



# Population Ageing and Government Age Pension Outlays

USING MICROSIMULATION MODELS TO INFORM POLICY MAKING

# **ESRI International Collaboration Project**

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# **ABOUT NATSEM**

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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 surveys.

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.

### SUMMARY

Population ageing is expected to present major challenges to the financing and sustainability of welfare state programs in industrialised countries. Policy makers are using dynamic microsimulation models to evaluate and test the longer-term revenue and distributional impacts of possible policy reforms to pension, taxation and other programs. This paper first reviews the dimensions of population ageing in Australia and Japan and then examines dynamic microsimulation models in use internationally. The paper then outlines the Australian 'three pillar' system of retirement incomes and describes how NATSEM is developing the Australian Population and Policy Simulation Model (APPSIM), in collaboration with government, to examine the future distributional impact of possible policy changes. While the APPSIM model is still under development, with the first prototype being scheduled for completion at end 2009, this study presents the first illustrative outputs from the APPSIM model of the impact of three possible policy changes – namely, increasing the government age pension age from 65 years to 67 years; increasing the superannuation guarantee rate from 9 to 15 per cent, and increasing the superannuation preservation age from 55 to 60 years.

# **1** INTRODUCTION TO POPULATION AGEING AND MICROSIMULATION

Australia and Japan, like most other OECD nations, are facing potential future budget and pension deficits as their populations' age. Their governments are evaluating a range of policy options to minimise these deficits. Commonly-used macroeconomic models and projections are insufficient to model the individual processes that impact on saving, health and retirement decisions, and the distributional impacts of changes in policies. Dynamic microsimulation modelling (DMSM) has proven itself to be a very useful tool in examining the individual decisions that make up macroeconomic and macrosocial changes and the distributional impact of policy change.

This paper discusses the ageing population issues that are facing Japan and Australia, gives a background to DMSM and explains how NATSEM is using this modelling technique to evaluate policy options to minimise the negative fiscal impacts of the ageing population.

## 1.1 BACKGROUND

Population ageing occurs when the average age of a population increases. Typically two factors contribute to this: lower fertility (lower percentage of the population in younger cohorts) and longer life expectancy (higher percentage of the population in older cohorts). Both factors have been occurring in all OECD nations over the last few decades: the former caused by improvements in contraception, delayed marriage and better opportunities for women; the latter caused by improvements in preventative health knowledge and medical treatments.

Population ageing, in itself, is not a problem. The reason governments are concerned about ageing populations is that they typically suggest a greater percentage of older people who are more likely to be reliant on pensions and have higher health care and aged care costs, allied with a smaller percentage of people who will be working and paying taxes or social security contributions to pay for those pension and care costs. The retirement, pension, taxation, health and aged care systems currently prevalent in the OECD were designed for populations with greater than replacement-level birth-rates and average life expectancies reaching the sixties and seventies. Since few OECD nations now have replacement level birth-rates and average life expectancies are now in the late seventies to eighties, governments, pension systems and healthcare systems face substantial deficits if they do not change in response.

One reason why this has become such a prominent issue in recent years is because the 'baby boomers,' the large cohort born in the two decades following World War II, are approaching the age at which they can claim retirement benefits and will generate increased health and care costs. The retirement of the baby boomers is projected to result in labour shortages, reduced growth in tax revenues and higher pension and care costs.

In short, in modern welfare states it is the taxes of the working age population that fund the pensions and services used by retirees. As the OECD noted in a recent clarion call to action: "People are realising that a shrinking number of young workers will have trouble paying for more and more pensioners. Time has come to open a frank debate among all members of society and address the question of how the cost of ageing should be distributed in each society" (OECD, 2005, p. 1).

It is important to remember that the problem is not with the ageing population – ageing populations simply mean that, on average, people are living longer lives – surely a cause for celebration! The problem lies in adapting social security, taxation, retirement, health care and aged care programs to meet the needs of these changing demographics while keeping government budgets balanced, keeping poverty levels to a minimum and maintaining intergenerational equity.

### 1.1.1 Japan and Australia's ageing populations

As with most OECD nations, birth rates in Japan and Australia have dropped significantly since the post-war baby boom, most noticeably in Japan. In 1950 total fertility rates were 3.07 in Australia and 3.65 in Japan (ABS 2008a, Statistics Bureau of Japan 2008a). However, fertility in both countries is now well below the replacement rate of 2.1 children per woman (in 2007 the rates were 1.93 in Australia and 1.34 in Japan). Both countries have recorded slight increases in fertility rates over the last few years, but these will have little effect on population ageing. Figure 1 shows the decline in fertility rates since 1950 and clearly illustrates how Japan's decline was more significant than that experienced in Australia.





Source: ABS 2008(a), Statistics Bureau of Japan, 2008(b)

While fertility has declined, life expectancy has increased, particularly so for Japan. In 1950, the average Australian male, or Japanese person, could not expect to see their 70<sup>th</sup> birthday. In fact, the average Japanese male born in 1950 could not expect to celebrate their 60<sup>th</sup> birthday. Since then, life expectancy has increased by more than ten years for both sexes of both nations, as shown in Figure 2. Now both Japanese and Australian men can expect to live to age 79, while Australian women can expect to reach age 84 and Japanese women age 86 (ABS 2004, 2008b, Statistics Bureau of Japan 2008a).



Figure 2 Life expectancy, Australia and Japan, 1950-2007

In 2000, twelve percent of Australia's population and seventeen percent of Japan's population were aged 65 or older. By 2050, this is expected to increase around 25 per cent in Australia and 36 percent in Japan (OECD 2007a) (although note that the latest ABS projections are somewhat lower than this, as a result of higher migration and higher fertility in Australia in recent years).

Figure 3 shows the percentage of the population in each age group in 2000, and projected to 2050, for Japan and Australia.

Source: ABS 2004, 2008(b), Statistics Bureau of Japan, 2008(a)



Figure 3 Age distributions of Australia and Japan, 2000 and 2050



There are a number of social differences between Japan and Australia which will mean that the two countries' experiences of ageing populations will be very different. Some of these differences may mean that one country will face greater difficulties with ageing than the other, while others suggest that a solution that works in one country may not work in the other.

Australia's fertility rate, while at 1.9 (ABS 2007a) is still lower than the replacement rate of 2.1 children per woman, is much higher than Japan's, which is 1.3 (Statistics Bureau of Japan 2008a). Babies born now will be part of the labour force in 2050. The impact of this can be seen in Figure 3 – children make up a smaller percentage of the population in Japan than in Australia, both in 2000 and 2050. Several reasons have been suggested for this discrepancy in birth rates – including financial support for parents in Australia, higher average age of marriage in Japan and a greater propensity for women to have children out of wedlock in Australia (OECD 2007b, p 45).

- Australia has higher net immigration than Japan, and its immigration program is targeted at young skilled workers, lowering the average population age and increasing the percentage of people in working age cohorts. Out of 28 OECD nations, Australia had the fourth-highest net migration rate from 2000-2004, while Japan had the second-lowest (OECD 2007b, p47).
- In Japan it is much more common to work past the age of 65, particularly for men. Higher levels of labour force participation, particularly later in life, reduce the need for government programs and pension schemes to maintain the living standards of older people, and result in higher taxes or higher pension fund contributions. Figure 4 compares the labour force participation rates of Australians and Japanese later in life, for both males and females.
- In Japan it is very common for elderly people to move in with their married children, far more common than it is in Australia. In the 1980s, 7 percent of Australians aged 65 and over lived with children or family members, compared with 69 percent of older Japanese (World Bank, 1994, p. 64). The ability to move in with adult offspring when one is elderly reduces living expenses and care costs, improving the living standards of the elderly and reducing the income required to keep the elderly out of poverty. However this practice is projected to decline in Japan (Inagaki 2008).



### Figure 4 Labour force participation of older Australians and Japanese, 2008

Source: ABS 2008(c), Statistics Bureau of Japan 2008(b)

## **1.2 IMPLICATIONS FOR GOVERNMENT**

Three major government reports have been issued over the last five years highlighting the fiscal difficulties Australia is likely to face as the population ages. The Australian Treasury's first *Intergenerational Report* (IGR) was released in 2002, while the second IGR was released in 2007. Both of these reports contained aggregated estimates of the likely budgetary impacts of the ageing population, after making assumptions about likely future fertility rates, immigration levels, labour force participation rates, tax rates and so on.

Treasury found that slower growth in the number of workers paying taxes and more people relying on government support for pensions, aged care and health care would mean that, if the Australian Government's revenue and expenditure patterns remained unchanged, by 2047 there would be a gap between revenue and expenditure amounting to 3.5 percent of GDP (Treasury 2007). Interestingly, this 'fiscal gap' was lower that that projected in the first IGR (of five per cent of GDP in 40 years time), as a result of the higher immigration and fertility rates that eventuated after 2002, which were thus incorporated into the projections of the second IGR. Despite this, a fiscal gap is still projected and the fiscal pressures associated with population ageing are expected to become increasingly apparent during the next decade or two as more and more of the baby boomers enter retirement (Figure 5).



Figure 5 Projected gap between Commonwealth revenue and outlays in Australia

The IGRs projected that male labour force participation trends would continue downward and stabilise, and that female participation rates would increase. People under the age of 20 are more likely now than in the past to work part-time rather than full-time, probably reflecting increased participation in education. Labour force participation rates for both sexes are projected to increase in the 60-64 and 65-69 age groups, reflecting better health among older members of the population and an ability to work longer. Overall, participation rates for people aged 15-64 are expected to rise from 76 percent in 2006-07 to 78 percent by 2046-47, due to an increase in participation of older workers. Participation rates for all persons over 15 are expected to decline from 65 per cent at the end of 2008 (ABS 2008c) to 57 percent in 2046-47, reflecting the increase in the proportion of the population over 65 years and the low labour force participation rates of this group (Treasury 2007).

IGR1 recommended a number of policy directions that could assist in minimising the fiscal gap. These included restraining the Pharmaceutical Benefits Scheme, promoting private saving for retirement, balanced budgets and efficient medical care. Labour force policies designed to promote participation were also strongly recommended in two areas: ensuring

Source: Treasury 2007.

the social security safety net did not discourage working age people from working and promoting mature age participation in the workforce (Treasury 2002). IGR2 reports that many relevant measures have been undertaken in these domains since IGR1 was released.

As a result of these and other factors, the projections from IGR2 are different from those in IGR1. IGR1 was published in 2002, at the very end of a long, steady downward trend in fertility rates, from 2.95 in 1971 to 1.73 in 2001. Based on this downward trend, Treasury and the ABS forecast Australia's fertility rate would continue to decline, from 1.75 in 2000 to 1.6 in 2042. However, since 2002, birth rates have rebounded, with the fertility rate reaching 1.81 in 2006 (ABS 2008a). As a result, IGR2 projected a fertility rate of 1.7 births per woman (Treasury 2007). Even this may prove to be a pessimistic estimate as births have since increased to 1.9 (ABS 2008a). Also, since IGR1, the Federal Government has delivered budget surpluses, eliminated net debt, established the Future Fund and made changes to the Pharmaceutical Benefits Scheme, so IGR2 contains more positive projections for future government spending. Furthermore, other measures to increase migration, improve productivity and raise labour force participation have been put in place. On the other hand, the IGR2 estimates were prepared before the current global economic crisis began, which again underlines the challenges facing long-term forecasters.

## 1.3 THE USES OF DYNAMIC MICROSIMULATION

Dynamic microsimulation models have properties that are uniquely suited to analysing the long-term and future impact of changes in pension and other policies (Harding, 1999, 2000). As Harding and Gupta observe, often prompted by concerns about the long-term sustainability of public pension programmes, government agencies across the world funded the development of dynamic microsimulation models in the 1990s and the 2000s (2007, p. 9). Dynamic microsimulation models provide both aggregate and detailed projections under a range of scenarios. This assists government policy makers to quantify the impact of a policy change in terms of the likely reduction in the expected growth in pension outlays due to the ageing population. It also allows policy makers to identify the groups within the community that are likely to be most impacted by the policy change. Finally, the microsimulation approach can help limit the unintended consequences of the policy changes, by better identifying post-change winners and losers.

Dynamic microsimulation modelling (DMSM) was pioneered by Guy Orcutt (1957, 2007), who proposed a model of interacting individuals to address some of the shortcomings of macroeconomic models. The focus of DMSM is on how fiscal and social policies affect the future distributional outcomes of individuals, which can then be aggregated to determine overall economic effects, rather than simply focusing on aggregate data. The major benefit of DMSM over conventional modelling is that it can examine the heterogeneity of future populations and the distributional impact of policy, economic and social changes (Klevmarken 2005). In other words, DMSM can measure the impact of changes on specific groups in a population, such as the poor, lone parents, the retired etc.

DMSM involves using statistical microdata on a country's population to develop a model subset of individuals and households and their characteristics, such as age, education, employment status, marital status and health. The lives of this subset of individuals are updated regularly as time passes in the model. During the simulated life of an individual within the model, they will be exposed to a range of *events*, such as commencing or finishing education, becoming unemployed, finding a new job, getting married or divorced, having a child, moving out of the parental home or retiring. Using existing panel datasets for their country, modellers can estimate the probability that an individual or household will experience a particular event during a certain period of time, based on such predictive characteristics as age, gender, highest educational qualification, and so on. A DMSM can then model the lives of hundreds of thousands of individuals over decades into the future, as they gain an education, start work, earn and save money, marry, have children, divorce, become unemployed, retire and die.

Even this brief description makes it clear that the construction of DMSMs is a complex, costly and time-consuming exercise, with costs typically running into the millions of dollars (Harding and Gupta, 2007). In the future, the International Microsimulation Association hopes to use its website to more effectively share information about these types of models, in a bid to cut development times and costs (www.microsimulation.org). In the interim, the following sections contain descriptions of three international DMSMs that are in active use by policy makers – SESIM within the Swedish Ministry of Finance, MOSART within Statistics Norway and DYNACAN within the Canadian Department of Human Resources. Descriptions of two Japanese microsimulation models then follow. In Section 3 below, there is a more detailed discussion of the construction of the new Australian APPSIM dynamic model, along with results of policy simulations from this model in Section 4. Overall, it is hoped that Japanese policy makers will find the Australian and international experience provides a useful illustration of how microsimulation models can be used to help inform policy reform processes associated with population ageing.

### 1.3.1 SESIM (Sweden)

SESIM commenced development in 1997 by the Swedish Ministry of Finance in consultation with Swedish academics. It was originally created to evaluate the Swedish education financing system. Since 2000 it has been adapted to assessing the impacts of the ageing population (eg the Swedish pension system, health care costs, elder care, housing etc) (Flood, Jannsson et al. 2005; Klevmarken and Lindgren, 2008; Sundberg, 2007).

SESIM's primary data source is Linda, a longitudinal data set drawn from administrative records, representing about 3.5 percent of the Swedish population. The model's base year is 1999 and the base population is a random sample of approximately 110 000 individuals from Linda. The outcomes of SESIM can be aligned with exogenous demographic and economic projections (Flood et al. 2005).

SESIM models demographics (eg births, deaths, couple formation and dissolution, children leaving home and disability), education, labour market participation and earnings, wealth and housing, taxes and transfers, non-cash government benefits such as health care.

SESIM is a very detailed DMSM, involving simulations of general household wealth and the retirement decision, as well as the usual simulations of marriage, birth, death, employment and pension accumulation. Thus it can be used not merely to calculate the sustainability of Sweden's pension system, but also the wellbeing of its elderly in retirement. It has been used to estimate the cost of education financing, the size of future pension payments relative to GDP and future health care burdens.

## 1.3.2 DYNACAN (Canada)

DYNACAN commenced development in 1994 in Canada's Office of the Superintendent of Financial Institutions. It was built to generate policy and fiscal analyses of the Canada Pension Plan (CPP), a mandatory, public, pay as you go pension scheme which provides retirement, survivor and disability pensions (Morrison, 2007a, 2007b, 2008, 2009). It was originally a derivative of the CORSIM model from the United States, created at Cornell University.

DYNACAN's base population is derived from one per cent of the population recorded in the 1971 census. It models mortality, fertility, couple formation and dissolution, education, disability, labour force participation, earnings, pension contributions and migration. Migration is classified as external migration, moving in and out of Canada; and internal migration, moving to and from the Canadian province of Quebec and the rest of Canada (Quebec has a separate pension plan system). The basic units of the model are individuals and families. It simulates the population from 1971 – 1997, and can project it forward to 2100, although it is more common to project until 2030.

DYNACAN consists of three stages. DYNACAN-A assembles data from the census into a single hierarchical database that can be used for longitudinal projection. This data feeds into DYNACAN-B, which applies transition probabilities to the base population to create projections for each individual. Based on the lives of the simulated individuals, DYNACAN-C calculates CPP coverage, CPP contributions and retirement and disability pensions (Morrison and Dussault, 2000).

The outcomes of DYNACAN are aligned with a macroeconomic model of CPP, called ACTUCAN. The Chief Actuary uses ACTUCAN for valuation of the CPP. These two models have companion status, and are closely coordinated to ensure that they are based on common assumptions.

DYNACAN was originally developed to model the sustainability of the CPP and has been used extensively for this purpose. Recently it has been updated to allow modelling of the impact of private retirement pension schemes (Morrison, 2007a). It is primarily used for policy development and evaluation, and is occasionally used by the Office of the Chief Actuary and the Department of Finance.

### 1.3.3 MOSART (Norway)

The first version of the MOSART model started in 1988 and was completed in 1991, comprising demographic events, marriage, education and labour supply. A revision of this model began in 1991, and incorporated labour market earnings and public pension benefits, with the results being tested against actual income distributions from 1967 to 1989. These first two models were designed to project public pension benefits until 2020 (Fredriksen 1998).

The latest version of the model includes demographics, education, labour force, public pension benefits, labour market earnings, household formation and a simple representation of other forms of income, taxation, savings and wealth (Fredriksen and Stolen, 2007a). Some of the underlying assumptions, such as net immigration, life expectancy at birth and propensity to study have been increased. Projection starts in 1989 and goes beyond 2050.

MOSART uses a one percent sample of the Norwegian population from their National Insurance Scheme data. Events that may occur each year are migration, deaths, births, household formation, educational activities, retirement, labour force participation, income and wealth. From these, an individual's likely pension benefits are calculated. It uses cross sectional simulation – all the people's transitions throughout the year are calculated before moving on to the next year, rather than calculating each individual's entire life before moving on to simulating the next individual. This requires more computer resources but allows people in the model to interact (e.g. marry), and allows external restrictions to be placed on each year's outcomes (e.g. total employment) (Fredriksen 2003).

MOSART has been used intensively in analysing the impact of recent reforms to the Norwegian National Insurance Scheme. Outputs of MOSART have also been incorporated into a general equilibrium model that analyses the macroeconomic effects of pension reforms, and general macroeconomic analysis (Fredriksen and Stolen, 2007b)

### 1.3.4 INAHSIM (Japan)

Many OECD nations have enthusiastically embraced microsimulation modelling and have several models operating or under development: however, such modelling in Japan is less common. There are two reasons for this: strict confidentiality of microdata and lack of demand for such analysis from policymakers in the past (Inagaki 2008).

INAHSIM (Integrated Analytical Model for Household Simulation) was first designed as a tool for household simulation in 1981-82, using microdata from a household survey. This was a fairly simple model at the time, and did not include data on extra-household familial relationships, health status, employment or earnings. (This summary of INAHSIM is drawn from Inagaki (2008) and Fukawa (2007)).

Additional features were gradually incorporated onto INAHSIM from the early 1990s onwards to record family relationships. Now the data base for the initial population is the Comprehensive Survey of the Living Conditions of People on Health and Welfare (CSLC). The CLSC is taken every three years and, in 2001, the sample size was 247 000 households. Forty-six thousand households were used as a base population, which represents 0.1 percent of the Japanese population. It is used to predict the characteristics of the Japanese population out to 2100.

INAHSIM's model population includes three segments: one for data on people as individuals, one for people in their family roles, and one for roles in households.

The family segment in INAHSIM lists details of couples and their children, plus information such as the year of marriage and age of the youngest child. These family relationships stay with the individual, to allow modelling scenarios such as offspring moving back in with parents after a divorce, or elderly parents moving in with children. It should be noted that this model assumes all children are born to married parents, as the number of extramarital births in Japan is very low.

The individual segment records the characteristics of individuals. These include year of birth, sex, marital status, employment status, health status and earnings. Employment status falls into four categories: regular employees, non-regular employees, self-employed and unemployed. This information is gathered based on what pension scheme they belong to. Health is classified as good or poor. The individual segment also records information on the person's parental status, plus their family number and household number.

The household segment records information such as the year of household formation, number of household members, total earnings of the household, household structure and the individual segment number that represents each household member.

The annual simulation cycle of INAHSIM runs as follows:

- 1. New Year
- 2. Births
- 3. Change in health status
- 4. Death
- 5. Marriage
- 6. Divorce
- 7. Change in employment status
- 8. Estimation of earnings
- 9. Young people leaving home
- 10. Aged parents moving into their children's households (Fukawa 2007).

Some of INAHSIM's projections find that increasing non-regular employment is likely to lead to lower rates of marriage and thus lower fertility rates, and that the proportion of elderly living with their children will decrease.

In comparison to other international dynamic microsimulation models, INAHSIM places greater emphasis on future social and demographic changes, rather than on economic matters such as the sustainability of pension systems.

### 1.3.5 PENMOD (Japan)

PENMOD is being developed by the Japanese Ministry of Health, Labour and Welfare and this summary of PENMOD is drawn from Shiraishi (2008). Data for PENMOD is sourced from the annual statistical report of Japan's Social Insurance Agency (SIA), the *Jigyo Nenpo*, 1961-2004) and the *Wage Census*, 1948-2006.

PENMOD contains three simulation modules:

- 1. generation of life histories;
- 2. simulation of life events; and
- 3. pension finance.

Module 1 forms a population dataset based on past SIA statistics. It first develops annual samples from the base data, and then develops these samples into a longitudinal dataset. It creates a series of histories for persons who were aged 20 or older from 1964-2004. The histories include details on employment transitions (employed, self-employed, unemployed, housewife) and whether a person is employed in the public or private sector. Changes of employment type are very important, as private sector employees and public sector employees are covered by different pension plans. It also simulates past contribution records, which determine what size pension one is entitled to.

Module 2 simulates the life events that affect pension accumulation and use from 2005 onwards. It is divided into two parts - the first simulates life events for those who are employed or of employment age, while the second simulates life events for those who are retired, including the retirement decision.

A crop of new 20-year olds are added to the sample each year (PENMOD only simulates individuals aged 20 or over.) A Monte Carlo process is used to allocate mortality, based on probabilities of death by age-sex group from Statistics Japan.

Since the vast majority of dependent spouses in Japan are female, it is presumed that all nonworking spouses are housewives. Marriage can change a female's status from self-employed or employee to the housewife of a self-employed husband or an employee husband. If she divorces, she will be reclassified as self-employed or employee.

A Monte Carlo method is used to simulate future labour force transitions, similar to the transitions estimated for Module 1. Job change probabilities are estimated from the Employment Status Survey (SKKC), which runs from 1956-2003. The amount of wages a person earns determines the volume of pension contributions he or she will make, so wages and wage growth must also be calculated. If a person is an employee, their annual wage increase is dependent on age and the passage of time. If a person becomes self-employed or unemployed, their wages are reset to a new level. Private sector employees

can fall into one of ten possible wage classes, with allocation being performed using the Monte Carlo method.

The second part of Module 2 simulates life events for the retired, which impact on their pension entitlements. First, it simulates the retirement decision, which is based on legal rules of retirement. Factors affecting when a person will retire are the total years of participation, the type of pension one is entitled to and pensionable age. The benefits a person is entitled to each year are based on actual pension rules, which allow for annual increases in pensions.

Module 3 converts the results of Modules 1 and 2 into aggregate figures, so that the solvency of the Japanese pension system can be calculated.

PENMOD is still in the development and trial stage, and it has the potential to be a valuable research tool.

### 1.3.6 Other international DMSMs

Other dynamic microsimulation models that have been used for modelling the impacts of policy changes include:

- MINT (Model of Income in the Near Term, United States) which has been used to assess the contribution of government income programs in protecting the income security of baby boomers in retirement (Butrica, Iams and Smith, 2006);
- CBOLT, dev eloped by the United States Congressional Budget Office, which has been used to project labour force participation patterns, the solvency of Social Security and other long-term policy issues (Harris, Sabelhaus, and Schwabish, 2006 p1; Sablehaus, 2007; Sablehaus and Topoleski, 2006);
- DYNASIM3, developed by the Urban Institute in the US (Favreault and Sammartino, 2002);
- DESTINIE, developed by INSEE in France (Blanchet and Le Minez, 2009; Afsa and Buffeteau, 2007);
- DYNAMOD, developed by NATSEM in Australia in the mid to late 1990s (Kelly, Harding and Percival, 2002 and King, Baekgaard and Robinson, 1999);
- SAGE (United Kingdom), which has been used to examine pension accumulation patterns of different birth cohorts and the distributional impact of changes in the UK pension system (Evandrou et. al. 2007; Zaidi and Rake, 2001).

## 2 RETIREMENT INCOMES IN AUSTRALIA

The most noticeable difference between Australia's retirement income system and those common in the rest of the world is that Australia is one of only two nations in the OECD that do not have social security taxes. This is, quite simply, because Australia does not have social security as other nations know it.

In most other OECD nations, a certain amount or percentage per employee is paid into a social security fund, which is kept separate from general taxation revenue. When a person retires or reaches pension age (or in some countries, becomes disabled or unemployed), their entitlement and level of payment is dependent on how long they have worked for and/or how much they have contributed to social security. Sometimes a flat base rate will be payable to all persons, which may be increased if an individual has paid a certain amount into social security, or worked for a certain time period.

Australia's system is quite different. Mandatory social security does not exist. Retirees are provided for through a combination of basic payments, mandatory saving and voluntary saving. Australia's system is often described as a 'three-pillar' system.

## 2.1 THREE PILLARS

A review of retirement systems around the globe by the World Bank concluded that a three-pillar retirement system consisting of (1) modest public pensions to alleviate poverty; (2) mandatory private savings; and (3) voluntary savings, is the best available method to minimise poverty in old age and encourage economic growth (World Bank, 1994).

Australia has just such a system. Our three pillars are:

Pillar 1 - a means-tested public age pension;

Pillar 2 - compulsory superannuation contributions for almost all employees; and

Pillar 3 - voluntary superannuation contributions and other private savings.

2.1.1 Age pension

A man becomes entitled to an age pension in Australia when they reach age 65. The age at which women became entitled to the age pension was originally 60 years, but this is gradually being increased to 65 and is currently 63.5 years. This is a flat-rate, means-tested payment funded out of general taxation revenue. The number of years spent working in Australia and the amount earned during working life have no direct impact on how much one is entitled to, although one must meet certain residence requirements.

Table 1 contains details on the means and assets tests applied to potential pension recipients today. One can earn a certain amount of private income per fortnight without one's age pension being affected. This threshold varies depending on whether one is single or lives as part of a couple, and whether one owns their home. Income over this amount reduces the pension by 40 cents for each dollar earned (20 cents each for couples). Once non-pension income (e.g. from interest or dividends) reaches the 'cut-off', no pension can be received.

The Australian age pension paid is affected by wealth as well as by non-pension income. The assets test reduces the amount of pension payable, depending on how many assets one owns. The family home is excluded from the assets tests (subject to rules on the use of the family home) but homeowners face lower assets tests thresholds for their remaining assets compared with non-homeowners. Even if a pensioner is not receiving any return from his or her assets, this test is still applied (the belief is that an asset-rich person should arrange their affairs so they can provide for themselves, rather than rely on government payments.)

Whichever test (i.e. the income or the assets test) results in the lower rate of pension payable is actually applied. In 2007, 66.2 percent of people old enough to qualify for the age pension listed it as their main source of income (ABS 2008d).

	Income	Test	Asset Test		
	Free threshold <sup>a</sup>	Part payment cut-off	Free threshold <sup>b</sup>	Part payment cut-off	
	\$ per fortnight	\$ per fortnight	\$	\$	
Homeowner – Single	138.00	1,558.25	171,750	550,500	
Homeowner - A Couple	240.00	2,602.50	243,500	873,500	
Non-homeowner – Single	138.00	1,558.25	296,250	675,000	
Non-homeowner - A Couple	240.00	2,602.50	368,000	998,000	

#### Table 1 Age pension income and assets tests, Australia, January 2009

a Income over these amounts reduces the rate of pension payable by 40 cents in the dollar.

**b** Assets over these amounts reduce pension by \$1.50 per fortnight for every \$1,000 above the limit (single and couple combined).

**Note:** Only the most common circumstances are shown. There are a number of factors that can vary the test cut-offs and payment rate (for example dependent children, separation of a couple due to illness or one member of a couple eligible).

Source: Centrelink 2009

The age pension is not generous compared to that of many European nations and is designed to keep the elderly out of poverty rather than to fully replace wage or salary income. It is set at 25 percent of male full-time average earnings. The current single rate of pension, at \$281.05, is 52 percent of the minimum full-time weekly wage of \$538.78 (Centrelink 2009). An official Pension Review is currently underway in Australia and is examining, among other issues, whether the age pension is set at an appropriate level (Harmer, 2008). This Review is due to be completed by the end of February 2009 but, at the time of drafting this ESRI report, no further information was publicly available from this Review.

### 2.1.2 Compulsory superannuation

The closest thing that Australia has to a contributions-based social security system is the compulsory superannuation system - 'super' for short. This was made mandatory for all employees earning over \$450 a week in 1993. When introduced, three percent of an employee's salary was to be placed in a superannuation fund by the employer (at the time the employer chose the fund, now the employee can choose.) This compulsory contribution proportion has gradually been increased to nine percent. The funds held in superannuation can be accessed from age 55 and from age 60 can be assessed with no tax payable. The aim of the superannuation system is to reduce dependence on the public, means-tested pension as the population ages, and to improve the living standards of retirees (Nielson and Harris, 2008).

The superannuation system in Australia is quite distinct from public or private pension programs overseas. First, it is different from private or occupational pensions in other countries, in that payments into a fund are mandatory for all employees who make more than minimal earnings. Secondly, all contributions that an individual makes to a superannuation fund (minus management fees) are his or her own private property, kept in his or her own separate account. Internationally, mandatory pension schemes often do not pay all contributions into individual funds for withdrawal at retirement: instead, the payments (or most of the payments) go to a common fund. Payments into the fund entitle one to an income stream when the individual meets certain circumstances.

In Australia, in the 25-34 age group (the age group in which most people who will ultimately enter the workforce have entered the workforce), 87.5 percent were accumulating superannuation in 2007 (83.8 percent of females and 91.2 percent of males.) Older age groups were increasingly less likely to have superannuation coverage (ABS 2008e).

Wage and salary earners were most likely to have superannuation (94 percent). The selfemployed were less likely (72 percent). Those with no income or on government payments were the least likely to have superannuation (36 percent and 23 percent respectively) (ABS 2008e).

### 2.1.3 Voluntary superannuation and other savings

Tax concessions for voluntary superannuation were first introduced in 1915, but coverage was low, only covering 30 percent of private sector employees in the 1980s (Bateman and Pigott, 2001). Any individual, whether working or not, can open a superannuation account and put money into it over and above the mandatory contributions described above. Such voluntary contributions are promoted by the government through matching schemes and tax advantages. For example, low income earners receive an additional \$1.50 for each \$1 they place into their superannuation account. Moderate to high income earners benefit from reduced income tax on income that is placed directly into super (ATO 2009a). These schemes are intended to promote saving sufficient amounts for retirement and to reduce future pension burdens.

In addition to these three methods, individuals may save for their retirement through other means, such as through bank deposits; purchase of a family home, shares and equities; investment properties; or developing a business to sell in retirement. These do not receive the same tax advantages as superannuation, but have the advantage that they can be accessed earlier in one's life.

## 2.2 DISTRIBUTION OF INCOME AMONG OLDER AUSTRALIANS

In 2005-06, households in which the reference person was aged 65 years or over had a median income of \$437 per week – substantially less than the median income of all households of \$1040 per week. For 70 percent of elderly households, most of their income came from government pensions and allowances. However, such households also appeared to have lower expenses: 79 percent owned their homes outright, compared to 34 percent of all households, and nearly 90 percent of such households were singles or couples only (with no children to support).

The ABS 2005-06 Survey of Income and Housing (SIH) provides very detailed information on the sources and levels of incomes received, characteristics of people in each household, the total income of families (income units)<sup>1</sup> and households, homeownership, net wealth, asset ownership and value of assets. Using a data file from the SIH, the distributions of the circumstances of individuals are presented in the tables below.

Comparisons on the basis of income could be made using total personal income, total household income, or many other possible income measures. In this report, equivalent disposable income is used. Equivalent disposable income is the total household income from all sources less the income tax payable, adjusted for the number of people in the family. This income measure gives the most accurate estimate of household resources, as it accounts for differing taxation levels and differing family needs. For example, it would show that a single person on a particular gross income is better off than a couple with two children on the same gross income. It is worth noting that it is one of the least uneven distributions. For example, use of gross family income would show the people in the top quartile have incomes seven times those in the bottom quartile. But, after payment of income tax and adjusting for the number of people in the family who have to share this income, the income of the top 25 per cent is only 4.3 times that of the bottom 25 per cent.

Tables 2 and 3 attempt to compare Age Pensioners with the broader Australian population and identify the highest and lowest income people. To do this, the table has divided all Australian adults into four equal groups – termed 'quartiles' - based on the equivalent disposable income of the household of which they are a member. The 25 per cent of Australians living on the lowest incomes are in Q1 (Bottom 25%) and the 25 per cent living on the highest incomes are in Q4 (Top 25%).

<sup>&</sup>lt;sup>1</sup> In this report, the terms families, income units and households are interchangeable as only households that consist of a single person or a couple have been considered. Multiple family households, group households, extended families and other types of families and households have been excluded from the analysis.

		Equiva	Equivalent Disposable Income Quartile					
		Q1 (Bottom 25%)	Q2	Q3	Q4 (Top 25%)	Total		
Mean Income	\$ p.a.	14,260	25,040	36,170	61,630	34,270		
Age Pensioner <sup>a</sup>	Рор	1,341,500	574,100	129,300	51,200	2,096,100		
Non Age Pensioner	Рор	2,651,800	3,420,000	3,864,700	3,943,100	13,879,500		
All adults	Рор	3,993,300	3,994,100	3,994,000	3,994,300	15,975,700		

#### Table 2 Distribution of adults by equivalent disposable income quartile, Australia, 2006

a Age Pensioner includes those receiving a Service Pension.

**Note:** Adults is used colloquially to mean all persons except those aged under 15 and those aged 15–24 who are full-time students. A more complete definition is in ABS, 2008.

Source: Author's calculation based on ABS 2005-06 Survey of Income and Housing unit record file.

The average annual equivalent disposable income according to the SIH was \$34,270. Table 2 shows that the highest income quartile of Australians had an average equivalent disposable income of \$61,630 per annum. As mentioned above, this is more than four times the average income of those in the lowest income quartile (\$14,260). Of the more than two million Age Pensioners, only 51,200 are in the highest income quartile.

# Table 3Proportional distribution of adults by equivalent disposable income quartile,<br/>Australia, 2006

		Equival				
		Q1 (Bottom 25%)	Q2	Q3	Q4 (Top 25%)	Total
Mean Income	\$ p.a.	14,260	25,040	36,170	61,630	34,270
Age Pensioner <sup>a</sup>	%	64.0	27.4	6.2	2.4	100.0
Non Age Pensioner	%	19.1	24.6	27.8	28.4	100.0
All adults	%	25.0	25.0	25.0	25.0	100.0

**b** Age Pensioner includes those receiving a Service Pension.

**Note:** Adults is used colloquially to mean all persons except those aged under 15 and those aged 15–24 who are fulltime students. A more complete definition is in ABS, 2008.

Source: Author's calculation based on ABS 2005-06 Survey of Income and Housing unit record file.

Table 3 shows that almost two-thirds (64%) of all those on the Age Pension <sup>2</sup> are in the bottom income quartile and 91 per cent are in the bottom half of the income spectrum. At the same time 2.4 per cent of Age Pensioners are in the highest income quartile. When compared with the broader population, Age Pensioners are very strongly over-represented in the low income quartiles. This is not unexpected, remembering that both income and assets tests are used to target Age Pension payments.

Table 4 looks *only* at Age Pensioners and shows the distribution of their weekly private or non-government income. The distributions are broken down by family type and homeownership. Non-government income has been calculated by subtracting the weekly cash government benefits received from the total income of each person. The table is based on personal data rather than equivalised household data.

<sup>&</sup>lt;sup>2</sup> Age Pension includes those on a Service Pension.

		Non-government income (\$ per week)						
		Zero	\$1 - \$19	\$20 - \$59	\$60 - \$99	\$100 - \$199	\$200 - \$499	\$500+
		%	%	%	%	%	%	%
Member of a Couple	Homeowner	16.1	38.6	15.0	6.9	10.1	10.3	2.9
	Non-homeowner	43.5	39.4	10.0	0.5	2.2	3.6	0.7
	All	18.5	38.7	14.6	6.4	9.4	9.7	2.7
Lone Person	Homeowner	16.9	39.9	14.4	7.2	10.3	9.6	1.6
	Non-homeowner	45.7	36.7	6.2	2.4	3.9	5.1	0.0
	All	24.2	39.1	12.3	6.0	8.7	8.5	1.2
All Age Pensioners	Homeowner	16.3	39.0	14.8	7.0	10.2	10.1	2.5
	Non-homeowner	44.9	37.8	7.6	1.7	3.3	4.5	0.3
	All	20.5	38.9	13.8	6.3	9.2	9.3	2.2

# Table 4Distribution by non-government income of Age Pensioners, by family type and<br/>homeownership, Australia, 2006

Source: Author's calculation based on ABS 2005-06 Survey of Income and Housing unit record file.

Table 4 shows that six out of every 10 (59.4%) Age Pensioners have private incomes of less than \$20 per week, and that 83 per cent of non-homeowners have private incomes of less than \$20 per week. At the other end of the spectrum, 12.6 per cent of homeowner Age Pensioners have private incomes of \$200 or more per week.

## 2.3 ACCESS TO SUPERANNUATION

At present, it is possible for many Australians to access accumulated superannuation at age 55 (the 'preservation age'). This superannuation may be taken as a lump sum or converted to an income stream managed by a superannuation fund.

Policy makers in Australia have been trying to strike a delicate balance between allowing people who have worked hard and saved hard for their retirement to retire earlier than 65 years if they wish; and discouraging people from spending all their superannuation before age 65 so they can claim the full-rate age pension. A number of policy changes have been put into place to encourage later retirement and use of superannuation in a way that reduces the age pension burden.

First, the preservation age is to be increased, so retiring at age 55 will become much less common. From 2015 onwards, the preservation age will gradually be increased to 60 years (ATO 2009b).

Secondly, under current tax rules, if a person accesses their super after they turn 55 but before they turn 60, retirement income from superannuation is taxed at the person's marginal tax rate. If a person does not access their super until after they turn 60, superannuation income is tax-free. This gives workers an incentive to stay in the workforce for longer (Nielson and Harrus 2008). To encourage people to reduce their working hours rather than retire completely, a person who is aged 55 or over can reduce their working hours and take some of their superannuation as an income stream (not a lump sum). This promotes labour force participation among 55-64 year olds who no longer wish to work full-time but cannot live comfortably on a part-time income alone (Nielson and Harris 2008).

A person may draw down some or all of their superannuation savings before they turn 55 in exceptional circumstances. Some of these exceptional circumstances are:

- When superannuation funds are to be used for life-saving medical treatments;
- When a person is terminally ill and therefore unlikely to reach the preservation age; and
- When a person is in severe financial difficulty for example if they are unable to make the mortgage repayments on the family home.

## 3 MODELLING FUTURE RETIREMENT INCOMES IN AUSTRALIA

As already discussed, population ageing is expected to have major consequences for Australian society and the economy – and for the Australian and State Governments. In 2002 and 2007 Australian Treasury released the IGRs that suggested that, if current policy settings remained unchanged, there would be a significant shortfall between government revenue and outlays. A similar analysis by the Productivity Commission (2005) showed comparable outcomes for the State governments within Australia (Australia contains eight states and territories). Accordingly, Treasury concluded that resolving this budget shortfall would require either higher taxes upon future generations or reductions in spending programs (or some combination of these).

To undertake the IGRs, Treasury constructed large and complex models to quantify the fiscal and other implications of an ageing population. However, these models were not microsimulation models of individuals but were 'cell-based' or 'group' models of the population (Harding and Gupta, 2007, p. 12). Accordingly, results from the Treasury IGR models can only derive outcomes for aggregated sub-groups of the population. Because the Treasury models do not simulate individuals and families at a micro-level, it is not possible to use them to analyse the distributional effect of possible policy responses to the fiscal strains caused by population ageing (although it must be acknowledged here that Treasury's RIMGROUP model is a very detailed cell-based model – Treasury 2007, p. 114). Nonetheless, a dynamic microsimulation model is required to give the fine-grained detailed distributional outcomes.

For this reason, Treasury, along with 11 other government agencies and with Australian Research Council funding, joined with NATSEM in a five year project to develop an up-todate dynamic microsimulation population model for Australia – the Australian Population and Policy Simulation Model (APPSIM). Construction of APPSIM began in 2005 and the first prototype will be completed at the end of 2009. At this stage, NATSEM is still trialling the imputation of income tax liabilities and social security benefits and the results contained below in this ESRI paper can thus only be regarded as indicative rather than definitive, designed to illustrate the types of policy relevant output that dynamic models can potentially provide to policy makers.

# 3.1 APPSIM

APPSIM simulates all of the major events that happen to Australians during their lifetime, on the basis of probability equations based on actual Australian data. The model starts with a large representative sample of Australians and then simulates up to 50 years into the future. The simulated events include mortality, household formation and dissolution, fertility, education, labour force participation, earnings, savings, retirement, wealth, social security and taxation (see Figure 6).

APPSIM has a similar structure to most other dynamic microsimulation models – an initial starting population, a simulation cycle and an output. Within the simulation cycle are sets of functions or tables of probabilities for calculating the chances of events occurring.

The simulation uses transition probabilities (calculated from equations or tables), based on the person's characteristics and the simulated date. As the simulation clock steps through time, the chance of a person transitioning from one state to another is considered (for example changing from the state of 'employed' to the state of 'unemployed'). In the case of a transition from employment to unemployment, the circumstances that influence a transition could be the person's age and sex; whether they are married; whether the person is an employee or self employed; the industry and occupation of the person; whether it is summer; overall wages and unemployment at that time and the proportion of people working part-time.

After calculation of a transition probability (in the range 0.0-1.0), this 'chance' is then compared with a random number. Based on the result of this comparison, the transition may be flagged to occur. For example, if person A's chance of transitioning from employment to unemployment in year t is 0.015 and a random number of 0.345 is drawn, then person A will not be flagged to transition to unemployment in year t.

The model has the ability to align its outcomes with external reference data. For alignment to occur, external benching data must be available and an 'align' switch must be turned on. Most modules will have such a switch. The most probable method to align the outcomes of the equations with the macro or external values is to rank the in-scope population based on their probability score. The appropriate number of people to make the transition are then selected based their ranking.

The APPSIM model is written in C#, with this source code reading in a series of Excel workbooks that contain the parameters (that can be readily changed by users).





Source: NATSEM.

### 3.2 MODELLING DEMOGRAPHICS IN APPSIM

APPSIM has a starting sample population that is one percent of the Australian population – 188,000 records. This sample accurately represents the age-sex profile of Australia in 2001. From 2001, annual events of immigration, childbirth, death, overseas emigration and ageing one year are simulated. The number of families that are simulated to be immigrating into Australia in any year is based on historical data or projected numbers, based on advice from departmental expert advice or other reference data. The characteristics of the families immigrating into Australia are based on historical records of migrants. The number of people emigrating overseas within the simulation is also based on departmental data or projected estimates.

There are four components within the demographics module – mortality, fertility, immigration and emigration. Over time, the impact of the differences in fertility, mortality and migration rates will replicate the ageing of the Australian population. An external benchmark, the Australian Bureau of Statistics Population Projections Series B, is used to ensure that projected APPSIM demographic outcomes align with government estimates.

#### 3.2.1 Immigration

The modelling of immigration in APPSIM involves three steps:

1. creating pools of potential immigrants based on visa status;

- 2. selecting immigrants from each pool; and
- 3. incorporating the chosen immigrants into the model population (see Pennec and Keegan, 2007).

In the first step, immigrants are classified according to their visa status: family, skilled, humanitarian, and non-program (mostly New Zealand citizens). This step is undertaken outside of the simulation and provides pools of migrants to APPSIM. Data on the Longitudinal Survey of Immigrants to Australia (LSIA) Wave 1 are used as the immigrant pools for family, skilled worker and humanitarian visa immigrants. Those recorded in the 2001 Australian Census who have arrived in Australia since 1996 and were born in New Zealand are used as typical non-program immigrants.

In the second step the target numbers of immigrants from each group are selected for integration into the model. The number of immigrants to be drawn in any simulated year is based on historical and projected arrivals data and the visa class. For example, there were 59,507 skilled migrants in year up to June 2006 and there were 131,593 migrants in the same year. This means that immigration represented 0.65% of the Australian population and 45.3% entered under the skilled visa program. APPSIM uses these historical percentages to randomly select those proportions from the skilled migrant pool.

The final step is to integrate the immigrants. Immigrants are selected by family. The selection process ensures that only entire families are selected.

## 3.2.2 Mortality

Every person that is alive in that simulated year is considered to be in-scope for death. As each person is evaluated, the probability of death is calculated based on their sex and age at that time. This calculated transition probability is then used for comparison with a randomly-drawn number (Pennec and Bacon, 2007).

## 3.2.3 Fertility

Only live births are simulated in APPSIM. All the data used to model fertility rates are based on live births. All women aged 15-49 are considered in-scope for child birth. The probability of childbirth in that simulated year is estimated using a logistic regression equation that is influenced by age, sex, marital status, student status, member of a couple, parity, years since last birth, and labour force status (Pennec and Bacon, 2007).

A potential list of people who might give birth is then calculated. If alignment is NOT being used, this list contains every woman with a random probability greater than the calculated childbirth probability. If alignment is being used, every woman in scope is ranked based on the difference between their random probability and their calculated transition probability and, based on the alignment, a proportion of the highest ranked people are selected for childbirth.

Every woman selected for transition (childbirth) is flagged as being a mother and processing is passed to the birth processing module where the child is created (or some might say "the miracle of birth occurs"!).

### 3.2.4 Emigration

Each simulated year, the model will estimate the number of emigrants required based on historical and projected overseas departures data. This number expressed as a percentage of the current population will then be used to randomly select the number of people to emigrate. Emigration is done on a family basis (Pennec and Keegan, 2007).

## 3.3 MODELLING LABOUR FORCE PARTICIPATION AND EARNINGS IN APPSIM

The labour force and earnings modules in APPSIM are fully functional. However, the earnings module is still being validated and the longitudinal profiles of the earnings assigned to individuals require further checking. For this reason, and due to time constraints for this project, a simpler earnings module was used in this version of APPSIM than will be implemented in the final operational model.

### 3.3.1 Labour force modelling

Those in scope for the labour force transitions are people aged 15 years and older, up to age 74 (Keegan, 2007). Those outside this age range are considered to be 'not in the labour force' (NILF).

The first step in the processing is to identify those that have retired. This is done by forcing everyone above a set age (a user-defined variable called *MaxRetireAge*, currently set to 74 years) into retirement and by using a logistic regression equation to select younger people for retirement. This regression equation is applied to everyone above a minimum age (another user-defined variable *MinRetireAge* and currently set to 55 years) and is influenced by sex, age, qualifications, labour force status in the previous two years, whether self-employed, whether they have a partner, and their health.

The retirement equation currently in APPSIM does not allow a person to re-enter the labour force after they have entered retirement. Those who are flagged as retired are assigned a labour force status of NILF.

The second step is to identify full-time students and assign employment status to them.

The next step is to assign a labour force status to all remaining people. This is done using a series of regression equations that are influenced by sex, age, qualifications, labour force status in the previous two years, whether they have a partner, the age of the youngest family member, eligibility to tax free superannuation or pensions, and their health. On the basis of these equations they are assigned full-time employment, part-time employment, unemployed or NILF status. The number of hours worked and whether they are

employees or self employed is assigned, based on their labour force status and probability tables.

A key feature of the model is the ability for the user to set the minimum and maximum retirement ages, the minimum eligibility age for the government's Age Pension, and the minimum age for access to superannuation. Some of these features will be exploited in the research presented later in this paper.

## 3.3.2 Earnings

For this ESRI project, annual earnings are assigned using regression equations, drawing upon the detailed research outlined in Thurecht and Keegan about important predictive factors (2008). Separate regression equations were developed for men and women, with each regression equation being influenced by age, whether the person holds a degree, labour force status, and the person's family type. The self employed, unemployed and those not in the labour force are assigned earnings of zero. The self employed are assigned an income from their business through the 'other income' process.

The equations were derived from the earnings data in the ABS 2005-06 Survey of Income and Housing data file. (In the final version of APPSIM more detailed equations drawing upon the HILDA panel data will be used.)

The estimated 2006 earnings are then uprated to 2009 dollars based on changes in Average Weekly Earnings over the period. The annual earnings for all simulated years are presented in real 2009 dollars.

# 3.4 MODELLING INVESTMENT INCOME AND RENT IN APPSIM

## 3.4.1 Other income

*Other Income* for those working is the sum of annual income they receive from investments and their annual income from business (Kelly and Keegan, 2008). For those that have retired, it is the annual income they receive from investments. Probability tables – one for non-retired people and one for those who have retired – are used to allocate other income. The probability tables are based on the business and investment income data in the ABS 2005-06 Survey of Income and Housing data file. Estimated values were calculated for the various percentiles – minimum, 25%, 50%, 75%, 90%, 95% and maximum. The skewed distribution dictated the need for a larger number of higher percentile divisions.

## 3.4.2 Rent paid

A housing tenure is assigned to every household that is simulated within APPSIM. The possible tenures are home owner, home buyer, renter or other (Kelly and Keegan, 2008). The tenure is updated on an annual basis. If a household is assigned tenure of *Renter*, then a weekly rent is assigned to that household. The assignment is done using a Look-up Table of the 25<sup>th</sup> and 75<sup>th</sup> percentiles of the weekly rent in the ABS 2005-06 Survey of Income and Housing. The rents are broken down by age of the oldest person in the household, their

sex, and household type. A random weekly RENT between the 25<sup>th</sup> and 75<sup>th</sup> percentiles is assigned based on the household characteristics. This rent is then up-rated to 2009 using changes in the consumer price index.

## 3.5 MODELLING SUPERANNUATION IN APPSIM

For this ESRI project, only 'defined-contribution' or 'accumulation fund' superannuation is implemented. (This means, for example, that we have not simulated any post-2001 increases in the 'defined benefit' superannuation rights of those still working - particularly significant for some public servants.) As 85 per cent of superannuation funds in Australia are of the defined contribution type, this is not believed to be a significant limitation to the broad findings of the project.

The simulation of the accumulation or drawdown of superannuation in APPSIM is done by estimating contributions, investment returns and drawdowns applying these to each individual account. This is done in each simulated year except 2006. In 2006 total superannuation balances are imputed from the ABS 2005-06 Survey of Income and Housing for every person aged 15 and above using two different techniques. For those that are not retired, two regression equations were developed – one for men and one for women. The non-retired regression equations are influenced by age, earnings, whether the person holds a degree, labour force status, the person's household tenure, and whether the person is self-employed.

For those that are retired, a probability table was shown to give a better distribution of superannuation. The reason for this was the skewed distributions of superannuation, with large numbers of people having a zero balance and a few having very large balances. The tables were broken down by sex, whether the person had a degree, and age. Estimated values were provided for the percentiles of 0%, 25%, 50%, 75%, 90%, 95% and 100%.

As for earnings and other income, the superannuation equations and probability tables were derived from the ABS 2005-06 Survey of Income and Housing data file.

In all years other than 2006, superannuation guarantee (SG) contributions were estimated based on annual earnings and added to the superannuation account. The SG rate is a user - defined variable within APPSIM, but is set to nine per cent by default. To simulate voluntary contributions above the SG, it is assumed that one in twenty earners voluntarily contributes a further 10% of their earnings and another 10 per cent contributes a further 5% of their earnings to superannuation. The return on all superannuation funds was assumed to be the same and set to four per cent per annum (in real terms). This return was added to all superannuation balances on an annual basis.

For those in retirement, an annual drawdown also takes place. For those under the minimum pension age (65 years by default), a drawdown of \$20,000 per annum occurs. For those over the minimum pension age, the drawdown is assumed to be only \$10,000, as it will generally be used to supplement the pension. For those over pension age and with a high superannuation balance, the drawdown is the minimum of five per cent of the superannuation balance or \$10,000.

## 3.6 MODELLING THE AGE PENSION IN APPSIM

STINMOD is NATSEM's static microsimulation model of the Australian income tax and cash transfer system (Vu, 2008). This publicly available model provides estimates of the distributional, revenue and expenditure impacts of taxation and transfer policies on Australian individuals and families. STINMOD is now a standard model used by Australian government departments for their analyses of existing and possible policy options in the tax/transfer field (e.g. Bremner, 2005) and it is consistently used by NATSEM to examine the immediate impact of policy change (Lloyd, 2007; Harding et. al., 2005).

For this study, the innovative approach was taken of generating a 20 per cent sample of output records for the base year and each of the four future years from APPSIM and then running that sample against the STINMOD income support and taxation code. The STINMOD income support code (which is written in SAS) includes a replication of the current Australian age pension payment parameters and implements the age pension income test and age of eligibility test for singles and couples. This version of the modelling assumes that those of age pension age meet the residency test. A simplified version of the age pension assets test is also simulated. If a person's assets are below their relevant asset test cut-off point (which varies by couple/single and homeowner/non-homeowner status), then they are assumed to pass the assets test and only their income is used to determine how much age pension they are simulated to receive. In the out-years, the rate of pension and all other pension parameters are held fixed at their 2009 level (as earnings and other income sources are similarly held fixed in constant 2009 dollars).

# 4 SIMULATIONS

In this section we present simulation results for three selected policy changes that might conceivably be raised as possible policy responses to future fiscal pressures associated with population ageing. As discussed earlier, given that the APPSIM model is still under development, these results are intended to provide insight into the types of contribution that dynamic microsimulation models might make to policy development processes, rather than to provide definitive estimates.

Results are provided for five years, showing cross-sectional 'snapshot' results for each of 2009, 2019, 2029, 2039 and 2049. At the moment in Australia, the needs and circumstances of the baby-boomers during their future years of retirement tend to dominate much policy debate. But one of the important factors that becomes immediately apparent when examining output that extends to 2049 is the changing generational profiles. Today, there are some 4 million baby boomers, born between 1946 and 1960 and now aged around 49 to 63 years. As Table 5 and Figure 7 illustrate, by 2019, according to current ABS population projections, there will be 3.85 million baby boomers, who by then will be aged 59 to 73 years old and will make up the key group among retirees. However, by 2049, the estimated remaining number of baby boomers is only about 820,000 and Gen Y, who by then will be

aged 74 to 88 years, will have transformed their status to become the key generation of retirees.

These changing generational profiles are extremely important to keep in mind when assessing the consequences of possible policy changes. For example, some possible policy changes, such as increasing the compulsory Superannuation Guarantee rate from 9 to 15 per cent, can be shown to have relatively little effect upon the baby boomers but a pronounced effect upon Generation Y.

### Table 5 Number and age, by generation, 2009 to 2049

	2009		2009 2019			2029		2039		2049	
	Age	Population	Age	Population	Age	Population	Age	Population	Age	Population	
GenY	18-33	4.84	28-43	5.53	38-53	5.85	48-63	5.88	58-73	5.71	
GenX	34-48	4.68	44-58	4.80	54-68	4.73	64-78	4.45	74-88	3.63	
Baby Boomers	49-63	4.01	59-73	3.85	69-83	3.41	79-93	2.30	89+	0.82	

Note: 'Age' is in years and 'Population' is in millions. The size of some generations initially increases because of immigration.



### Figure 7 Population number, by generation, 2009 to 2049

Note: The entire Australian population is not included within this graph Source: ABS 2008f.

### 4.1 INCREASING THE ELIGIBILITY AGE FOR THE AGE PENSION

In the first policy scenario, the minimum eligibility age for the Age Pension is assumed to be the same for men and women and to have been increased by two years from its current value of 65 years to 67 years. (Thus, we have simulated an immediate increase in the age pension age for women to 67 years, even though the actual current age pension age for women is 63.5 years, increasing to 65 over the next six years.) Interestingly, there has been extended debate in many OECD countries during the past decade about the financial sustainability of pension systems; seven OECD countries have introduced gradual increases in pension ages for both men and women such that, when current reforms are complete, Denmark, Germany, Iceland, Norway, the UK and the US will have a standard retirement age of 67 years (OECD, 2007c, p. 2). In Australia, however, there has been

relatively little debate about an increase in the minimum age of eligibility, although Knox raised the issue in 2008. There is also a concern about how effective changing the age of eligibility would be in constraining welfare outlays, given that a substantial proportion of the relevant population receive income support prior to reaching age pension age and then simply transfer from another form of income support to the pension when reaching the statutory age.

Despite these concerns, as the eligibility age for age pension clearly has some influence on labour force behaviour, it could be expected that more people would remain in the labour force if the age of eligibility was raised and would continue to contribute to their superannuation rather than begin to draw it down. This change in behaviour should have benefits for both the government and the retiree. The government will have lower outlays in future years as people are more self-reliant and making lower claims on the Age Pension and the retiree will have more income to supplement their pension.

In modelling the changes in behaviour that might result from this increase in the age of eligibility, it was assumed that the labour market and earnings behaviour of 65 year olds would be like that of today's 63 year olds, while that of 66 year olds would be like that of today's 64 year olds.

Age pension outlays today are about Aust\$28 billion. Figure 8 provides an illustration of the expected impact of this scenario on aggregate pension outlays out to 2049. It shows that the simulated age pension savings would increase in future years, largely because population growth would mean that commensurately more Australians would be prevented from receiving the age pension in 40 years time compared to in 10 years time. The graph also provides an indicative illustration of the relative savings in aggregate pension outlays from this and the other two reform options (discussed further below), relative to the 'base case' of a continuation in existing policy. However, it should be emphasised again that, while increasing the age pension age to 67 years would reduce age pension outlays, a significant proportion of the caseload could be expected to be eligible for other forms of income support, and this would need to be simulated and tested before the aggregate impact of this policy reform on all government income support outlays could be evaluated.



Figure 8 Simulated change in future age pension outlays, current policy and three reform options, 2009-2049 (2009 Age Pension outlays = 100)

### 4.2 INCREASING THE COMPULSORY CONTRIBUTION RATE TO SUPERANNUATION

In this scenario the current superannuation guarantee contribution rate is raised from nine per cent to 15 per cent. (This is the compulsory contribution made by employers to the named personal accounts of their employees, as discussed in Section 2.1.2.) This policy change should result in higher levels of superannuation for all earners. Many would argue that this change should have benefits for both the government and the retiree. The government will have lower outlays in future years as the people are more self-reliant and making lower claims on the Age Pension and the retiree will have more income to supplement their pension. In modelling this policy option we have currently assumed no change in labour force behaviour (on the part of either employees or employers).

As would be expected, one of the most interesting perspectives revealed by APPSIM is that the aggregate impact of this policy change on government age pension outlays is relatively minor in 2019, with Figure 8 suggesting that the increased private superannuation savings resulting from such a policy change would reduce the growth rate in age pension outlays from only 1.5 times current outlays to 1.47 times current outlays in 2019. The aggregate impact of this policy change would increase through the decades, with the simulation suggesting that the growth rate in age pension outlays between 2009 and 2049 would be reduced from around 2.5 times to 2.3 times current outlays by this reform. This relatively slow pace of change in aggregate age pension outlays is because it takes many decades for individuals to accumulate enough additional private superannuation for it to affect their government age pension. While superannuation balances are always going to be higher under this scenario, the balances are rarely increased by an amount that is sufficient to make them exceed the 'free' thresholds of the means test (Table 1) and reduce the level of public pension received.

**Note:** Indicative estimates only based on the limitations and assumptions outlined in the text **Source:** see text.

Figure 9 provides an illuminating insight into how the impact of this policy would vary by generation and by gender. Concerns have often been expressed about the inadequate superannuation savings of the baby boom generation, with the compulsory superannuation scheme only commencing in the late 1980s and 1990s and thus not being in operation for the full working careers of the baby boomers. This is particularly a concern for baby boomer women, who often worked part-time or remained out of the labour force while raising their children. Figure 9 provides some very preliminary estimates of the private superannuation incomes of various generations, comparing scenarios where the current nine per cent SG rate continues and where it is immediately raised to 15 per cent.



Figure 9 Average estimated weekly superannuation income in 2019 and 2049, by age and gender (2009 \$)

**Note:** Indicative estimates only based on the limitations and assumptions outlined in the text. 'BB' denotes 'Baby Boomer'. **Source:** see text.

The estimated weekly superannuation income of female baby boomers in 2019 is \$17 a week (in current dollars), with the baby boom generation being aged 59 to 73 years by this point in time. It is notable that increasing the SG would have relatively little impact on the superannuation incomes of female baby boomers by 2019. This is because the baby boomer generation are now already aged 49 to 63 years. Roughly two-thirds of baby boomer women in their early 60s and two-fifths of baby boomer women in their late 50s have already retired (Kelly and Harding, 2007, p. 5). As a result, increasing the compulsory superannuation paid by employers on their behalf based on their earned incomes is a relatively ineffective way of boosting their superannuation income in retirement, as they have already ceased holding down paid jobs. Thus, increasing the SG to 15 per cent is simulated to result in only a modest increase in the weekly superannuation income of baby boomer of baby boomer women in 2019, to \$23 a week (Figure 9).

When comparing these results to those for baby boomer men in 2019, it is immediately obvious that men in this generation are expected to receive two to three times as much superannuation income in 2019 as women of this generation. This reflects the more stable working careers of males in the baby boom generation, which meant that they were more

likely to be covered by superannuation schemes during the early to mid part of their working lives and also earned higher salaries, resulting in higher superannuation accumulations. Increasing the SG to 15 per cent is simulated to boost the private weekly superannuation of baby boomer men in 2019 by around one-quarter, to \$59 a week. This might have a positive impact upon the living standards of baby boomer men in retirement but, from the government's perspective, it would not be a sufficient change to have much impact upon government age pension outlays.

Figure 9 also provides some broadly indicative estimates of the impact of the current system and the proposed reform upon Generation Y in 2049. By this time, Generation Y are aged 58 to 73 years, so they are the same age as the baby boomers in 2019, providing a fruitful point of comparison. Even if the SG rate remains unchanged from its current level, the impact of having a much longer proportion of the typical working life covered by this policy is evident when comparing the baby boomers in 2019 and Gen Y in 2049. Thus, Gen Y are expected to have roughly twice as much income from superannuation in 2049 as the baby boomers did in 2019.

The relative gap between men and women is still apparent, although somewhat less pronounced than it was for the baby boomers. Thus, while baby boomer men had around three times as much superannuation income as baby boomer women, Gen Y men are anticipated to have around twice as much superannuation income as Gen Y women. The narrowing of the gender gap reflects factors such as the increased likelihood of Gen Y women gaining higher educational qualifications relative to their baby boomer mothers (Cassells and Harding 2007). On the other hand, the continuation of a gender gap, even in four decades time, underlines the ongoing significance of the gender wage gap and the continuing propensity of Gen Y women who have had children to work fewer hours and/or fewer years compared with both Gen Y men and Gen Y women without children (Cassells and Harding, 2007; Cassells, 2008).

The other notable feature revealed in Figure 9 is the much greater impact of any increase in the compulsory SG for the generations following the baby boomers. This is due to the longer period of working life still lying ahead of Gen X and Gen Y, relative to the baby boomers, many of whom have already entered early retirement. Thus, the increase in the SG rate from 9 to 15 per cent is simulated to approximately double the superannuation income of Gen Y in 2049, compared with the minor increases indicated for the baby boomers in 2019 from this policy change.

## 4.3 INCREASING THE PRESERVATION AGE

As noted earlier, one of the features of the Australian retirement income landscape has been for Australians to access their accumulated private superannuation when they reach age 55 and then spend a significant proportion of that superannuation before going onto the government age pension at age 65 (Kelly , Farbotko and Harding, 2004). In response, the government has announced a gradual increase in the preservation age, with those born before 1 July 1960 still able to access their superannuation at age 55 but those born after 30 June 1964 not able to access their superannuation until age 60. Thus, by around 2025 in Australia, the preservation age will have reached 60 years.

To examine the magnitude of the impact of policies that increase the preservation age, we have here compared a base world where the preservation age is 55 and this is assumed to continue out into the future, with an alternative future world where the preservation age is assumed to immediately increase to 60 years. As shown in Figure 8, such a policy shock is simulated to have a greater effect in restraining future age pension outlays than the increase in the Superannuation Guarantee option discussed in the section immediately above. For example, future government age pension outlays in 2049 were estimated to be 2.5 times age pension outlays in 2009 in our base case world (which is the continuation of current policy). Under the 'immediate increase in preservation age to 60 years' scenario, future government age pension outlays in 2049 are estimated to be 2.23 times current age pension outlays. As Figure 8 shows, such a policy change has a significant impact by 2029, but with the simulated proportional reduction in government age pension outlays apparent in 2029 not increasing much further past that point.

Consequently, to illustrate the capacities of dynamic microsimulation and to highlight outcomes for a different generation, the analysis below focuses on the impact of the preservation age increase upon Generation X in 2029. Generation X are today aged 34 to 48 years and thus essentially unaffected by the preservation age. However, by 2029 they are aged 54 to 68 years and thus many of them would be directly impacted by the preservation age increase applying to 55 to 59 year olds.

Figure 10 traces the estimated private incomes of Generation X in 2029, under superannuation preservation ages of 55 years and 60 years. (Private incomes are the incomes received from such sources as earnings, interest, dividends etc and specifically exclude government cash transfers.) The simulation suggests that the increase in the preservation age would cause some members of Generation X to remain in the workforce for longer, because they are unable to access their superannuation until age 60. For example, the private incomes of Gen X in 2029 are estimated to increase from \$657 in the 'preservation age 55' base case to \$850 under the alternative 'preservation age 60' scenario. In addition, those members of Gen X who have reached age pension age by 2029 are simulated to receive an age pension that is roughly 25 per cent less than under the 'preservation age 55' base case policy. This is because they reach age pension age with greater accumulated superannuation once the preservation age is increased - and this thus affects their government age pension, because of the pension income and asset tests.



# Figure 10 Projections of private income of Generation X in 2029 under preservation age of 55 and 60 years, by gender (2009 \$)

**Note:** Indicative estimates only based on the limitations and assumptions outlined in the text **Source:** see text.

## 5 CONCLUSIONS

Structural population ageing is creating challenges for welfare states across the world. Many of the possible policy responses involve making changes whose full effects will take decades to unfold. Further, there are a wide range of considerations to take into account, including fairness between and within the different generations. In such an environment, dynamic microsimulation models can be a very powerful tool for policy makers

The examples presented in this paper are designed to illustrate the potential usefulness of dynamic microsimulation in providing quantitative estimates and generational insights for policy debate in Australia and Japan. One of the striking aspects of the output contained within this study is how greatly the generational impacts of policy change can vary. As always, the use of microsimulation underlines how crucially important it is to dig below the summary outcomes or averages to fill in the distributional picture.

# REFERENCES

ABS, 2004, Australian Historical Population Statistics, Cat. No. 3105.0.65.001, Canberra. http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3105.0.65.0012004?Open Document

ABS, 2008a, Births, Australia 2007, Cat. No. 3301.0, Canberra.

http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3301.02007?OpenDocum ent

ABS, 2008b, Deaths, Australia 2007, Cat. No. 3302.0, Canberra.

http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3302.02007?OpenDocum ent

ABS, 2008c, *Labour Force Australia*, Detailed – Electronic Delivery, Cat. No. 6291.0.55.001, Canberra

http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/6291.0.55.001Dec%20200 8?OpenDocument

ABS, 2008d, *Australian Social Trends*, 2008, Cat. No. 4102.0, Canberra. http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/4102.02008?OpenDocum ent

ABS, 2008e, *Employment Arrangements, Retirement and Superannuation*, Australia. Cat. No. 6361.0

ABS, 2008f, *Population Projections, Australia 2006 to 2101*, TABLE B9. Cat. No. 3222.0 http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3222.02006%20to%20210 1?OpenDocument

Asfa, C and Buffetea, S, 2007, 'DESTINIE', In Gupta, A. and Harding, A, '*Modelling our Future: Population Ageing, Health and Aged Care*', International Symposia in Economic Theory and Econometrics Vol. 16, Elsevier: Great Britain

Australian Taxation Office (ATO), 2009a, Individuals superannuation essentials: Growing and Consolidating Super,

http://www.ato.gov.au/individuals/pathway.asp?pc=001/002/064/002/003&mnu=4 4903&st=&cy=1&mfp=001 Accessed 28 January 2009.

Australian Taxation Office (ATO), 2009b, *Transition to retirement: Understanding the Preservation Age*,

http://www.ato.gov.au/super/content.asp?doc=/content/74219.htm&page=1 Accessed 2 February 2009

Bacon, B. and Pennec, S. 2007, *APPSIM - Modelling Family Formation and Dissolution*, Working Paper No. 4, National Centre for Social and Economic Modelling, University of Canberra, September.

Bateman, H. and Piggott, J. 2001, *Australia's Mandatory Retirement Saving Policy: A View from the New Millennium*, Social Protection Discussion Paper Series No. 0108, Human Development Network, World Bank.

Blanchet, D. and Le Minez, S. 2009, 'Projecting Pensions and Age at Retirement in France : Some Lessons from the Destinie 1 Model', in Zaidi, A., Harding, A. and Williamson, P., (eds), *New Frontiers in Microsimulation Modelling*, Ashgate, Vienna (forthcoming).

Bremner, K. 2005, 'Net tax thresholds for Australian families', *Economic Roundup*, Winter, Department of the Treasury, Canberra. (available from http://www.treasury.gov.au/documents/1009/PDF/04\_Net\_Tax\_Thresholds\_for\_Au stralian\_families.pdf).

Butrica, B.A. Iams, H.M. Smith, K.E. 2006, 'The Changing Impact of Social Security on Retirement Income in the United States', in Papadimitriou D.B. (ed), *The Distributional Effects of Government Spending and Taxation*, Palgrave McMillan, New York pp112-132.

Cassells, R. 2008, 'The gender wage gap for generation Y in Australia', 37th Australian Conference of Economists, Gold Coast, 30 September – 3 October.

Cassells, R. and Harding, A. 2007. 'Generation whY', *AMP.NATSEM Income and Wealth Report* Number 17, July. (available from www.amp.com.au/ampnatsemreports)

Cassells, R. Harding, A. and Kelly, S. 2006, *Problems and Prospects for Dynamic Microsimulation: A Review and Lessons for APPSIM*, NATSEM Discussion Paper No. 62, National Centre for Social and Economic Modelling, University of Canberra, December.

Centrelink, 2009, Retirement Payment Rates 1 January – 19 March 2009, Retirement Payment Rates Factsheet,

http://www.centrelink.gov.au/internet/internet.nsf/filestores/co030\_0901/\$file/co0 30\_0901en.pdf Accessed 27 January 2009.

Evandrou, M. Falkingham, J. Johnson, P. Scott, A. and Zaidi, A. 2007, 'The SAGE Model: A Dynamic Microsimulation Population Model for Britain' in Gupta, A. and Harding, A. (eds), *Modelling Our Future: Population Ageing, Health and Aged Care,* Elsevier, Amsterdam, pp 443-447.

Favreault, M. and Sammartino, FJ. 2002, *Impact of Social Security Reform on Low-Income and Older Women*, AARP Public Policy Institute Report No. 2002-11, AARP, Washington, DC.

Flood, L. Jansson, F. Pettersson, T. Sundberg, O. and Westerberg, A. 2005, *SESIM III - a Swedish dynamic microsimulation model*, Ministry of Finance, Sweden. http://www.sesim.org/

Fredriksen, D. 1998, *Projections of Population, Education, Labour Supply and Public Pension Benefits: Analyses with the Dynamic Microsimulation Model MOSART*, Social and Economic Studies, Statistics Norway, Oslo.

http://www.ssb.no/emner/02/03/sos101/sos101.pdf

Fredriksen, D. 2003, '*The MOSART model - a short technical documentation*'. Paper presented at the International Microsimulation Conference on Population, Ageing and Health: Modelling our Future, Canberra.

Fredriksen, D. F. and Stolen, N. M. 2007a, '*MOSART (Dynamic Cross-Sectional Microsimulation Model)*' in Gupta, A. and Harding, A. (eds), *Modelling Our Future: Population Ageing, Health and Aged Care, Elsevier, Amsterdam, pp* 433-437.

Fredriksen, D. and Stolen, N M., 2007b, 'Effects of Demographic Developments, Labour Supply and Pension Reforms on the Future Pension Burden in Norway' in Harding, A and Gupta, A. (eds), *Modelling Our Future: Population Ageing, Social Security and Taxation*, International Symposia in Economic Theory and Econometrics, Volume 15, Elsevier B. V., Amsterdam

Fukawa, T. 2007, *Household projection 2006/07 in Japan using a micro-simulation model*, IPSS Discussion Paper Series No. 2007-E02, National Institute of Population and Social Security Research, Tokyo.

Harding, A. 1999, 'Modelling Techniques for Examining the Impact of Population Ageing on Social Expenditure', *Policy Implications of the Ageing of Australia's Population*, Productivity Commission, Melbourne.

Harding, A.,2000, 'Dynamic Microsimulation: Recent Trends and Future Prospects', in Anil Gupta and Vishnu Kapur (eds), *Microsimulation in Government Policy and Forecasting*, Contributions to Economic Analysis Series, North Holland, Amsterdam

Harding, A, Vu, Q.N, Percival, R & Beer, G. 2005, "Welfare-to-Work Reforms: Impact on Sole Parents", *Agenda*, Volume 12, Number 3, pages 195-210.

Harding, A. and Gupta, A. 2007, 'Introduction and Overview' in Harding, A. and Gupta, A. *Modelling Our Future: Population Ageing, Social Security and Taxation*, (eds), International Symposia in Economic Theory and Econometrics, Elsevier, Amsterdam.

Harmer, J. 2008, *Pension Review: Background Paper*, Department of Families, Housing, Community Services and Indigenous Affairs, August.

Harris, A.R. Sabelhaus, J. Schwabish J.A. 2006, *Projecting Labour Force Participation and Earnings in CBO's Long-Term Microsimulation Model*, Congressional Budget Office Background Paper, the Congress of the United States.

Inagaki, S. 2008, A Microsimulation model for projections of Japanese socioeconomic structure, *The Review of Socionetwork Strategies*, vol 2 no 1, pp 25-41.

Keegan, M. 2007, *APPSIM - Modelling the Labour Force*, Working Paper No. 6, National Centre for Social and Economic Modelling, University of Canberra, December.

Kelly, S. Farbotko, C., and Harding, A., 2004, 'The Lump Sum: Here Today, Gone Tomorrow', *AMP. NATSEM Income and Wealth Report*, Issue No 7, March (available from www.amp.com.au/ampnatsemreports)

Kelly, S. and Harding, A. 2007. 'Baby Boomers - doing it for themselves', *AMP.NATSEM Income and Wealth Report* Number 16, March (available from www.amp.com.au/ampnatsemreports)

Kelly, S. and Keegan, M. 2008, *APPSIM - Modelling Household Savings and Wealth*, Working Paper No. 9, National Centre for Social and Economic Modelling, University of Canberra, May.

Kelly, S. 2006, *Objectives and Requirements*, APPSIM Technical Note No. 1, Working Paper No. 1, National Centre for Social and Economic Modelling, University of Canberra, November.

Kelly, S. 2006, *Selection of the Main Source Data File for the Base Data*, APPSIM Technical Note No. 2, Working Paper No. 2, National Centre for Social and Economic Modelling, University of Canberra, November.

Kelly, S. Harding, A. and Percival, R. 2002c, 'Live Long and Prosper? Projecting the Likely Superannuation of the Baby Boomers in 2020', Paper presented to the 2002 Annual Conference of Economists Business Symposium, Adelaide, South Australia, October (all NATSEM conference papers available from www.natsem.canberra.edu.au) King, A., Baekgaard, H. and Robinson, M. 1999, 'DYNAMOD-2: An Overview', Technical Paper No. 19, National Centre for Social and Economic Modelling, University of Canberra, December.

Klevmarken, N. A. 2005, *Dynamic Microsimulation for Policy Analysis - Problems and Solutions*, Department of Economics, Uppsala University, Sweden.

Klevmarken, A and Lindgren, B, 2008, *Simulating an Ageing Population: A Microsimulation Approach Applied to Sweden*, Contributions to Economic Analysis, Emeral Group Publishing Ltd, UK.

Knox, D. 2008, 'Some Policy Implications of Population Ageing, Presentation to the CEDA *State of the Nation* Conference, Hotel Realm, Canberra, 5 June

Lloyd, R. 2007, 'STINMOD: Use of a Static Microsimulation Model in the Policy Process in Australia', in Harding, A. and Gupta, A. *Modelling Our Future: Population Ageing, Social Security and Taxation*, (eds), International Symposia in Economic Theory and Econometrics, Elsevier, Amsterdam.

Morrison, R. and Dussault, B. 2000, *Overview of DYNACAN: a full-fledged Canadian actuarial stochastic model designed for the fiscal and policy analysis of social security scheme,*. International Actuarial Association, from

http://www.actuaries.org/CTTEES\_SOCSEC/Documents/dynacan.pdf.

Morrison, R. J., 2007a, 'DYNACAN (Longitudinal Dynamic Microsimulation Model)', in Gupta, A. and Harding, A. (eds), *Modelling Our Future: Population Ageing, Health and Aged Care*, Elsevier, Amsterdam

Morrison, R. J., 2007b, 'Adding Private Pensions to the Canadian DYNACAN Model', in Harding, A. and Gupta, A. *Modelling Our Future: Population Ageing, Social Security and Taxation*, (eds), International Symposia in Economic Theory and Econometrics, North Holland, Amsterdam.

Morrison, R. 2008, *Validation of Longitudinal Microsimulation Models: DYNACAN Practices and Plans*, Working Paper No. 8, National Centre for Social and Economic Modelling, University of Canberra, March.

Morrison, R. J. 2009, 'Rates of Return in the Canada Pension Plan: Sub-populations of Special Policy Interest and Preliminary After-tax Results', in Zaidi, A., Harding, A. and Williamson, P., (eds), *New Frontiers in Microsimulation Modelling*, Ashgate, Vienna (forthcoming).

Nielson, L. Harris, B. 2008, *Chronology of superannuation and retirement income in Australia*, Background Note 6 February 2008, Parliamentary Library, Canberra. http://www.aph.gov.au/library/pubs/BN/2007-08/Chron\_Superannuation.htm

OECD, 2005, *Solving the Pensions Puzzle*, OECD Policy Briefs, Paris. www.oecd.org/publications/policybriefs

OECD, 2007a, OECD Demographic and Labour Force database, used in Society at a Glance, OECD Social Indicators 2006, www.oecd.org/els/social/indicators/SAG

OECD, 2007b, *Society at a Glance, OECD Social Indicators*, 2006 edition, OECD Publishing www.oecd.org/els/social/indicators/SAG

OECD 2007c, 'Pension Reform: The Unfinished Agenda', Policy Brief, September.

Orcutt, G. 1957 and 2007, *A New Type of Socio-economic System*, Review of Economics and Statistics, vol. 58, no. 2 (reprinted with permission in Volume 1 of the

*International Journal of Microsimulation*, Autumn 2007, available from http://www.microsimulation.org/IJM/IJM.htm).

Payne, A. Percival, R. Harding, A. 2008, *APPSIM - Modelling Education*, Working Paper No. 10, National Centre for Social and Economic Modelling, University of Canberra, June.

Pennec, S. 2008, *The challenges of creating babies in dynamic microsimulation models : the Australian APPSIM model and international comparison*. Paper accepted to be presented to the International Microsimulation Association 2009 conference Canada, Ottawa, June 2009.

Pennec, S. and Bacon, B. 2007, *APPSIM - Modelling Fertility and Mortality*, Working Paper No. 7, National Centre for Social and Economic Modelling, University of Canberra, December.

Pennec, S. and Keegan, M. 2007, *APPSIM - Modelling Migration*, Working Paper No. 5, National Centre for Social and Economic Modelling, University of Canberra, November.

Percival R. 2006, *Software Selection and Data Structures*, APPSIM Technical Note No. 3, Working Paper No. 3, National Centre for Social and Economic Modelling, University of Canberra, November.

Productivity Commission, 2005, *Economic Implications of an Ageing Australia* (available at www.pc.gov.au)

Sabelhaus, J. 2007 'Using Dynamic Microsimulation to Improve Long-Term Social Security Analysis', PowerPoint Presentation, Congressional Budget Office, The Congress of the United States, 10<sup>th</sup> November.

Sabelhaus, J. and Topoleski, J. 2006, 'Uncertain Policy for an Uncertain World: the Case of Social Security', Working Paper No 2006-05, Congressional Budget Office, Washington, D.C. (available from http://www.cbo.gov/ftpdocs/70xx/doc7090/2006-05.pdf)

Shiraishi, K. 2008 *The Use of Microsimulation Models for Pension Analysis in Japan,* PIE/CIS Discussion Paper 409, Institute of Economic Research, Hitotsubashi University (available from http://www.esri.go.jp/jp/workshop/080821/02\_01\_01\_06.pdf)

Statistics Bureau of Japan, 2008a, 2008 *Labour Force Survey*, November, Tokyo http://www.stat.go.jp/english/data/roudou/154.htm

Statistics Bureau of Japan, 2008b, *Statistical Handbook of Japan 2008*, published by Statistics Bureau, Ministry of Internal Affairs and Communications, Tokyo.

Sundberg, S. 2007, 'SESIM (Longitudinal Dynamic Microsimulation Model)', In Gupta, A. and Harding, A., '*Modelling our Future: Population Ageing, Health and Aged Care*', International Symposia in Economic Theory and Econometrics Vol. 16, Elsevier, Amsterdam

Thurecht, L. and Keegan, M. 2008, *APPSIM – Modelling Earnings*, Working Paper No 11, National Centre for Social and Economic Modelling, University of Canberra, July.

Treasury, 2002, *Intergenerational Report 2002-03*, 2002-03 Budget Paper No. 5, Department of Treasury, Canberra. http://www.budget.gov.au/2002-03/bp5/html/01\_BP5Prelim.html#P42\_796

Treasury, 2007, *Intergenerational Report* 2007, Department of Treasury, Canberra. http://www.treasury.gov.au/igr/IGR2007.asp

Vu, Q. N. 2008, *STINMOD Interface User Guide V06b*, National Centre for Social and Economic Modelling, University of Canberra (available from www.natsem.canberra.edu.au)

World Bank, 1994, Averting the Old Age Crisis: Policies to protect the old and promote growth, World Bank Policy Research Report, Oxford University Press. http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/1994/09/01/00 0009265\_3970311123336/Rendered/PDF/multi\_page.pdf

Zaidi, A. and Rake, K. 2001, *Dynamic Microsimulation Models: A Review and Some Lessons for SAGE*, SAGE Discussion Paper no. 2, London School of Economics (available from

www.lse.ac.uk/collections/SAGE).