to modify criteria on the need for formal aged care services (identified as ‘filter’ in Figure 2). This enables the impact of alternative policy settings with respect to entry criteria to aged care services to be tested. For example, it can test what happens to future demand when older persons with moderate or less severe disability and receiving informal care may choose not to seek formal care. When the filter is off, the results reflect upper range of potential aged care needs as revealed in the SDAC.
The ‘supply’ of informal care is projected using currently available information on the likelihood of an aged person having a carer. In the ACM, the determinants of having a carer include age, gender and living arrangements. Availability of informal care is then used as an influence on the likelihood of needing a given type and level of formal aged care.

The supply of home and community, and residential aged care services (the number of aged care places available) is an external input to the module. In the current research, the historical number of aged care places (until 2008) was drawn from services statistics compiled by the Australian Institute of Health and Welfare (AIHW). The projected number of community and residential aged care places was suggested by the Australian Government Department of Health and Ageing (DoHA), which the authors then split into low and high care categories on the basis of the trend in the immediate past. Individuals assigned a certain level of need are then randomly allocated to be users of the available services (i.e. the existing and projected supply of aged care places are randomly allocated among the potential ‘eligible’ population) through a Monte Carlo simulation until the supply of aged care services is exhausted within the modelling environment.

3 Technical Specifications

3.1 Source Data and Basefile

The probability of various events relevant to the need and use of aged care considered in the ACM were estimated using data from the 2003 SDAC. The choice of the SDAC was based on its comparative advantage over other data such as HILDA in terms of the availability of required information, coverage and sample size. The 2003 SDAC is a cross-sectional survey which has been conducted by the Australian Bureau of Statistics. The SDAC’s Confidentialised Unit Record File (CURF) contains data on 5,145 persons in 554 residential care establishments, 36,088 persons from 13,998 private dwellings and 272 other non-private dwellings (ABS 2005). The data include detailed information on demographic and socio-economic characteristics as well as information on health and use of care. Disability information includes: disability status; disabling condition; core activity restrictions and the respondent’s need for and receipt of help for a range of daily life activities; the level of and reasons for unmet need; types of providers of formal and informal care; access to transport; participation in community activities; relationships of primary carers to recipients; and the type of care undertaken (ABS 2005). The dataset was considered appropriate for the analysis of the characteristics of elderly people in or requiring residential care. However, an important limitation of the SDAC is that it is a cross-sectional survey.

As stated previously, the ACM uses the APPSIM base file, namely, the unit record file of the one per cent sample of the 2001 Census. The one per cent Census file contains 188,013 person, 75,451 dwellings and 79,320 family records (Kelly 2007). Theoretically, the ACM can draw on all the variables in all the other modules in APPSIM. A list of variables used in
APPSIM and their definitions, and the variables from the 2001 Census sample file used as the basis of the starting population are provided in the APPSIM data dictionary (Kelly 2010).

3.2 **Outcome Variables**

Given the extensive range of variables available in APPSIM, there is potential for a large output to be generated from each simulation run of the model. A number of key outcome variables have been identified for this first version of the ACM. These are listed in Table 1 and the results given in Section 5.

<table>
<thead>
<tr>
<th>Domain</th>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic</td>
<td>number of older persons by age and gender</td>
</tr>
<tr>
<td>Disability</td>
<td>number of persons aged ≥ 65 years by the six levels of disability</td>
</tr>
<tr>
<td>Informal Care</td>
<td>number of persons aged ≥ 65 years with a disability for whom informal care is available</td>
</tr>
<tr>
<td>Need for care</td>
<td>number of persons aged ≥ 65 years by level of care needed</td>
</tr>
<tr>
<td>Community care</td>
<td>number of persons aged ≥ 65 years needing community aged care</td>
</tr>
<tr>
<td></td>
<td>number of persons aged ≥ 65 years needing low level community aged care</td>
</tr>
<tr>
<td></td>
<td>number of persons aged ≥ 65 years needing high level community aged care</td>
</tr>
<tr>
<td>Residential care</td>
<td>number of persons aged ≥ 65 years needing residential aged care</td>
</tr>
<tr>
<td></td>
<td>number of persons aged ≥ 65 years needing low level residential aged care</td>
</tr>
<tr>
<td></td>
<td>number of persons aged ≥ 65 years needing high level residential aged care</td>
</tr>
<tr>
<td>Supply</td>
<td>projected supply of low level community aged care places</td>
</tr>
<tr>
<td></td>
<td>projected supply of high level community aged care places</td>
</tr>
<tr>
<td></td>
<td>projected supply of low level residential aged care places</td>
</tr>
<tr>
<td></td>
<td>projected supply of high level residential aged care places</td>
</tr>
<tr>
<td>Unmet need</td>
<td>difference in number of persons aged ≥ 65 years needing low level community aged care and supply</td>
</tr>
<tr>
<td></td>
<td>difference in number of persons aged ≥ 65 years needing high level community aged care and supply</td>
</tr>
<tr>
<td></td>
<td>difference in number of persons aged ≥ 65 years needing low level residential aged care and supply</td>
</tr>
<tr>
<td></td>
<td>difference in number of persons aged ≥ 65 years needing high level residential aged care and supply</td>
</tr>
</tbody>
</table>

3.3 **Imputing Disability in APPSIM**

As previously stated, the starting population for APPSIM is based on the 2001 Census. Since no questions were asked in the 2001 Census regarding disability levels, disability had to be imputed onto the APPSIM basefile. Disability level was allocated using the 2003 SDAC to generate the percentage of the population who would suffer from one of the six levels of disability. Probabilities of being disabled in one form or another are broken down
by sex and five-year age groups (refer to the tables in the Appendix). Naturally, the probability of being disabled increases over time: in the late teens and early 20s, around 93 per cent of people are free of a disability; at age 65-69 years, only 67-68 per cent of individuals are free of a disability; and at age 85 or more years, only 23 per cent of males and 17 per cent of females.

3.4 Model Testing, Benchmarking, Alignment and Validation

A number of processes were undertaken to ensure the module’s output is reasonable and credible. This included basic activities such as code walk throughs, debugging, specification and re-specification of parameters and equations, and data quality checks.

The existing modules in APPSIM used to inform the ACM – namely the Demographic, Family Formation and Movement, and Disability Modules – have been benchmarked against external data sources (usually administrative estimates) and independently validated. The validation process for the disability module is fairly straightforward, as disability is only dependent on two factors – age and sex. The validation process simply requires ensuring that the percentage of people at each level of disability, by age and sex, at base line match with the targets from the SDAC.

During the initialisation of each simulation in APPSIM, the user has the opportunity to turn alignment ‘on’ or ‘off’ for particular modules. By selecting ‘on’ for a given module, the outcomes of that module will align with external benchmarks, such as the official projections from Australian Government agencies. No modules were aligned to external benchmark data for the simulation presented in this paper.

4 Simulation Results - Base Case Projections

A simulation run was undertaken to generate a base case projection over the 50 year period 2001-2051. The sample size of this simulation was 45,000 individuals. This run essentially simulated the effects of a growing and ageing population with no policy change or major shift in population characteristics other than those that would be expected to occur as a consequence of an ageing population, for example, a changing disability profile. Alternative simulations were also run to compare the effect of modified assumptions regarding the definition of a care need (see section 4.7).

4.1 Demographic Projections

Figure 3 provides the APPSIM annual estimates of Australia’s total population over the simulation period 2001-2051. The change in the age composition of Australia’s population that is expected to occur between 2006 and 2051 is clearly evident when the two population pyramids are compared (Figure 4). The relative growth in the numbers of persons aged 65 years or over and 85 years or over is clearly visible.
Figure 3  Australian Population Projection, 2001-2051

Source: APPSIM May-2011 version (run 10-05-2011)
Figure 4  Population Pyramids and Share of Older Population, 2006, 2031 and 2051

Age-sex structure

2006

Population: 2.7 million
Percentage: 13%

2031

Population: 5.6 million
Percentage: 19%

2051

Population: 7.7 million
Percentage: 22%

Source: APPSIM May-2011 version (run 10-05-2011)
Figure 5 Distribution of People by Degree of Disability, 2006, 2031 and 2051

Source: APPSIM May-2011 version (run 10-05-2011)

Prevalence of Disability

A key output of the modelling is the projection of the number of Australians expected to have a disability. The simulation results are shown in Figure 5. For simplicity, it is assumed in this base case simulation that the ratio of those without and with a disability within each age group remains constant over the simulation period, and the effect in the rise in the numbers with disability is due only to increased numbers of older persons. In effect, the simulation holds the prevalence of disability among older Australians constant at 2003 levels.

In 2006, the model estimated that there were approximately 1.36 million Australians aged 65 years or over who had a mild or more severe disability. By 2031, in the span of 25 years, Australia is estimated to have a significantly larger number of older persons who have a disability –2.90 million persons. By 2051 the figure is likely to reach as high as 4.10 million.

The numbers of oldest old persons, that is, those aged 85 years or over, who have a disability is projected to more than quadruple from 253,000 in 2006 to 629,000 in 2031 and 1.15 million in 2051. While these nominal increases are large, they also rest on the assumption the prevalence of disability remains unchanged over the simulation period. It is a matter of conjecture whether this is a conservative or aggressive assumption as there are contending views about compression and expansion of disability into the future and it may change over time and vary across populations depending on their stage of population ageing (e.g., Robine and Michel 2004).
4.2 **NEED FOR AGED CARE**

The distribution of the aged population across the levels of need will reflect the underlying patterns of disability (see the Appendix for data on the proportion of the population affected by the different levels of disability). Informal care is an important element in the aged care system in Australia. Many aged people with a disability, especially if it is mild or moderate disability, tend to receive informal care as a sole or supplementary service to meet their care needs. The availability of informal care is also expected to influence the demand for formal care, for example, by moderating demand for residential low care. The ACM first models availability of informal care and then uses this information to model the projected need for formal care.

4.3 **INFORMAL CARE**

To what extent can this pattern of need be met from informal care at home? The number of persons aged 65 years and over who have a disability, who are not in residential care and for whom informal care is unavailable, has been modelled. In the base case scenario, around 33 per cent of aged persons with a disability are projected as not having access to informal care. In terms of numbers, the population of aged individuals lacking access to informal care is projected to grow from about 400,000 in 2006 to over 800,000 in 2031 and over one million in 2051. The base case projection of the number of persons aged 65 years or and over with a disability and the proportion of these that are projected to have access to informal care is shown in Figure 6.

Figure 6 Number of Persons Aged 65 years or Over With a Disability and for Whom Informal Care is Unavailable, 2006-2051

Source: APPSIM May-2011 version (run 10-05-2011)
Note: Residential care users excluded.
4.4 **NEED FOR FORMAL CARE**

The next step in the modelling the need for aged care was to determine the adequacy of community care in meeting the care needs of older Australians. The modelling suggests that in 2006 nearly one million persons aged 65 years and over and living with a disability could have their care needs met with formal home or community aged care packages, while there would be inadequate supply for over 400,000 older persons (refer to Figure 7). However, the number of individuals for whom community care would be inadequate is expected to grow over time, reaching over 900,000 by 2031 and about 1.40 million by 2051.

This group of older individuals may need either institutional or residential low care or high care depending on their disability level. By 2051, over 370,000 persons aged 65 years and over are estimated to need residential low care and over one million are estimated to need a residential high care (Figure 8). These projections are based on the assumption that every older person with a mild or more severe disability would need formal care. However, these results would be different if the criteria for entry into formal care arrangements were modified. Work currently in progress will provide the capacity for the ACM to test the impact of changing the entry criteria to different forms of aged care. However, no results are available from this enhancement currently being built.

**Figure 7  Number of Persons Aged 65 Years or Over With a Disability and Whether Their Need Could be Met by Formal Home or Community Care, 2006-2051**

Source: APPSIM May-2011 version (run 10-05-2011)
4.5 Supply of Aged Care Places

Using data from the AIHW on the historical number of aged care places (until 2008) and the projected number of community and residential aged care places suggested by the DoHA, the future supply of low and high, community and residential aged care places and packages was estimated. At present, the community packages only include Community Aged Care Packages (CACP), and Extended Age Care at Home packages (EACH) including EACH Dementia packages. The supply of Home and Community Care (HACC) services is substantial with over 600,000 people aged 65 years and over receiving HACC services in 2008-09. While CACP is a federally funded program, the HACC program is a joint Federal, State and Territory Governments initiative that funds services for domestic assistance, personal care as well as professional allied health care and nursing services. The aim of this program is to support older Australians, younger people with a disability and their carers to be more independent at home and in the community and to reduce the potential or inappropriate need for admission to residential care (http://www.health.gov.au).

Since the supply of services provides an upper limit to the use of services, this is taken as a measure of the level of use of services (it is assumed that there is no free capacity given the existence of substantial excess demand for services). The expected growth in supply over the period 2006-2051 is shown in Figure 9. This Figure provides a comparison of future aged care places with and without the inclusion of HACC services. In this estimate, HACC services are expected to remain constant. While this is a strong assumption, this avoids an arbitrary alternative having to be specified. This also represents an assumption of stable government commitment to the funding of this program. About 15 per cent of HACC

services dedicated to aged people are assumed to serve those with a need for high care. However, it should be noted that this assumption has been made only to highlight a problem with using HACC statistics (data on the disaggregation of HACC services was not publicly available at the time of this modelling).

Figure 9  
**Historical and Projected Supply of Aged Care Places Applied in the APPSIM Aged Care Module, 2006-2051**

Not including HACC service

Including HACC service (current level)

Source: APPSIM input data.

### 4.6 Need and Unmet Need for Aged Care by Care Type

Figure 8 showed the expected growth in the need for aged care by care type. The growth rates between three of the four types are not dissimilar, with the increase in the need for high level residential aged care greater than the other type of aged care.

If the estimated needs for aged care (Figure 8) are compared with the possible supply of aged care places (Figure 9) then an estimate can be derived of the level of unmet need. The difference in the two graphs is shown in Figure 10. This suggests that a very large number of older Australians are not having their aged care needs adequately met, and furthermore,
this situation is set to deteriorate over time. Inclusion of HACC services in the model substantially reduces the magnitude of unmet need for community low care. However, given the limitations of the available information about HACC services, further investigation and expert advice is needed to further refine these estimates.

**Figure 10  Unmet for Aged Care, Number of Persons, 2006-2051**

Not including HACC service

Including HACC service (current level)


### 4.7 Policy Experiments

The Aged Care Module can be used by researchers as well policy makers to conduct policy experiments. An example of such experiments would be to compare the number of people needing care when assumptions regarding who will be in need of care are changed. As an illustration, Figure 11 contrasts the impact of two alternative assumptions: 1) a liberal assumption that every person aged 65 years and over with a mild or higher degree of disability may need formal aged care, and 2) a more restrictive assumption that a person with a mild or a moderate disability and with access to informal care may not need formal aged care. As Figure 11 shows, the impact of softening this assumption would substantially reduce the number of people needing low and high community care. These assumptions...
can be viewed a sensitivity analysis of possible range of outcomes within which actual need will fall.

**Figure 11**  Percentage decline in estimated number of people needing aged care when more restrictive definition is applied to define a need, 2006-2051


### 4.8 Comparison with external estimates

The 2009 SDAC (ABS 2010) can be considered a natural source of comparative data because the parameters used in the ACM are based on 2003 SDAC and the successive SDAC surveys are reasonably comparable. However, detailed, directly comparable estimates were not published and as such only some broad comparisons could be made at this stage.

The 2009 SDAC estimated that 1.2 million out of 2.9 million people 65 years of age and older reported a need for assistance with personal as well as other activities. The ACM estimated that in 2009, about 1.49 million out of 2.97 million people aged 65+ would need aged care. The ACM estimates are thus higher than 2009 SDAC estimates. The discrepancy may be due to differences in definitions, particularly due to some people with a disability not reporting a need for care in SDAC but ACM assuming everyone with a disability would have a need for care. Further comparative analysis of SDAC microdata and ACM outputs is desirable to resolve the source of this discrepancy.

According to the 2009 SDAC, 835,000 older people (65+) needed assistance with personal activities. However, the ACM does not currently distinguish between personal and other care needs. Yet this figure seems to be closer to ACM estimate of care needs in 2009 (960,000) obtained by applying the more restrictive definition of a care need.

The 2009 SDAC estimated that 404,000 people 60 years of age and older had an unmet need for a care. Unmet need is an area where the ACM estimates tend to vary widely depending on the definition of need for care chosen and the type of supply-side statistics used. This flexibility was consciously retained during the construction of the model to allow users to modify the model to suit their analytical purposes. When the ACM uses the liberal
definition of need and excludes HACC data from supply-side, the unmet need would stand at 1.2 million. However, with the more restrictive definition of aged care need, the unmet need would drop to 737,000. With the liberal definition of need and excluding HACC, unmet need would be nearly 660,000 in total and 570,000 for high care (community and residential). Narrowing the definition to the restrictive assumption and incorporating HACC data, the ACM would then estimate the total unmet need at 125,000 and the unmet need for high care (community and residential) at 450,000. These widely varying estimates illustrate the flexibility of the model and its use in analysing alternative policy settings and projections concerning the characteristics of the aged population in the future. A more detailed analysis of the 2009 SDAC microdata is required to make further detailed comparisons.

5 DISCUSSION AND CONCLUSIONS

The APPSIM Aged Care Module now forms an integrated part of the overall structure of APPSIM. As such, it has twin roles in terms of functioning as a research tool for aged care specific research and for contributing to a more comprehensive picture of the characteristics and needs of the Australian population in the coming decades. While this joint role places some limits on the complexity of the aged care detail that has been included in the module, one of the goals of the design was to give priority to accurately modelling those aspects of the aged care system that are most important and which are likely to be sensitive to the expected demographic and socio-economic changes that APPSIM is designed to capture.

An important application of the module is the projection of the need for aged care into the future. The base case results show how the need for aged care places will increase as the population ages ceteris paribus. It was shown that the population of people aged 65 years and over is likely to grow from just under 3 million in 2006 to over 7 million in 2051. If the current age-pattern of disability prevails into the future, there will be as many as 4 million older persons with a disability and who may need varying degrees of care and support. However, the results presented here suggest over one million of them may not have access to informal care. By 2051, over 370,000 persons aged 65 years and over may need residential low care and over one million residential high care. These figures can be considered as the upper range of the estimate. The magnitude of formal care needs would become more modest if more restrictive criteria for formal care is applied. With the capacity of the ACM currently being enhanced to provide this functionality, the impact of alternative policy settings such as modifying entry criteria to different forms of aged care will then be able to be tested. If the population changes in other ways, such as in the prevalence of disability and the level of disability or in levels of family support and other informal care, then the need for aged care places will be accordingly impacted, and the cost to governments in maintaining the minimum number of residential aged care places as a proportion of the population aged 65 years and over affected. The range and scope of these variables that will ultimately impact on the need for and potential under supply of aged
care services underlies the need for flexible modelling capacity such as provided by the ACM within the broader APPSIM modelling environment.

Separate modelling of the ‘need for’ and the ‘use of’ aged care services in APPSIM is an important feature of the ACM as it allows the investigation of the gap between use and need (i.e. unmet need), and the simulation of the impact of changing availability of aged care services, in terms of both the type of care and the cost to government and individuals. This capacity allows the simulation of scenarios such as which groups of elderly people would be most likely to take up additional residential aged care places, and who perhaps would be most likely to miss out, or choose not to take up such places. The significance of this type of research was recently signalled in the report of the National Health and Hospitals Reform Commission, which placed high importance on increasing the aged care choices available to users (NHHRC 2009). The model also provides a useful tool for government and researchers to consider and better understand how the use and cost of community and residential aged care services are distributed across the income scale and socioeconomic status – for example, are those on low incomes less likely to be able to take advantage of increases in the supply of aged care places, and how might changes to policy settings impact on this?

The capability of ACM can be enhanced in a number of areas. For example, the potential cost of aged care services is an important policy concern to which this module can contribute. Information derived from other modules in APPSIM, particularly labour force, income and wealth, can be used to calculate how many individuals can afford aged care services and how much public funding may be needed to cover the cost of aged care services in the future.

This ACM can be further improved by addressing uncertainties surrounding future disability prevalence and the likelihood of informal care being provided. It would also be worthwhile to model various scenarios that reflect possible changes in disability prevalence patterns into the future. It will also be useful to look at the changing nature of labour force participation on availability of informal care. This information can of course be linked to the ACM from other modules of APPSIM. Such scenarios could be viewed as sensitivity tests and could be used to identify likely bounds of future age care needs and shortfalls in supply of aged care services to better inform government and other policy makers.

Another area of improvement is to further examine the nature of HACC data. In terms of the number of aged care services, this is a very large component of aged care supply and hence can significantly impact on the outcome of the simulation. The flexibility within APPSIM allows users to revise the input statistics on the supply of aged care places and rerun the module where revisions in the use of HACC data are decided upon.

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### Table A1 Probability of Having a Disability, Males, 2003 Survey of Disability, Ageing and Carers

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<th>Severe</th>
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These values are set to zero as it is assumed people over 65 have low rates of schooling and employment, therefore restrictions of this nature will have little or no impact on their lives.

**Source:** (ABS 2004)
<table>
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