Session Number: 8B
Session Title: Issues in Income Distribution Contributed Papers
Paper Number: 2.1
Session Organiser: Edward Wolff

Paper Prepared for the 26th General Conference of
The International Association for Research in Income and Wealth
Cracow, Poland, 27 August to 2 September 2000

MODELLING THE IMPACT OF HOUSING VALUES ON THE WEALTH OF AUSTRALIANS

Simon Kelly
National Centre for Social and Economic Modelling
University of Canberra, Australia

For additional information please contact:

Simon Kelly
NATSEM
University of Canberra
CANBERRA ACT 2601

e-mail: simonk@natsem.canberra.edu.au
fax : 61-2-6201-2751
ph : 61-2-6201-2784

This paper is available on the following websites:

www.stat.gov.pl
www.econ.nyu.edu/dept/iariw
www.natsem.canberra.edu.au

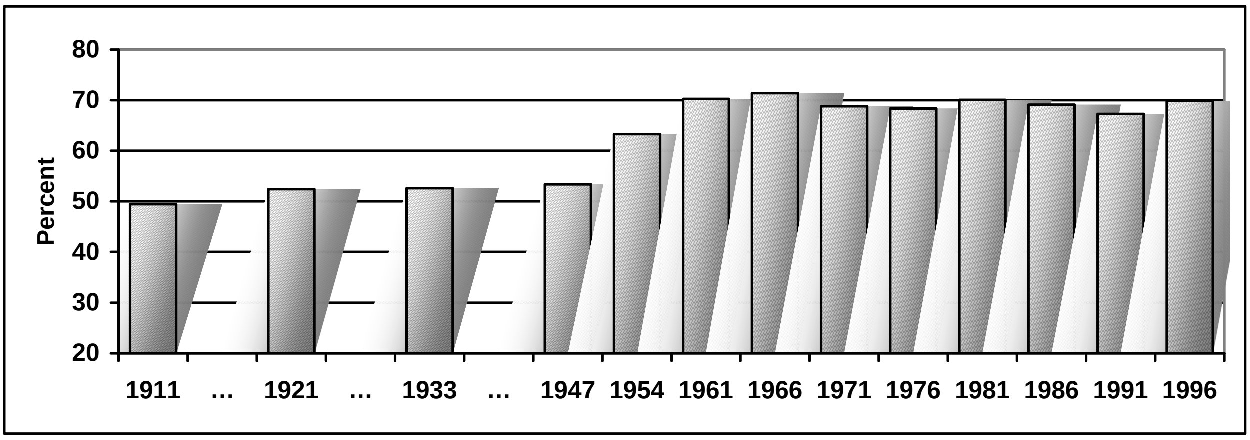
Modelling the Impact of Housing Values on the Wealth of Australians

Simon Kelly
National Centre for Social and Economic Modelling
University of Canberra, Australia

1. Introduction

The 1997 film "The Castle" was extremely popular in Australia. The film depicted the plight of a lower socio-economic Australian family ("the Kerrigans") fighting to retain ownership of their very modest "castle". One of the reasons for the success of the film was that it used the long-established belief that a home is an integral element of every family. Home ownership is the great Australian dream and research has found that the vast majority, nearly 90 percent, of Australian households become home owners at some stage of their lives (Neutze & Kendig, 1989).

Figure 1 Home Owner/Purchaser Ratio, 1911-1996



Source: Bourassa et al (1995), Table 1 and ABS, 1999

What impact has this desire to own their own home had on wealth creation? Has the desire accelerated or adversely impacted on the accumulation of personal wealth? Will the younger generations accumulate housing wealth at a different rate to their parents? To answer these questions we need to look at lifetime wealth accumulation. A method of doing this is using dynamic microsimulation. A paper outlining one approach to such a development was presented at the 24th General Conference of IARIW in 1996 (Bækgaard and King).

In this technical paper, I discuss modelling done at the National Centre for Social and Economic Modelling (NATSEM) on the development of a wealth module since the Bækgaard and King paper. Specifically, the paper reports on the methods used to model the purchase decision, housing purchase prices and the changes in family wealth that accrue from the decision.

2. WEALTH MODELLING

Before discussing the method used to model wealth in DYNAMOD, I provide a general overview of DYNAMOD and briefly summarise the methods used by other researchers to model housing wealth. A more complete coverage of DYNAMOD is available in a number of NATSEM technical papers (such as King, Bækgaard, and Robinson, 1999a and 1999b). These papers are available from the NATSEM website (www.natsem.canberra.edu.au).

DYNAMOD

DYNAMOD is a dynamic microsimulation model of the Australian population. The model is able to project the Australian population up to 50 years ahead. It does this by starting in 1986 with a one percent sample of the Australian population and simulating events that will occur in their lives - births, deaths, migration, education, leaving home, forming couples, divorcing, being employed, earning money, accumulating wealth, becoming disabled and recovering from a disability.

DYNAMOD-3.3 is the current version. It runs on a PC, contains around 40 modules, and is written in the programming language C. The major changes from DYNAMOD-2 are (i) it runs on a PC rather than a Unix-based machine; (ii) incremental improvements to the education and labour force modules; and (iii) the addition of the wealth module. A fuller description of DYNAMOD can be found in King, Bækgaard, and Robinson (1999b).

The simulation uses two methods to replicate events that happen during people's lives. The first is through the use of a clock that steps through time in increments of one month. At the start of each month, 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'). The chance that a person makes the transition varies with their circumstances at that time. In the case of a transition from employment to unemployment the circumstances that are considered are 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. All of these factors have been found to influence the transition and they are examined for every person every month.

The application of these factors is done through the use of a regression equation which applies weightings to each of these circumstances based on historical data. This method is used extensively by DYNAMOD-3.3 to simulate changes in relation to the labour force, education and wealth.

The second method used to simulate an event in a person's life is through survival functions. With this method, rather than do a calculation for every person every month, the calculation is only done when trigger events take place. When this trigger event occurs, a calculation is made of when a subsequent event will occur. For example, when a birth occurs (a trigger event), the date of death is decided (the subsequent event). The advantage of this method is that calculations only have to be made a few times rather than every month (as an example, date of death is only calculated once or twice in a person's live - at birth, if a person becomes disabled, or if a person recovers from a disability - rather than 12 times per year). The disadvantage of the survival function method is that durations of being in a given state are required and only limited amounts of data are available in this form. DYNAMOD uses survival functions to model most demographic occurrences.

The simulation uses Australian Bureau of Statistics data from the July 1986 Census as its main source of starting data. This one percent sample is representative of the entire Australian population. Onto this starting data a variety of other characteristics are imputed to give a "basedata" of 150,000 people with some 80 characteristics held on each person.

Housing Methodologies

The modelling of housing wealth can be divided into two quite separate elements. The first is the decision to purchase a home. This decision model needs to examine and balance the various factors that influence the decision to buy a house.   The second element of the housing wealth modelling is the attribution of a value (and mortgage) to the decision to purchase a home.

In the next few paragraphs, the approaches taken by various researchers to handle these two elements of the housing wealth model are presented.

Kendig

Kendig studied the Adelaide housing market by surveying 697 people who moved during 1976/77. He found that the selection of tenure did not lie in different preferences for home ownership. The preference for ownership by the movers ranged between 80 and 90 percent irrespective of life cycle stage or current tenure. Using automatic interaction detection (AID) techniques, Kendig found that constraints of limited income and savings were more important determinants than life cycle stage or age. He suggests that wealth is the most important variable, then family income. After the assets and income criteria had been meet then the influence of life cycle factors became important. Those married and in the child bearing years were particularly likely to buy if they had the means. Kendig found that age of the family head had no effect on tenure choice after economic means and life cycle stage were considered.

The analysis by Kendig highlighted the one of the rewards of ownership. After living in a previous dwelling for seven years (on average), the profit on the sale of the previous dwelling provided 80% of an average home. The 80% was composed of 24% original deposit, 11% to repayments, 57% to appreciation.

In summary, Kendig found that almost all surveyed held the Australian dream to own a home and it was only the lack of income and/or wealth that prevented them from currently achieving the dream.

Bourassa

Steven Bourassa (1995) developed a model of the house purchase decision. He notes that typically tenure decisions are modelled as a function of household income, the relative costs of owning and renting and demographic variables such as age and household size. Using 1991 ABS Housing and Location Choice Survey data for Sydney and Melbourne, he developed a model based on the costs of owning (called "user costs") for Australia. *User costs* attempt to capture the taxation benefits of ownership in addition to the ratio of prices to annual rent. The variables in his user costs model are:

- household's "permanent" tenure choice tax rate
- the loan-to-value ratio
- interest rates
- expected rate of house price inflation
- the rate of depreciation and maintenance costs
- property tax rate

A model of tenure choice was developed and the inclusion of user costs was found to significantly improve the goodness-of-fit. Transitional income, but not permanent income as in most US studies, was found to have a positive and significant impact on the probability of ownership. The model also uncovered the observation that widows have a higher probability of ownership than never married or divorced. This is often overlooked when marital status is simply divided into married and single. No significant difference was found between immigrants and Australian born populations.

CORSIM

CORSIM is a descendent of the first dynamic simulation model, DYNASIM, and has been in development since 1986. It is now at version 3.0. The CORSIM wealth module uses 28 equations to forecast the ownership (yes or no) and value of 14 types of assets and debts. Value of the family home and home mortgage are two of the 14. The variables used in the regression equations are the same for both predicting whether a family will decide to purchase a house and value of the house. They are:

- race of the head (white/non–white)
- age
- number of children living at home
- marital status
- current tenure
- income of the family
- level of education

Three levels of alignment (macro, meso, and micro) are then performed on the data to ensure that it aligns with historical information.

Badcock

Blair Badcock (1994) analysed housing data on eight Adelaide suburbs and found

- the location and timing of the purchase in relation to the property cycle had a powerful effect on housing prices
- 8.8% had moved in 1988/89 to release some equity upon retirement
- 21% were forced to sell their home in 1988/89 to restructure mortgages, refinance assets and business ventures or settle a divorce.

Longley

In a study of owner occupiers in the United Kingdom, Paul Longley et al (1991) developed a microsimulation model to quantify gains accruing to each household over a ten year forecasting period. The microsimulation was based on two premises:

- Key dwelling attributes (location, dwelling condition, dwelling type, price at purchase) control the gain to be obtained.
- Residential mobility households are able to anticipate gains.

It used three types of calculations:

- Baseline data consisting of mortgage term, current house value, asset accumulation (current – original purchase price), amount of mortgage outstanding
- An annual household and dwelling profile (age of head, household income – incremented by regional wage, house value - incremented by regional housing inflation, mortgage repayments, mortgage outstanding, asset accumulation, mortgage tax relief)

- Residential mobility (household formation, mobility of existing households into owner occupation, mobility of households already in owner occupation, and dissolution of owner occupied households.

The initial model was limited to only those already in owner occupied housing.

King and Bækgaard
Using the 1986 ABS Income Distribution Survey, King and Bækgaard have calculated net equity in owner occupied housing. The data also showed a strong relationship between owner-occupied housing wealth and age, however, data from the 1993/4 Household Expenditure Survey suggested a shift in the age profile.

While identifying the age relationship, they also noted considerable variation housing wealth within age cohorts. Within an age cohort there were those with zero housing wealth (renters), those with almost nothing (just purchased with small deposit) through to those with significant wealth in housing.

Summary of the Approaches
There are two parts to modelling housing wealth – the ownership decision and the value to assign to the house after the decision is made to purchase. In regard to the decision, Kendig almost goes as far as to say that everyone wants to purchase a home, it is only income and deposit that form a barrier to people moving to this most desirous of states. This would imply that a model of income and deposit is all that is required. Bourassa's model is probably at the other end of the spectrum. It assumes that the decision is based on a considerable number of economic details and forecasts such as taxation benefits, interest rates, expected house price inflation, etc.. The other models from Australia and overseas fall somewhere in between. The value that is attributed to the purchase is normally modelled as a function of age, income and assets.

In the NATSEM model described in the next section, the housing decision is based on a larger number of variables than just income and deposit but less than those suggested by Bourassa. While price is a function of more than ten variables so it is considerably more sophisticated than has been done before.

3. Development of the DYNAMOD Housing Wealth Module

Dynamic microsimulation of housing wealth consists of three clear parts. Firstly, there is the housing decision i.e. whether to purchase a home or not. This decision triggers the second part – paying for the house. The second part changes the wealth characteristics of the person (for example, the purchase of a house will reduce the cash holdings, increase the value of housing component and probably increase the housing loan liability). The third part of the simulation is the continual updating of these parts over time. Each of these parts is discussed in detail below.

The methodology used in the DYNAMOD wealth module differs significantly between the starting population and those that decide to buy a house during these the simulation. For the first group, the starting population, there is no housing decision required, the current tenure is known and only a 'one-time' housing value and loan need to be imputed. For those who buy a house during the simulation, the decision of whether to transition from renter to purchaser needs to be modelled in addition to calculation of the purchase price of the house and the amount of any loan. These methodologies are quite different and are discussed separately.

Starting Values

The starting population for DYNAMOD is a one percent sample of the Australian population taken from the 1986 ABS Population Census. Onto the starting population a large number of extra attributes have been imputed to create the simulation starting population – the "basedata" (this is covered in detail in King, Bækgaard and Robinson, 1999a). The 1986 Census sample file contains two attributes which up until now have not be used in the basedata. These are a tenure attribute and an indicator of location. The tenure attribute indicates one of six tenure states – home owner, home buyer, renter, other, not stated and not applicable. The location field notes whether the dwelling location was in major urban, other urban or rural/migratory. As part of the development of the wealth module, version 4 of the basedata has been developed which imports both the Census tenure information and the dwelling location indicator.

In DYNAMOD housing wealth is assumed to be a family asset. The value of the house and the mortgage are considered to belong to the entire family rather than to a particular family member. For this reason, the housing attributes are only recorded once for each family. For convenience this is the family reference person. This person was selected as they are always present, even when the family consists of only one person. This is not true for other members of the family.

Information from the 1986 ABS Income Distribution Survey (IDS86) was imputed onto the basedata. IDS86 is a smaller sample of the Australian population (it covers one-sixth of one percent of the Australian population aged 15 and over) but it provides more detailed information on income and assets than the Census. In particular, IDS86 has estimates of the current value of the house and current related mortgages.

There is no direct link between IDS86 and Census 86 to allow the transfer of this housing value and related mortgages. For this reason, the IDS86 housing value and mortgage data needed to be imputed onto the 1986 Census data. This matching was done on the basis of tenure, state, age, marital status and income. Tenure, as noted above, was available on both files. State was available on the IDS file (with ACT and NT combined) and had already been imputed onto the 1986 Census data (King, Bækgaard and Robinson, 1999a). Indicators of age were also available on both files and were used to assign one of seven age groups for matching purposes. The groups were <25, 25-29, 30-34, 35-44, 45-54, 55-64, 65+. Marital status was matched using three groups – never married, married and separated/divorced/widowed. This division partially handles the issue noted by Steven Bourassa (1995) that widows respond differently to those who have never married or divorced. The IDS86 data does not allow the complete separation of the widowed from the divorced.

The imputation of housing values and loans was done as part of a larger imputation of personal asset wealth information. For this reason, the matching of data was done for those with a tenure of "renting" and "other" in addition to those with tenure of "owner" or "buying". Only the first two groups – owners and buyers – are discussed in the remainder of this paper. The matching of the data was done by initially dividing the data into four groups based on tenure and then into 147 cells based on state, age group and marital status (7x7x3=147). The original incomes in the 1986 Census and in IDS86 had been censored to zero and above. For the simulation basedata, the incomes had been recalculated to include negative incomes – a more accurate representation (Bækgaard, 2000). This change to the basedata made matching incomes impossible and ranking of incomes was used in its place. Within each cell, people were ranked based on income and then the housing and mortgage information was linked.

Despite having 5,650 valid observations on the IDS86 data file in regard to the two tenure types "Owner" and "Buyer", the fine level of detail used to impute housing values resulted in a number of IDS cells containing zero values. A remapping of these zero cells was undertaken before the matching took place. In general the basedata cells that corresponded with a zero cell were moved to a cell with similar characteristics and housing values in another state of Australia.

Each observation on the basedata file represents 103 Australians while the weighting on the IDS86 data file varies. The different weightings were taken into consideration during the matching of basedata observations with IDS86 observations.

In the tables below average housing valuations for each state and age group are presented. Table 1 contains the housing value after imputation into the basedata.

Table 1 1986 Imputed Basedata Housing Prices ($) (Mean)

Age Group	NSW	Vic	Qld	SA	WA	Tas	NT	ACT	Australia
<25	85,128	62,118	77,180	80,292	45,048	67,852	77,750	65,908	72,839
25-29	71,611	83,238	59,303	76,473	64,628	69,948	80,768	75,891	72,301
30-34	93,352	86,941	90,597	83,389	70,816	54,161	100,661	86,819	87,203
35-44	115,273	106,930	90,829	88,028	84,975	59,478	111,574	112,589	102,396
45-54	123,794	102,040	87,705	95,108	81,934	62,606	102,961	102,951	103,830
55-64	103,843	101,342	82,197	111,078	94,256	64,267	126,346	107,690	98,611
65+	83,112	85,157	73,402	103,319	78,477	60,474	87,990	80,274	83,086
All Ages	101,523	95,332	82,466	95,616	80,341	61,685	103,338	98,064	93,285

The information in the table above is presented in graphical form below in Figure 2 and Figure 3. Figure 2 shows the overall alignment that was achieved on a state basis while Figure 3 shows the alignment by age groups. The only significant discrepancy appears to be in the *Under 25* age group. Given that there were only 11 observations on IDS86 for this age group, the inaccuracy is not unexpected. With this low number of observations, considerable remapping of the base population was required and clearly this led to a reduction in the accuracy of the alignment. The *Under 25* group is the smallest of the age groups and represents only 2.6% of the home owner/buyer population. The misalignment is not expected to have a significant impact on the overall model.

Figure 2 Mean Housing Values by State, June 1986

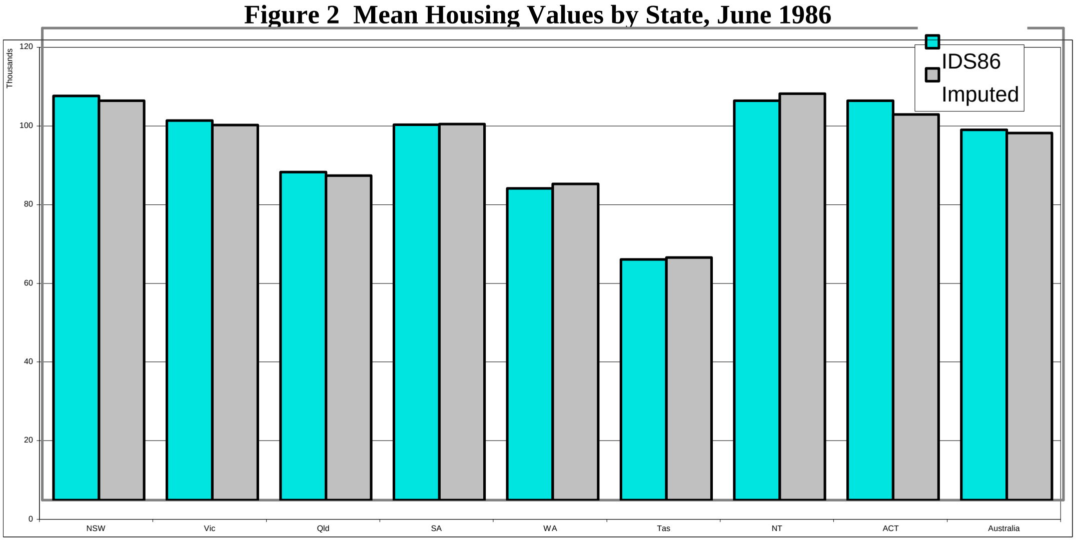
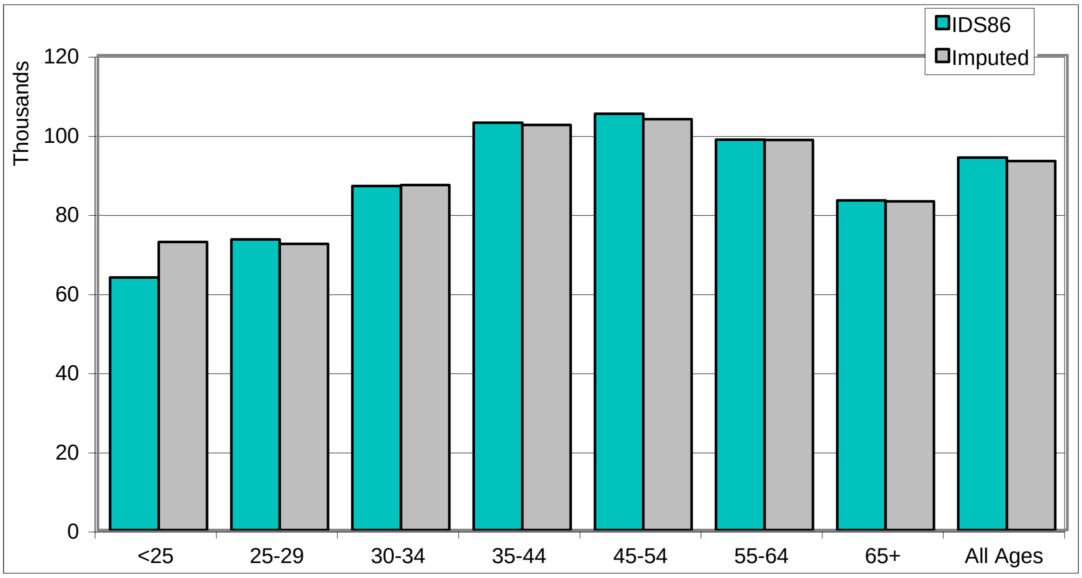


Figure 3 Mean Housing Values by Age Group, June 1986



The overall outcome of the imputation in regard to housing values and loans is shown in Table 2 below.

Table 2 Imputed Housing Numbers, Values and Mortgages, 1986

Tenure	Age Group	Married	Sep/Div/Wid	Single	Total No.	Value	Loan
Owner	<25	7,519	4,944	34,917	47,380	$88,523	$0
	25-29	31,106	7,313	15,553	53,972	$73,373	$0
	30-34	61,285	14,420	9,373	85,078	$105,776	$0
	35-44	232,471	48,204	16,068	296,743	$109,415	$0
	45-54	302,305	61,903	16,480	380,688	$107,629	$0
	55-64	383,160	118,656	31,106	532,922	$100,243	$0
	65+	372,345	308,794	41,303	722,442	$83,543	$0
Buyer	<25	38,316	8,755	35,226	82,297	$64,752	$39,597
	25-29	172,834	26,059	34,093	232,986	$72,052	$35,333
	30-34	239,578	36,977	24,823	301,378	$81,960	$31,235
	35-44	481,628	83,121	27,398	592,147	$98,879	$26,878
	45-54	232,986	51,397	6,386	290,769	$98,856	$20,006
	55-64	112,991	36,050	3,090	152,131	$92,895	$13,529
	65+	43,054	27,604	1,957	72,615	$78,542	$7,225
		2,711,578	834,197	297,773	3,843,548	$93,285	$11,743

Based on tenure, state, age, marital status and income ranking, housing values and mortgages have been imputed onto the basedata. This data along with all of the other characteristics of those in the basedata is available at the start of the simulation.

The Home Purchase Decision

The preceding topic provided the starting population of DYNAMOD, the basedata, with appropriate housing value and housing loan information. Now the method used to model the housing decision made by non-homeowners during the simulation is presented. The next part of this section determines the price paid for the home.

The method used to model the housing decision is a logistic regression equation (a *logit* equation). This method makes use of standard regression equation techniques but uses the knowledge that the dependant variable has only two values (to either buy a house [1] or not buy a house[0]). With a normal regression equation, there is no guarantee that the answer obtained will be between 0 and 1, the use of a logistic curve ensures that the answer will be on this interval. The output from the *logit* equation can then be compared with a random number to decide if a house is to be purchased.

The ABS 1997-98 Survey of Income and Housing Costs Australia (SIHC97) was used as the basis for development of a *logit* model of the decision to become an owner-occupier. Additional information in regard to values for deposits and equities were calculated using a capitalisation technique. SIHC97 was selected as the source file as it has two useful variables-*Year of Purchase* and *First House*-included. These two variables were used to derive the decision variable. If a family has purchased a home in the last year and it is their first house then they were considered to have decided to transition from a renter to a home purchaser. They were coded with *home* = 1, while all other home owners were removed from consideration and a random selection of renters coded with *home* = 0. This provided 768 observations - 233 for first time homeowners and 535 renters. This represented weighted populations of 252,173 buyers and 593,332 renters.

The independent variables tested for possible inclusion in the model were sex, age, marital status, family composition, employment status (employed, unemployed, not in the labour force), whether studying, occupation, educational qualifications, resident state of Australia, country of birth, income, cash deposits, equities, residential investment properties, business assets, location (city or rural), number of dependent children, and whether a new parent (one child under three years). A particular advantage of the SIHC97 file is that in addition to current income and interest earned, it also contains the previous financial year's income and interest earned. This previous year's information was used as a proxy to the circumstances of the person at the time of the decision to purchase a home.

The *logit* equation found to give the most acceptable results was one which used only some of these variables. The impact of age was found to be non-linear. This agrees with the observations of other researchers that housing is not important in the early adult years, becomes more important in their middle years and then deceases in the latter years. Dummy variables for various age groups were used to model this non-linear relationship. Income and size of deposit (in both cash and shares) were significant in the decision but the value of investment real estate and business assets were not found to be significant. Marital status and the number of children were found to be significant. This was not unexpected given previous research noting the relationship. The compound dummy variable *dink* (an abbreviation of Double Income No Kids) is used to represent a couple with no children. The other variables found to be significant were location variables – both an dwelling location indicator and residential state indicator. The states and cities where the cost of housing were high had a negative impact on homeowners. The final characteristic that was found to be significant was the occupation of the reference person. Here professionals and managers were less inclined to become homeowners, while tradespeople were more likely that the average to buy. Managers were the least likely to become home buyers with only a 37 percent ($e^{-0.9835}$) chance of becoming a home buyer compared with other occupations. Professionals had a 85 percent chance while tradespeople had a 173 percent chance compared with other occupations and all other significant characteristics being equal. The significant characteristics that influenced home ownership are presented in Table 3.

Table 3 Housing Decision Logit Equation

Parameter	Estimate	Std Error	Chi Squared	Pr > Chi Sq
Intercept	-1.9351	0.0129	22498.42	<.0001
Inc	0.0068	0.0001	3744.09	<.0001
Dep	0.0123	0.0001	32717.89	<.0001
Equit	-0.0006	0.0001	24.13	<.0001
Sex	-0.0435	0.0084	26.83	<.0001
City	-0.0607	0.0068	79.13	<.0001
bornasia	0.4629	0.0106	1889.10	<.0001
married	1.6420	0.0120	18694.60	<.0001
Dink	0.0844	0.0122	47.81	<.0001
Nrkids	-0.2381	0.0050	2254.46	<.0001
ageu20	-2.2596	0.0512	1947.86	<.0001
age2024	0.4394	0.0113	1506.10	<.0001
age2529	0.8610	0.0105	6763.83	<.0001
age3034	1.0004	0.0113	7868.34	<.0001
age3544	0.2379	0.0109	471.96	<.0001
age5564	-1.2460	0.0249	2494.13	<.0001
Lfempft	0.3694	0.0080	2117.41	<.0001
xocman	-0.9835	0.0180	2973.75	<.0001
Xocpro	-0.1610	0.0084	370.99	<.0001
Xoctra	0.5523	0.0086	4090.58	<.0001
Resnsw	-1.1892	0.0102	13545.82	<.0001
Resqld	-1.0114	0.0113	8067.93	<.0001
Resvic	-0.5505	0.0106	2682.38	<.0001
Restas	-0.6471	0.0216	898.21	<.0001
Reswa	-0.3586	0.0121	873.04	<.0001

The Home Purchase Price

The previous part of this section modelled the decision of families to purchase a home and in this section the process is completed by determining the price that will be paid for the home. Initially it was hoped that only two characteristics would be needed to model the price paid - *State* and *Location Indicator* (Capital City, Rest of State or N/A). Table 4 shows a breakdown of the average value of houses based on these two variables. The table is based on SIHC97 data.

Table 4 Housing Values By State, 1997/98

State	N/A	Capital City Avg Values (1997 $AU)	Rest of State Avg Values (1997 $AU)	Overall Avg Values (1997 $AU)	Rest of State Value as percentage of Capital City
NSW		290,793	141,598	231,815	48.7%
Victoria		176,649	113,322	158,532	64.2%
Queensland		180,003	158,674	167,793	88.2%
South Aust		136,092	107,997	128,129	79.4%
Western Aust		191,450	155,205	182,287	81.1%
Tasmania		128,258	108,220	116,393	84.4%
ACT + NT	177,119			177,119	
Australia	177,119	210,882	137,792	183,041	65.3%

The first model developed (which used a dummy variable for each state and an indicator for capital city location) was a rated a poor predictor of housing prices. The correlation using these variables was 18.4%.

A second model was developed which added new variables and changed others. The capital city location indicator was broken down into dummy variable for each state. Additional variables considered were income, cash deposit, marital status, occupation, qualifications and first home buyer. The result of the addition of some of these characteristics was a much stronger correlation (R^2 = 43.0%). The final regression equation consisted of those shown in Table 5.

Table 5 Housing Purchase Price Regression Equation

Variable	Estimate	Std Err	t Value	Pr > |t|	
Intercept	97.7025	9.0230	10.83	<.0001	
inc	0.6686	0.1150	5.81	<.0001	Family Income in 1997 $'000s
dep	0.2487	0.0556	4.47	<.0001	Cash deposit in 1997 $'000s
first	-41.0636	7.2211	-5.69	<.0001	1 if first home buyer
married	22.6182	7.8322	2.89	0.004	1 if marital status is married or defacto
xocman	43.7970	12.9477	3.38	0.0008	1 if employed as a manager
xocpro	26.4751	9.6637	2.74	0.0063	1 if employed as a professional
quni	16.4701	9.9633	1.65	0.0989	1 if ref person is degree/diploma qualified
resvic	-38.9841	15.0494	-2.59	0.0098	1 if resident of Victoria
reswa	35.2017	10.5072	3.35	0.0009	1 if resident of Western Australia
nswcity	119.3138	9.9950	11.94	<.0001	1 if resident of Sydney
viccity	62.0578	16.1401	3.84	0.0001	1 if resident of Melbourne
qldcity	27.9216	12.8415	2.17	0.0301	1 if resident of Brisbane

This equation gives the value of a house in thousands of 1997 Australian dollars.

Updating Values

The methodology for assigning of a home and a value to this home have been covered and now a method of updating that value is needed. The value needs to be updated annually, on immigration or emigration, on marriage, on divorce, on retirement and on death.

Annual

At the end of each financial year, the circumstances of each person are evaluated and all assets including housing are updated. The new value of either a family home or investment property is a function of its value last year and where in Australia the property is located. Each State of Australia is allocated an annual housing value growth rate and this rate (plus inflation) is applied to every house in that State. The growth rate varies for each year and State. Actual ABS data for the period 1987–1999 is used initially while future growth rates are a random number drawn from a normal distribution based on the mean and standard deviation for the period 1987-1999. These values are calculated after removing inflation from the data. This process gives the mean and standard deviation change in real terms rather than nominal terms. The values found are presented in Table 6.

Table 6 Average Real Growth in Housing Values 1986-1999

	Average Growth (after inflation)	Standard Deviation
Sydney	4.58%	11.20%
Melbourne	2.52%	10.21%
Brisbane	2.70%	7.75%
Adelaide	-1.11%	4.67%
Perth	2.76%	10.94%
Hobart	-0.37%	3.92%
Darwin	1.72%	9.12%
Canberra	0.23%	7.41%
Weighted Average of 8 Capital Cities	2.73%	8.38%

An assumption here is that the mean and standard deviation for the period 1987-99 will be representative of the future.

The repaying of mortgages on owner-occupied housing and investment rental properties is also modelled at the end of the financial year. If a mortgage exists, a family will try to use their savings to reduce this mortgage. The model assumes that 50% of any available cash savings will be used to reduce the home mortgage. In contrast to this, it is assumed that no attempt is made to reduce investment properties i.e. that the mortgage is an interest only loan. The reason for this is that interest on an investment loan is tax deductible under Australian laws while interest on a home loan is not deductible. This encourages people to reduce their home loan as quickly as possible but offers no incentive to reduce an investment loan.

Immigration
On immigration, family is assigned a certain wealth. At present all of this wealth is in the form of cash. There is no specific housing wealth assigned at this initial stage. At the first annual review, the family is assessed in the normal way and a decision to purchase some form of housing may result.

Emigration
At the time of emigration, any home or investment properties are sold. The value obtained for the properties are assumed to be their current value. No allowance is made for disposal costs. The wealth in this form (cash) is then removed from the simulation.

Marriage
When a couples marries, most of their assets are combined. If one of the couple already has a home then this home is moved to family reference person. If both own a home then the reference person's house becomes the family home and the spouse's house becomes an investment property. Mortgages are handled in the same manner.

Divorce
When a couple divorce, their assets are divided 50/50. This simplistic view results in everything being sold and then attributed back to each partner on an equitable basis.

Retirement
After retiring, a person is assumed to no longer be pursuing investments and hence a new home or investment home will not be purchased. However, any owner-occupied home or investment housing will be maintained and continue to change in value over time.

Death
Normally, when a person dies all of their assets and debts transfer to their spouse. This is the case with DYNAMOD. All assets are simply transferred and added to those already owned by the spouse. If the spouse does not exist then the family home and any investment properties are sold and debts are repaid. The residual cash or investments are then divided evenly between the children (if any exist). In the event that there is no spouse or children then the inheritance is given to the person's parents. Finally if none of the above exist, then the inheritance is given to a random person. This is very roughly designed to simulate the equivalent of a lottery win for that random person.

Summary

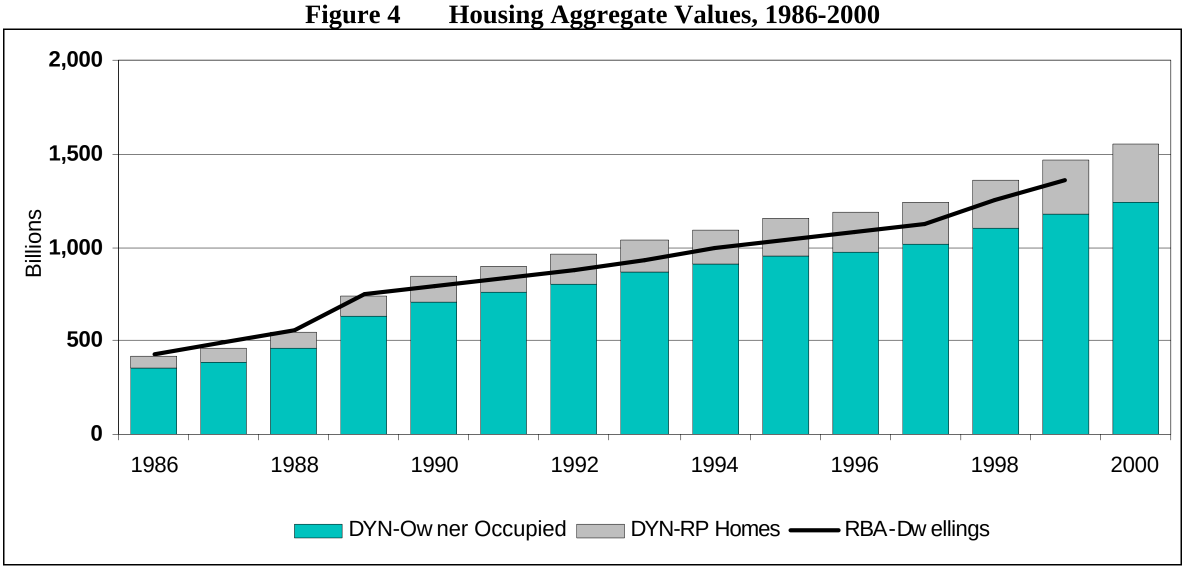
Home ownership and its associated housing value and mortgage are imputed onto the starting population of DYNAMOD. The imputation is done on the basis of tenure, residential state, age and income. The circumstances of the simulation population are then examined on an annual basis with regard to purchasing a home. The decision to purchase a home is based on income, cash deposits, equity portfolio, state of residence, sex, age, marital status, country of birth, employment status, occupation and the number of dependent children. The amount paid for the house is a function of income, cash deposits, whether it is a first home, marital status, occupation, residential state and location within the state. The sale or transfer of the house is only considered under specific circumstances. The circumstances include on marriage, divorce, death, and emigration. The value of housing assets are updated actual ABS state data or projected based on the mean growth in each state.

4. Model Alignment

Armed with the methodology to model the decision, value of the asset and grow it with time, the real test is whether the model aligns with the real world. The advantage of using 1986 data is that it allows more than ten years of predicted data to be compared with actual known outcomes. These comparisons can then be used for two purposes. Firstly, to refine or align the model's parameters and, secondly, to validate the alignment of the algorithms' results with those experienced in the real world.

For DYNAMOD a range of historical aggregate figures for 1986–1996 are available. Original data is available from the ABS and the Reserve Bank of Australia (RBA) while calculated data is presented King and Bækgaard (1996). In Figure 4 a comparison of RBA aggregate dwelling values (1986-1999) and DYNAMOD dwelling values for the period 1986–2000. There is a very close alignment between the RBA figures and the combined owner-occupied plus rental properties.

Figure 4 Housing Aggregate Values, 1986-2000



Similar results are found when the DYNAMOD data is compared with ABS data or with the calculated data. Overall, at the aggregate level, it appears the model is reflecting the actual values of housing.

5. *Current Limitations*

Interstate migration is not modelled in DYNAMOD at this stage. The model does assign a state of residence to each family and this state of residence is used in simulating housing wealth and events. However, there is no internal migration. This will impact on the results found for individual states but should not have a material impact on the overall results that have been presented here. In addition complete state by state alignment of the imputed state information has, as yet, not been undertaken. For both of these reasons, results are not given on a state by state basis.

The model does not allow home owners to upgrade at this stage. While they can reduce their mortgage, they cannot upgrade to a more expensive home. This will be revisited in a future version.

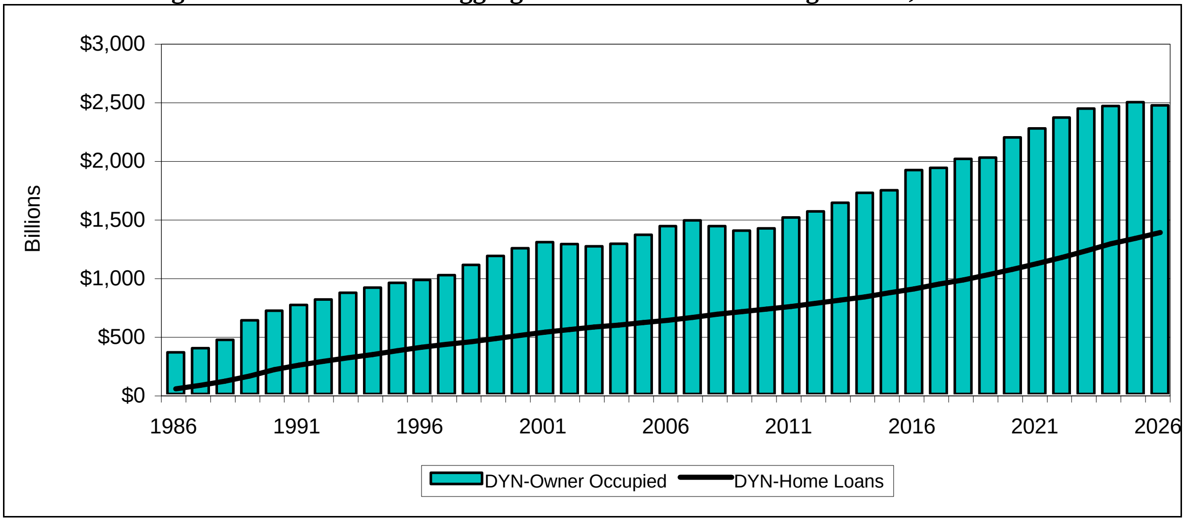
In DYNAMOD the mother's age on the birth of her first child is reasonably constant at 25.7 years old. In the near future this will be changed to more accurately reflect the increasing age of the first-time mothers. ABS data suggests the age has increased from 26.3 to 27.1 years over the period 1991 to 1996. This limitation of the current system impacts on the housing decision model variables. The family income is often reduced with the birth of a first child which has a negative impact on the chance of deciding to buy and the increased number of children in the family also reduces the chance of buying. However, if the birth results in marriage occurring then the chance of buying increases. It is difficult to judge the overall impact of the increasing mother's age at first birth will have, due to the complexity of the interaction within the model. The impact will vary considerably with the circumstances of each family and thus be different in almost every case.

6. *Results*

Total Housing Wealth

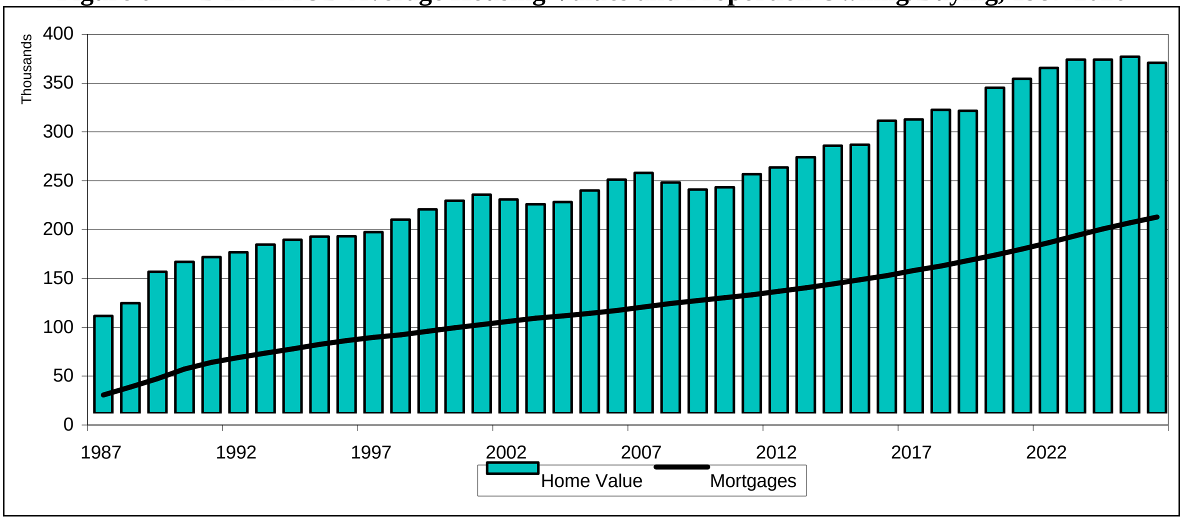
The alignment section shows that the DYNAMOD simulation appears to providing a reasonably good indication of the overall growth in the value of housing wealth. Figure 5 shows that growth for the forty years from 1986 – up until 2026. A noticeable feature of the graph is overall upward trend but the occasional downward movement due to unevenness in the growth rate. The columns in the figure represent total housing values and it can be seen that the aggregate value of owner-occupied housing grows from $354b by seven times to $2450b during the 40 years. In the same period the housing loans steadily increase from $43b to $1376b. This is the line in Figure 5. The overall result is although housing values have increased three fold, housing debt has also increased and the overall effect is a decline in the proportion of housing actually owned by families.

Figure 5 DYNAMOD Aggregate Home Owner Housing Wealth, 1986-2026



These same results can be seen in Figure 6 for the average owner occupier. The house increases in value from $100,000 to over $350,000 for the average Australian but the average loan increases from $11,500 to $200,000.

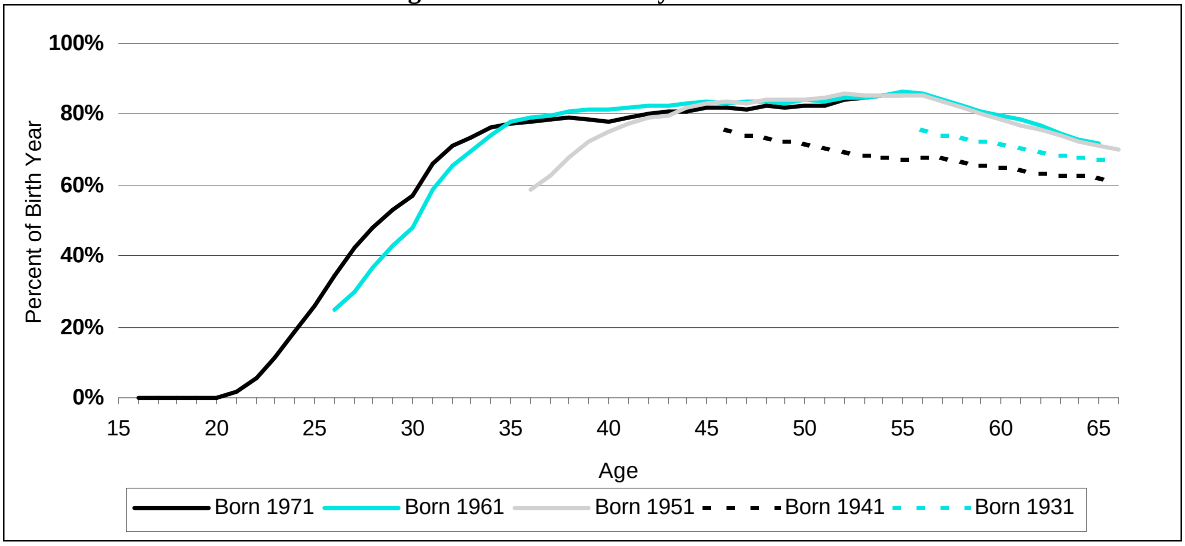
Figure 6 DYNAMOD Average Housing Values and Proportion Owning/Buying, 1987-2026



Age of Home Owners

The higher income of dual income families should result in people being able to purchase their own home earlier than people in the past. As the popularity of dual income families over time, we should see more families purchasing homes at an earlier age. This trend can be seen in Figure 7. Examination of those born in 1951 shows that 60% home ownership was not achieved until they had reached age 36 while the younger Australians (born in 1971 and 1961) reached 60% by age 30-32.

Figure 7 Homeowners by Birth Year



In direct opposition to this point of view, ABS data suggests that the home ownership rates in the age group 25-34 has fallen from 42.3% to 32.1% over the period 1988-1996/7 (ABS 1999). A similar fall has occurred in the 35-44 age group. This fall is not evident in the DYNAMOD modelling. This could be due to relatively constant age of mothers having their first child. This was discussed in the Limitations section. The inclusion of an increasing age is expected to result in a longer period at low levels and then a rapid increase to the higher levels. This would result in the *Born 1971* people remaining below the *Born 1961* people until their late 30s and then rising quickly to the same level as the *Born 1961* by the mid 40s.

7. Conclusion

Home ownership is the Australian dream and 90 percent of Australians achieve this dream during their lives. At any time around 70 percent of Australian are living out this dream in their own home. This paper discussed the development of a housing wealth module for the dynamic microsimulation model at NATSEM. This model allows the impact of the Australian dream to be considered from a wealth accumulation perspective.

The current dynamic simulation model at NATSEM, DYNAMOD, required home ownership and its associated housing value and mortgage to be imputed onto the starting population of DYNAMOD. The imputation was done on the basis of tenure, residential state, age and income. The circumstances of the population were then examined annually in regard to possibility of purchasing a home. The decision to purchase a home is based on income, cash deposits, equity portfolio, state of residence, sex, age, marital status, country of birth, employment status, occupation and the number of dependent children. The amount paid for the house is a function of income, cash deposits, whether it is a first home, marital status, occupation, residential state and location within the state. Once purchased the house increases or decreasing in value according to actual data where available or using a rate based on the mean for projections. At this stage the sale or transfer of the house is only considered under specific circumstances, such as, marriage, divorce and death.

Aggregate alignment of housing wealth appears to be good, however, further work needs to be done before the model can be used to forecast with a degree of certainty. One of the great advantages of dynamic simulation is that the variables are able to interaction and a change in one involves behaviour in another part of the model. This interaction also makes alignment an extremely complex and time consuming task. One that is not complete in all areas of DYNAMOD at present.

8. References

ABS (Australian Bureau of Statistics), 1999, *Australian Social Trends*, , Catalogue No. 4102.0, ABS, Canberra.

Bækgaard, H., 2000, ‘Modelling the dynamics of the distribution of earned income’, Technical Paper No. 24, NATSEM, University of Canberra, July.

Bækgaard, H. and King, A. 1996, ‘Modelling the Accumulation and Distribution of Australian Household Assets’, Paper presented to the 24th General Conference of the International Association for Research in Income and Wealth, Lillehammer, NATSEM, August.

Badcock, B., 1994, “‘Snakes or Ladders?’: The Housing Market and Wealth Distribution in Australia’, *International Journal of Urban and Regional Planning*, p609-627, Cambridge, MA, USA.

Bourassa, S., 1995, ‘A Model of Housing Tenure Choice in Australia’, *Journal of Urban Economics*, 37, p161-75.

Bourassa, S., Greig, A. and Troy, P., 1995, ‘The Limits of Housing Policy: Home Ownership in Australia’, *Housing Studies*, Vol. 10(1), pp 83-104.

King, A. and Bækgaard, H., 1996, ‘The Dynamics of Housing Wealth’, Paper presented to the 8th National Conference of the Australian population Association, Adelaide, NATSEM, December.

King, A., Bækgaard, H. and Robinson M., 1999a, ‘DYNAMOD-2: An Overview’, Technical Paper No. 19, NATSEM, University of Canberra, December.

____, 1999b, ‘The Base Data for DYNAMOD-2’, Technical Paper No. 20, NATSEM, University of Canberra, December.

Longley, P., M. Clarke and H. Williams, 1991, ‘Housing Careers, Asset Accumulation and Subsidies to Owner Occupiers - A Microsimulation’, *Housing Studies*, Vol. 6(1), pp 57-69.

Neutze, M. and Kendig, H., 1989, ‘Achievement of Home Ownership Among Post-war Australian Cohorts’, *URU Working Paper No 16*, Urban Research Unit, Australian National University, September.