APPSIM - Dynamic microsimulation modelling of social security and taxation

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About NATSEM

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

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

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

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

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

NATSEM is in the process of building a dynamic microsimulation model, the Australian Population and Policy Simulation Model (APPSIM). This model is being developed to assess the distributional and intergenerational impacts of policies designed to deal with the ageing population in Australia.

One of the final stages in APPSIM is developing a module to simulate Australia’s social security and taxation systems. This module must be able to take a person’s family, employment, education, earnings, health and wealth situation into account and assess what tax each individual will pay and what social security benefits they are entitled to.

This paper summarises the features of Australia’s social security and taxation system. It then considers the methods used to model social security and taxation in dynamic microsimulation models from overseas, and the appropriateness of these methods for an Australian dynamic microsimulation model. It also considers STINMOD, a static model of the Australian tax-transfer system. Finally, it recommends using STINMOD as a base for the social security and taxation modules in APPSIM.

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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 non-sampling errors in the microdata and because of the assumptions underlying the modelling techniques.

The microdata do not contain any information that enables identification of the individuals or families to which they refer.
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1 Introduction

The ability of dynamic microsimulation to model social security and taxation is one of the main reasons why dynamic microsimulation has come to prominence over the last 20 years as a useful modelling tool (Harding and Gupta 2007). Concerns about the ageing population have increased interest in using dynamic microsimulation to model the sustainability of pension systems.

The National Centre for Social and Economic Modelling (NATSEM) is building a dynamic microsimulation model called APPSIM (Australian Population and Policy Simulation Model) which will model a one per cent sample of the Australian population from 2001 to 2050. The base data used for the initial population is derived from a one percent sample of the 2001 census, and transition probabilities have been developed from a wide range of data sources, including the Household, Income and Labour Dynamics in Australia Survey (HILDA) and the Longitudinal Survey of Immigrants to Australia (LSIA).

Figure 1 Flow chart for APPSIM

Source: NATSEM
Figure 1 shows the structure of APPSIM and the flow between the different modules. Taxation and social security are among the last modules to be run in an APPSIM simulation, as the amount of tax one is obliged to pay and the social security one is entitled to depend on one’s earnings, student status, marital status, asset accumulation and health and other factors which are modelled in the earlier modules.

Even though social security and taxation are separate modules in APPSIM, they will be reviewed together as they are often closely interlinked in dynamic microsimulation models (DMSM).

This paper explains how Australia’s social security and taxation systems work, and reviews the methodology used to model social security and taxation systems in DMSMs from around the world. The methodologies used are often quite different due to the variation in social security and taxation systems in different countries.

2 Australia’s social security and taxation system

The most noticeable difference between Australia’s taxation and social security systems and other OECD nations is that we are one of only two nations 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 is of pension age, unemployed or disabled, their entitlement to a payment and/or the size of their payment is dependent on how long they have worked for 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 over a certain time period (Arza and Johnson 2004).

Australia’s system is quite different. Social security payments – age pensions, disability pensions, parenting payments and unemployment benefits - are paid out of general revenue. Thus revenue collected from non-employee sources, such as sales, excise and company tax, contribute to social security in Australia.
Table 1  **Australian taxation/social security systems compared to OECD norm**

<table>
<thead>
<tr>
<th></th>
<th>Australian system</th>
<th>OECD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payment of contributions</td>
<td>No separate accounting for social security payments</td>
<td>A proportion of employee income/payroll/employer contributions is collected for social security</td>
</tr>
<tr>
<td>Storage of payments for social security</td>
<td>General revenue from taxation</td>
<td>Kept separate from general revenue and invested</td>
</tr>
<tr>
<td>Entitlement to social security payments</td>
<td>Means-tested and universal for permanent residents who meet criteria for being unemployed, over pension age, etc</td>
<td>Based on size or duration of contributions. May be a ‘basic rate’ that all are entitled to, that can be topped up with voluntary payments</td>
</tr>
<tr>
<td>Size of social security payments</td>
<td>Flat rate, may be reduced by means test</td>
<td>May be a function of size or duration of contributions or a percentage of previous earnings</td>
</tr>
<tr>
<td>Means testing</td>
<td>Entitlement subject to assets (excluding family home) and income tests</td>
<td>Basic payments may be means-tested</td>
</tr>
</tbody>
</table>

*Source: (OECD 2007), (Centrelink 2009a)*

For this reason, to some extent reviewing some international DMSMs might not prove very enlightening. For many other OECD nations, taxation is not particularly relevant to sustainability of pension, aged care and health systems as the latter are paid for by social security contributions rather than income, sales or company taxes.

### 2.1 Taxation in Australia

The main sources of Federal Government revenue in Australia are personal income tax (40 percent), company tax and petrol resource rent (24 percent) and sales taxes, including the Goods and Services Tax (GST) (15 percent) (Treasury 2008). Other sources of taxation are fringe benefits tax, superannuation tax, excise and customs duties. Figure 2 shows a breakdown of federal revenue sources.
In 2007-2008, the total Federal Government revenue was $303.7 billion (Treasury 2008).

### 2.2 Types of taxation in Australia

**Income tax**

Taxable income can come from wages or salary, some social security payments, capital gains, interest and dividends. Income tax is charged on a progressive scale in Australia, with tax rates ranging from 0 percent to 45 percent. Table 2 shows the marginal income tax rates for Australians.

<table>
<thead>
<tr>
<th>Taxable income</th>
<th>Marginal tax rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0-$6 000</td>
<td>0</td>
</tr>
<tr>
<td>$6 001-$34 000</td>
<td>15</td>
</tr>
<tr>
<td>$34 001-$80 000</td>
<td>30</td>
</tr>
<tr>
<td>$80 001-$180 000</td>
<td>40</td>
</tr>
<tr>
<td>$180 001+</td>
<td>45</td>
</tr>
</tbody>
</table>

*Source: (Australian Taxation Office 2009a)*
In addition to this, a Medicare\textsuperscript{1} levy at the rate of 1.5\% of income is payable. Those on low incomes or in special circumstances may be exempt from the levy or may have it reduced. Persons earning over $75,000 per year for singles or $150,000 per year for couples must pay an additional 1.5\% as a Medicare levy surcharge if they do not have private health insurance.

\textit{Company tax}

Company tax is generally charged at a rate of 30\% on company profits (Australian Taxation Office 2009a). Some exceptions apply for non-profit companies and superannuation or private pension providers.

\textit{Superannuation tax}

To encourage Australians to contribute extra money to their retirement funds, superannuation receives preferential treatment. Special taxation rates apply on contributions, earnings and withdrawals of superannuation. Individuals can make pre-tax contributions to superannuation and be taxed at 15\% instead of their marginal income tax rate. Superannuation fund earnings are taxed at 15\% (Australian Taxation Office 2009a). For most people making a claim from their superannuation at retirement, provided they are aged 60 and over, the amount withdrawn will be tax free. However the tax treatment varies depending on a number of factors, including age, whether the money was held in a funded or unfunded account\textsuperscript{2}, the amount being withdrawn and whether superannuation is taken as a lump sum or income stream.

\textit{Sales tax/GST}

Goods and services tax (GST) is levied on all goods and services sold in the Australian economy at a rate of ten\% with the exception of certain essential household purchases such as food. Other additional sales taxes apply to certain goods such as alcohol and luxury cars.

\textsuperscript{1} Medicare is the scheme that gives Australian residents access to health care.

\textsuperscript{2} ‘Unfunded’ and ‘funded’ refer to whether money is being put into specific accounts to pay benefits when they fall due. Historically most government funds were unfunded and most private funds were funded. With the demise of defined benefit accounts, almost all superannuation funds have become funded.
Fringe benefits tax

Employers and employees can agree for the employee’s remuneration to include non-cash forms of remuneration, that is fringe benefits, in place of an all-cash salary. For example, an employee may decide to receive a lower salary in exchange for use of a company car or the employer paying for private health insurance. Fringe benefits tax prevents employers and employees from using excessively generous fringe benefits as a means of avoiding tax. If an employee receives a benefit that is not in a category that exempt from fringe benefits tax, then the employee must pay tax on the value of the fringe benefit at their marginal income tax rate (Australian Taxation Office 2009b).

Only some of these taxes will be able to be modelled in any detail in APPSIM. Income tax is essential and should be relatively straightforward to model, as APPSIM calculates earnings and non-wage income. Superannuation contributions tax can be calculated as the accumulation of superannuation will be modelled in APPSIM. Other sources of Federal Government revenue, such as petrol excise and company tax, are not collected on a household basis and outside the scope of APPSIM.

2.3 Social security in Australia

In the 2008-09 budget the Federal Government projected that spending on social security and welfare would add up to $102 billion (Treasury 2009). Social security attracts the largest share of Federal Government funding: specifically 35 percent of the budget, compared with 16 percent on health, 7 percent on education and 6 percent on defence.

Figure 3 shows the breakdown of social security expenditure in Australia.
The biggest sources of expenditure are assistance to the aged, the disabled and families with children.

### 2.4 Types of social security that can be claimed in Australia

The following sections summarise the main social security benefits claimable in Australia. All of these payments are subject to means tests and most are subject to assets tests, with the strictness of the tests varying by benefit. The means test generally has an income and asset threshold below which entitlement remains at the maximum rate, and a taper in which the level of assistance is gradually withdrawn. The home that one lives in is always excluded from the assets test.

#### The Age Pension

The Age Pension ensures that Australians have an adequate income in retirement. The minimum eligibility age for the Age Pension is 65 years for men and 63.5 years for women (the pension age for women was 60 and this is gradually being increased to 65 years) (Nielsen and Harris 2008). This is a flat rate, means-tested payment funded out of general taxation revenue.
Unemployment benefits

Australia and New Zealand are the only OECD nations in which the primary method of providing for the unemployed is through a flat rate, taxpayer-supported unemployment payment\(^3\), rather than having a system of unemployment insurance as occurs in other OECD nations.

Unemployment schemes vary between nations, but generally an employed person pays a small percentage of their income into insurance and can claim a payment of a certain percentage of their employed income while unemployed. Generally there is a minimum period before being able to claim unemployment assistance and the assistance can only be claimed for a number of months.

A minority of nations (Austria, France, Germany, Finland, Greece, United Kingdom, Ireland, Portugal, Spain, Sweden) have unemployment assistance, which is a means-tested, (usually) fixed rate payment provided to people who have exhausted unemployment assistance requirements. Some countries limit the duration one can be in receipt of this payment.

Australia provides for its unemployed people solely through a flat rate, means-tested unemployment benefit. This is paid out of general taxation revenue. There are no criteria in the Australian system to have had any previous employment history, recent or otherwise, to claim unemployment benefits. Although it is theoretically possible to remain on unemployment benefits indefinitely, this is most unlikely given the ‘activity’ requirements, for example applying for a certain number of jobs per fortnight, undertaking training or temporary employment on a work project. Failing to comply with these requirements may result in benefits being reduced or withdrawn for a period of time.

Disability support

As with the Age Pension and unemployment payments, Australia has no mandatory or public-run disability insurance scheme, unlike most other nations in the OECD. Disability Support Pension (DSP) is available to persons aged 16 and over and under the Age Pension eligibility age. A person who is permanently blind or incapable of working or undertaking training for 15 hours per week for the next two years due to disability is entitled to DSP (Australian Workplace 2009). This is a more generous payment than unemployment benefits. The level of a person’s disability, and thus

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\(^3\) Private unemployment insurance can be purchased voluntarily through some financial institutions.
their entitlement to a disability pension, may be reviewed periodically. This payment is also subject to income and assets tests.

**Families with children**

Benefits to families with children include the Parenting Payment for people with dependent children and little or no income, and Family Tax Benefit A and B.

Parents with nil or low income, including both singles and couples, can claim Parenting Payment. This is a higher rate than unemployment benefits and can be claimed until the youngest child is eight years old. The parent(s) must start seeking part-time work when their youngest child is six years (Australian Workplace 2009). Parenting payments are subject to income and assets tests.

Family Tax Benefit A is a means-tested, flat rate benefit provided to parents for each dependent child under age 21. Both working parents and non-working parents are entitled to claim this benefit.

Family Tax Benefit B is payable to families with children under 16 in which the secondary earner has little or no income. It is paid at a flat rate and is means-tested based on the secondary earner’s income. A single payment is made to the secondary earner, it does not increase with additional children (Centrelink 2009b).

### 2.5 Where do superannuation/private pensions fit in?

The closest thing that Australia has to a contributions-based social security system is the retirement savings system called superannuation. Superannuation 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 (at the time the employer chose the fund, now the employee can choose.) This amount has since increased to nine percent. This money can be accessed from age 55 with a tax penalty, and age 60 with no tax penalty (Nielson and Harris 2008). The aim of the superannuation system is to reduce dependence on the public, means-tested pension as the population ages and to improve the welfare of retirees.

The superannuation system in Australia is quite different 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, and most importantly for APPSIM, all contributions an individual makes to a superannuation fund (minus management fees) are their own private property and kept in their own separate account. Although generally they cannot access these funds until they are 55 years,
legislation permits early access to superannuation in some circumstances, for example if the holder is terminally ill or is unable to pay a mortgage and risks losing the family home without additional funding (Nielson and Harris 2008). In comparison to the Australian scheme, international mandatory pension schemes do not pay all contributions into individual funds for withdrawal at retirement, rather the payments (or most of the payments) go into a common fund. Payments into the fund entitle a person to an income stream when the individual meets eligibility criteria.

For these reasons, this quite significant contributor towards retirement incomes in Australia is being modelled in the wealth module.

3 International modelling of social security and taxation

The following section discusses the methods used to model social security and taxation in four overseas dynamic microsimulation models, and the methods used in an Australian static microsimulation model.

3.1 SESIM (Sweden)

Sweden’s social security/taxation system

Sweden has a high-taxing, high-spending government: in 2007 the tax revenue was 48.2 percent of GDP (Australia’s was 30.6 percent for the same year). It provides a comprehensive social insurance system to individuals who are ill, unemployed, suffer a work-related injury, are retired or on maternity leave.

Sweden has a mandatory public pension system funded by a fixed percentage contribution from income. Pension payments in Sweden are financed through an 18.5 percent tax on all incomes earned in the country. Sixteen percent of this goes to a defined contribution pay-as-you-go scheme and 2.5 percent goes to individual retirement accounts. Recently Sweden changed its pension system to phase out defined benefit schemes and introduce defined contribution schemes (Flood 2007). Swedes have a choice of five mutual funds into which their pension contributions can be invested.

Sweden has a system of voluntary unemployment insurance supplemented by unemployment assistance. A person must have made contributions for twelve
months before claiming insurance. An income-tested, flat rate payment of unemployment assistance is available to individuals who have worked for six months or are recent graduates.

Sweden pays a flat rate, non-means-tested payment to all parents of children aged less than 16, although single parents get a different rate from families with two parents. An additional supplement is paid if the family has three or more children. This is paid out of general taxation revenue.

How SESIM models social security and taxation

SESIM was originally developed in 1997 to assess the Swedish education-financing system. As concerns about the ageing population arose, SESIM was adapted to model the Swedish pension system. This has been the focus of SESIM since 2000.

The main source of data for SESIM is a longitudinal administrative dataset called LINDA. It represents a 3.5 percent sample of the Swedish population, with information on education, marriage, employment, earnings and retirement.

SESIM models a number of taxes – income tax, real estate tax, capital income tax and wealth tax. On the social security side, it models student loans and allowances, child allowance, housing allowance, social assistance, old age pension and disability pensions (Flood 2007). In addition to this, it also models other non-cash benefits such as child care, education funding, aged care, health care, unemployment benefits and medication.

For each year in the model, SESIM gives every individual a status which determines the taxes they are likely to pay and social security benefits they are likely to be entitled to. These categories are child, student, disability pensioner, employed, unemployed, parental leave, old age pensioner, miscellaneous and emigrant.

- Children receive non-cash benefits in the form of education and child care subsidies.
- Students receive non-cash benefits in the form of education subsidies, as well as health care and medicine subsidies. They may pay taxes on their income if they are employed.
- Disability pensioners are, obviously, entitled to a disability pension, plus health care and medication subsidies.
- Employed persons pay income tax, and are entitled to health care and medication subsidies. Depending on income, may be entitled to social assistance.
• Unemployed people may receive subsidies for labour market activities, may be entitled to social assistance and are entitled to health care and medication subsidies.
• Parental leave may be taken by mothers and fathers of young children.
• Old age pensioners are entitled to claim some form of old age pension, receive subsidies for medicine and health care, and may receive subsidies for old age care.
• Emigrants are people who have at some stage lived in Sweden but no longer do. They are modelled because people who have worked in Sweden retain pension entitlements even when they emigrate (Flood, et al. 2005).

All modelled individuals are required to pay real estate tax, capital income tax and wealth tax if they have sufficient assets. (Flood 2007)

3.2 DYNASIM (USA)

The USA’s social security/taxation system

Workers in the USA are required to hold a social security number when they enter employment. Payroll tax, taken partly from the employer and partly from the employee, is payable as a percentage of earnings and transferred to the Social Security Trust Fund (SSTF), which is maintained by the US Treasury. When revenues into the SSTF exceed payouts, the surplus can only be invested in US government bonds.

‘Social security’ in the United States refers to the government programs that provide income support for elderly, long-term disabled and widowed persons. The name of this program is Old Age, Survivors, and Disability Insurance (OASDI). The OASDI contribution rate for wages paid in 2009 was 6.2 percent for employees and employers.

OASDI pensions can be claimed from Social Security from 62 years of age. However a reduced rate is paid if claimed before age 67. Additional credits can be claimed if persons keep working and not claim a pension until age 70. To be eligible for OASDI, a worker must have spent at least 40 three-month periods in employment over their lifetime. The entitlement amount depends on the length and volume of lifetime contributions to Social Security, and any current earnings. If a person dies, their surviving spouse is entitled to a proportion of their social security benefit (Jousten 2001).
A person is entitled to Social Security Disability Insurance (SSDI) payments if they have worked for the last 5 out of 10 years, they are under 65, and they have a physical or mental condition that prevents them from working for at least 12 months or will result in death.

In addition to OASDI a worker may contribute to a private or employer pension plan. Many such plans have tax advantages, such as deferral of the tax on earnings of the pension plan until retirement. This allows employees to plan for a wealthier retirement than would otherwise be possible with OASDI.

The USA has a federal-state program of unemployment insurance paid for by state and federal payroll taxes. These taxes are paid into a fund kept separate from general revenue. A worker who becomes unemployed through no fault of their own, for example made redundant, may apply for unemployment benefits. The amount they are entitled to depends on their quarterly earnings. Unemployment benefits may be claimed for up to 26 weeks (United States Department of Labor 2009). There is no ‘unemployed’ assistance for individuals whose unemployment benefits have expired.

Another payment called Supplemental Security Income (SSI) may be paid to those aged over 65 or the disabled. This is quite different from the main social security system as it is based on need: one’s entitlements are not affected by lifetime contributions to social security. In addition to this, households whose wealth and income fall below certain levels, essentially those living below the poverty line, are entitled to food stamps4. Public housing or rental vouchers for private housing may also be made available (Jousten 2001).

How DYNASIM models social security/taxation

DYNASIM is divided into three sectors - a demographic sector, an economic sector and a taxes and benefits sector. Take-up of OASDI and private pensions are modelled as part of the economic sector. Pension, old age, survivor, disability and Supplemental Security Income benefits are modelled as part of the taxes and benefits sector, as are personal saving accounts and payroll taxes to fund OASDI programs and health insurance taxes.

DYNASIM models private pensions, the OASDI program, Supplemental Security Income benefits, mandatory personal savings accounts and payroll taxes. Income and company taxes are not modelled, nor are medical insurance programs and benefits. The old age, survivor and disability insurance schemes were modelled

4 Food stamps are issued by the government to persons with low incomes and can be redeemed for food at stores.

**Old age and survivor insurance (OASI)**

DYNASIM uses discrete-time hazard models to determine take-up or benefit claim of OASI pensions. Individuals face this hazard model from age 62 until they turn 70 or start to claim OASI, whichever comes first. Explanatory variables in the take-up model are spousal characteristics and certain social security policies which are known to influence benefit take-up.

When a person reaches take-up age, DYNASIM first checks that the individual is insured with social security. Then it calculates a primary insurance amount, adjusts this amount based on age and makes sure earnings are low enough to entitle a person to a pension (Favrealt and Smith 2004).

**Disability insurance**

Very few people who are entitled to disability insurance leave it for reasons other than death; so in DYNASIM, once a person is disabled and claiming disability insurance, they remain on it. Clearly the prerequisite for claiming disability insurance is to become disabled. Since DYNASIM3 has no disability/health module, the explanatory variables are those generally used to predict likelihood of becoming disabled, namely age, education levels, lifetime earnings, marital status, race and country of birth.

### 3.3 DYNACAN (Canada)

Canada is described as having a ‘three pillar’ retirement system. The three pillars are:

1. the Old Age Security Program (the OAS);
2. the Canada Pension Plan (CPP) and Quebec Pension Plan (QPP); and
3. Registered Pension Plans and Registered Retirement Pension Plans.

The OAS provides a basic flat rate, means-tested pension and means-tested benefits to Canadians aged 65 or over. The entitlement is dependent on the person having lived in Canada for at least 40 years after turning 18; those who do not meet this requirement can claim a partial pension. It is financed out of general revenue and is in that sense similar to Australia’s public pension (Hoffman and Dahlby 2001).

The CPP and QPP are compulsory pension schemes. They are funded by a payroll tax on employers, employees and the self-employed. CPP payments are paid as
retirement benefits, disability benefits, survivor benefits and death benefits. Retirement benefits can be claimed from age 60, though a penalty applies if one claims a pension before age 65. A person’s entitlement is dependent on their recent earnings and the amount they have contributed throughout their working life. Individuals who are prevented from working by a physical or mental disability can claim a disability pension prior to age 65, which consists of a flat rate plus 75 percent of the pension they would have been entitled to had they been over 65 when they became disabled. Additional disability benefits are payable if the individual has children under 18, or under 25 and in full-time study. When the contributor dies, there is lump sum payment to the estate of the deceased.

*How DYNACAN models social security/taxation*

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 CPP. It was a derivative of the CORSIM model from the United States, created at Cornell University.

DYNACAN is a discrete-time, open, probabilistic full cross-section model of the Canadian population. The 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). Basic units of the model are individuals and families. It simulates the population from 1971 to 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.

Because DYNACAN’s original purpose was to model the sustainability of the CPP, it does not calculate income, sales or company taxes, nor does it model unemployment, disability or family-related social security payments. Likewise, OAS and private...
pensions are not modelled, although there are plans to incorporate private retirement savings into DYNACAN in the future.

DYNACAN-C, the module primarily involved in calculating CPP entitlements and benefits, is run once a year after changes to population characteristics have been completed in DYNACAN-A and DYNACAN-B. It does this using several stages:

- First, it identifies all the individuals within its sample who are required to make CPP contributions on their earnings in certain years, and all individuals who are entitled to receive CPP payments in certain years.
- Secondly, it calculates the size of contributions and payments that must be made. These calculations are based as closely as possible on the calculations made by the Income Security Programs Branch in administering actual CPP benefits.
- Finally, it consolidates all this data into a user-relevant form, that is, it calculates the total contributions and benefits to individuals based on age, sex and so forth. It also discards irrelevant information; for example contributions data for individuals who were only in the system briefly (Morrison and Dussault 2000).

DYNACAN is in the process of being updated to include modelling of private pensions (Morrison 2007).

3.4 SAGE (UK)

The UK’s pension system is funded by mandatory National Insurance contributions (NICs) paid by individuals and employees based on a formula applied to the individual’s earnings. The rate is currently 11 percent for middle income earners.

Pension payments in the UK are based on two levels. The first is the basic pension, which provides a flat rate subsistence level of income for those in retirement (over 65 for men or over 60 for women, to be gradually equalised by 2020.) To be eligible for the basic pension, one must have worked for 90 percent of one’s working life (44 years for men and 39 years for women) but credits can be granted for time spent out of work due to disability, illness or unemployment. In addition to this, in 1978 the State Earnings-Related Pension Scheme (SERPS) was introduced. This scheme pays a pension of a certain percentage of earnings over a period of the individual’s working life. This scheme had an ‘opt-out’ clause, which allowed individuals to escape the additional NIC payments required if they joined an occupational or self-funded pension scheme (Emmerson and Johnson 2001).

In addition to the pension, means-tested income support, housing benefits and council tax benefits are available.
How SAGE models social security and taxation

SAGE does not model taxation (Scott, et al. 2003). It models NICs, based on data from the Family and Working Lives Survey (FWLS) to create a set of variables that indicated the accumulation of pension entitlements at SAGE’s start date.

3.5 STINMOD (Australia)

STINMOD (Static Incomes Model) is a static, rather than a dynamic, microsimulation model. It was developed by NATSEM to simulate the impact of changes in Australia’s tax and transfer (that is, social security) system. The first version was released in 1994 and since then has been updated regularly to take into account the major changes in tax and welfare systems in Australia (Lloyd 2007).

STINMOD has been used to estimate the effective marginal tax rates experienced by single mothers (Harding et al. 2006a), couple families (Payne et al. 2007) and the impact of wage rises (Harding et al. 2006b). It has also been used with other models to simulate returns from a university education, the impact of indirect taxes, paid maternity leave and the regional impact of the tax and transfer system.

It is available with a user-friendly interface upon payment of a licence fee, and is regularly used by Australian government departments to assess the impact of policy changes that affect social security and taxation.

How STINMOD models social security and taxation

Rather than simulating the gradual changes in an individual’s situation over decades, it measures the change in the circumstances of households, individuals and families over a single unit of time, due to changes in the tax and transfer payment system.

STINMOD has two major components. The first component is a series of modules or equations that applies the rules of Australia’s tax and transfer system to individuals, families and households. These can be quite complex, as most taxes are applied to an individual’s circumstances while transfers are generally assessed based on family circumstances. These modules are updated regularly to take into account changes in the tax and transfer systems.

The second component is the basefile. This is a dataset of individuals and families derived from the Survey of Income and Housing (SIH) and the Household Expenditure Survey (HES), to make up a representative sample of the Australian population. This dataset is divided into income units (an income unit is an individual
or a group of individuals who are assumed to share income, for example couples with each other or parents with their children.) Each record in the basefile contains a wide range of demographic and economic indicators about the income unit and the people within it, for example employment, earnings, age of children, child care usage, type and cost of residence, family members living away from home and receiving financial support, etc. The complete basefile contains around 20,000 income unit records.

Income units in the basefile are reweighted and private incomes are uprated from the year of the survey to the year under study. If required, basefiles are available for ‘outyears’; that is projected base data sets that have had populations reweighted based on population projections and earnings uprated. Outyears are available for up to five years in the future to estimate impacts of policy changes on future populations. A regional version of STINMOD, which can report the impacts of the tax-transfer system in different regional areas of Australia, is currently under development.

Although the basefile is designed to be representative of the population, a user may choose to examine the impact of a policy change on representative households, for example employed parents with two children or pensioner couples.

4 Conclusions and recommendations for APPSIM

Reviewing international DMSMs has provided some insight into general modelling techniques and data imputation issues. However the vastly different methods of providing for the unemployed, disabled and elderly in other countries limits the insight they can provide into how APPSIM should approach modelling social security and taxation.

As is noted in the previous section, NATSEM already has a model capable of simulating tax and transfer payments for a large number of households – STINMOD. NATSEM has maintained STINMOD for over a decade and will continue to maintain and update it in the future. Rather than duplicating effort and expending unnecessary resources in developing unique taxation and social security modules for APPSIM, it is proposed that STINMOD be used.

It is proposed that for each simulation cycle, APPSIM will use its own algorithms to simulate changes in demographics, household formation, education, labour force, earnings, housing, wealth, and other income and expenditure. Then STINMOD will be used to estimate tax payments and social security entitlements for the updated population.
To enable STINMOD to perform the social security and income taxation calculations will require the development an interface between APPSIM and STINMOD. It may also require APPSIM users to obtain STINMOD license. Despite these possible obstacles, the reduction in costs of updating and maintaining two sets of very complex code makes recommending the linking of the two models a clear choice as the best long term solution.
References


Centrelink 2009a, Retirement Payment Rates Factsheet, Department of Families, Housing, Community Services and Indigenous Affairs, Canberra, 27 January 2009.


