

Research Paper

# Updating the AHURI Housing Microsimulation Model (HOUSEMOD)

authored by

**Robert Tanton and Justine McNamara**

for the

**Australian Housing  
and Urban Research Institute**

RMIT-NATSEM Research Centre

October 2008

ISBN: 1 921201 30 4



## **ACKNOWLEDGEMENTS**

This material was produced with funding from the Australian Government and the Australian States and Territories. AHURI Ltd gratefully acknowledges the financial and other support it has received from the Australian, State and Territory governments, without which this work would not have been possible.

AHURI comprises a network of twelve universities clustered into seven Research Centres across Australia. Research Centre contributions, both financial and in-kind, have made the completion of this report possible.

## **DISCLAIMER**

AHURI Ltd is an independent, non-political body which has supported this project as part of its programme of research into housing and urban development, which it hopes will be of value to policy-makers, researchers, industry and communities. The opinions in this publication reflect the views of the authors and do not necessarily reflect those of AHURI Ltd, its Board or its funding organisations. No responsibility is accepted by AHURI Ltd or its Board or its funders for the accuracy or omission of any statement, opinion, advice or information in this publication.

# CONTENTS

<b>1</b>	<b>BACKGROUND</b> .....	<b>1</b>
<b>2</b>	<b>THE EXISTING HOUSEMOD MODEL</b> .....	<b>2</b>
<b>3</b>	<b>WHY HOUSEMOD NEEDS UPDATING</b> .....	<b>4</b>
<b>4</b>	<b>WHAT UPDATES HAVE BEEN DONE</b> .....	<b>5</b>
4.1	Change from 1998-99 HES to 2002-03 and 2003-04 SIH .....	5
4.2	Adjustment of projection methodology .....	6
4.3	Refinement to housing costs uprating .....	7
4.3.1	Uprating costs from 2003-04 and 2003-04 to 2006 .....	7
4.3.2	Projections of financial values .....	7
4.3.3	Summary of how financial values are uprated and projected in HOUSEMOD .....	8
<b>5</b>	<b>IMPLEMENTING NEW SCENARIOS</b> .....	<b>9</b>
<b>6</b>	<b>FUTURE WORK</b> .....	<b>10</b>
	<b>REFERENCES</b> .....	<b>11</b>

# 1 BACKGROUND

In recent projects with AHURI, the National Centre for Social and Economic Modelling (NATSEM) has been using a microsimulation model of the Australian housing system. This model is based on the 1998 99 Household Expenditure Survey (HES), combined with data from the 2001 Census of Population and Housing. The model updates the 1998 99 HES using NATSEM's static microsimulation model of Australia's tax and transfer system, STINMOD. This regional microsimulation housing model, HOUSEMOD, is capable of measuring at a detailed regional level the incidence of various government housing programs, the impact of reforms to those programs and the interaction between housing and non-housing programs. Two earlier versions of the model were developed – the original version and a later version, which incorporated a forecasting component.

The model has been used in a number of NATSEM-AHURI research projects, but with the release of new ABS income survey data and continuing changes in house prices, rents and housing affordability across Australia, an updated version of the model was required. This paper describes the process of updating HOUSEMOD.

In the next section of this report, we briefly describe the existing HOUSEMOD model and then go on to explain the various aspects of the current update of the model. Finally, we briefly discuss possible future updates and refinements.

## 2 THE EXISTING HOUSEMOD MODEL

As described in earlier NATSEM-AHURI reports, HOUSEMOD was developed to overcome a lack of detailed small area data suitable for answering questions related to housing policy. HOUSEMOD is based on spatial microsimulation techniques which merge information-rich data from ABS income surveys with geographically disaggregated Census data to create synthetic microdata for small areas. HOUSEMOD is used to create synthetic households for each Statistical Local Area (SLA) whose number and characteristics match as closely as possible the number and characteristics of the households living in that SLA, as shown in the Census data. This process involves the use of benchmark variables from the Census, which are selected to match variables in the income survey, and which closely reflect the concepts which the model will be used to measure.

The synthetic households are produced through a reweighting process, which produces a set of weights for each of the households in the income survey, for each small area in Australia. These weights are further aligned with administrative benchmarks for receipt of Commonwealth Rent Assistance (CRA), so that our estimates of CRA are as accurate as possible. The weights are then applied to a version of NATSEM's microsimulation model of Australia's tax and social security system, STINMOD, which itself is based on the same income survey used to produce the weights. Combining the HOUSEMOD weights with STINMOD allows us to model the effects of existing policy and possible policy changes at a detailed regional level. For example, HOUSEMOD has been used to examine the impact of Commonwealth Rent Assistance, and possible changes in CRA policy, on housing affordability and financial disadvantage (Melhuish, King and Taylor 2004; McNamara, Tanton and Philips 2007).

In 2005, HOUSEMOD was further developed by incorporating into the model a forecasting capacity, so that the synthetic households created through spatial microsimulation could be used to measure future (as well as current) housing patterns, such as future demand for housing assistance. This projection aspect of the model allows policymakers to see not just the current effects of any housing policy changes, but also the effect of any such changes in future years. Thus the long-term effects of possible policy changes can be taken into account, and the effect of demographic change can also be considered.

The major steps involved in building the model are:

- selecting appropriate data sources and benchmark variables
- combining data from income survey(s) and the Census, using the benchmark variables and the GREGWT reweighting program (a software program written by the Australian Bureau of Statistics). This produces an initial set of small-area weights.
- aligning the weights with CRA administrative data
- inflating populations for the weights to produce outyears versions of the model
- applying the weights to a STINMOD outfile to provide data about housing and housing policy at a detailed regional level. STINMOD outfiles are available for current and future years, and can be matched with either current or forecasting versions of the HOUSEMOD weights.

Detailed descriptions of earlier versions of the HOUSEMOD model can be found in (Melhuish 2004) and (Kelly 2006). In this paper, we are focusing on the changes

made to the model. The next section describes the rationale for the current set of changes, followed by a detailed description of the changes made.

### **3 WHY HOUSEMOD NEEDS UPDATING**

The HOUSEMOD model needs to be periodically updated if it is to remain viable, relevant and capable of policy impact analyses. This is because successive Commonwealth budgets change the government's tax transfer system, new programs and tax measures are introduced and existing programs and tax measures are reformed, so the model needs to be revised to take these into account. In addition, changes in income levels, housing costs and population also need to be updated. While survey data can be updated to reflect changes in the dollar values of income and housing costs, and the weights can be inflated to reflect population changes, not all changes that occur to housing patterns and populations over time can be captured through updating. For example, any changes in the composition of the sub-population of Australians renting in the private market can only be captured by incorporating new data into the model.

While previous versions of HOUSEMOD have used a range of well established methodologies to update income, housing costs and population to the year of interest, more accuracy can be achieved in the model by using the latest possible available data as the base file. Finally, although the underlying data are more up to date in this version of HOUSEMOD, updating of incomes, housing costs and population numbers is still incorporated into the model so that current and future housing policy questions can be answered. Our updating methodology for housing costs has been refined since the earlier version of HOUSEMOD, and we have revisited our population updating methodology. In addition, we have added some increased functionality to the model's scenario-building capacity.

## 4 WHAT UPDATES HAVE BEEN DONE

This project was designed to bring the new Survey of Income and Housing data into the HOUSEMOD model, and this has been done. In updating the model with new survey data, we have also changed the population projection methodology to make it simpler, and made some improvements to the uprating of housing costs. A final aspect of the model update – alignment to new Commonwealth Rent Assistance benchmarks – was not covered under this project, and will need to be funded before HOUSEMOD is next used to estimate CRA, as the data to which we are currently benchmarking are six years old.

Table 1 summarises the changes between earlier versions of HOUSEMOD and the current update. The following sub-sections deal with each of the three major changes to the model.

**Table 1: Key features of HOUSEMOD, versions 1 to 3**

	<i>Version 1</i>	<i>Version 2</i>	<i>Version 3</i>
<b><i>Underlying survey data</i></b>	ABS Household Expenditure Survey 1998-99	ABS Household Expenditure Survey 1998-99	ABS Survey of Income and Housing 2002-03 and 2003-04
<b><i>Underlying census data</i></b>	ABS Census 2001	ABS Census 2001	ABS Census 2001
<b><i>Sample size</i></b>	6,892 households	6,892 households	21,571 households
<b><i>Population projection methodology</i></b>	NA	Use of a combination of SLA-level population projections and state-level population projections	Use of SLA-level population projections only
<b><i>Alignment with CRA benchmarks</i></b>	Aligned with CRA data from Commonwealth Housing Data set 2002	Aligned with CRA data from Commonwealth Housing Data Set 2002	No alignment to CRA as Commonwealth Housing Data Set out of date.
<b><i>Uprating of mortgage costs</i></b>	Uprated using changes in housing CPI	Uprated using changes in housing CPI	See Table 2 for details.
<b><i>Uprating of public rents</i></b>	Uprated using changes in the rental component of the housing CPI	Uprated using changes in the rental component of the housing CPI	See Table 2 for details.
<b><i>Uprating of private rents</i></b>	Uprated using changes in the rental component of the housing CPI	Uprated using changes in the rental component of the housing CPI	See Table 2 for details.

Note that the CPI figures used are different for each capital city, and that capital city figures have been used for the Rest of State, as the housing CPI is only available for capital cities in each State.

### 4.1 Change from 1998-99 HES to 2002-03 and 2003-04 SIH

As noted earlier, previous versions of HOUSEMOD have used the 1998-99 Household Expenditure Survey (HES) and the 2001 Census of Population and



Housing as the two base data sets used to produce the weights which form the essence of the HOUSEMOD model. In addition, previous output from the model has been produced by applying the weights to a special version of the STINMOD model, also based on the 1998-99 HES.

For this new version of the model we have moved from using the HES as our base data set to using the Australian Bureau of Statistics (ABS) Survey of Income and Housing (SIH) for 2002-03 and 2003-04. This change has a number of advantages. First, newer data capture population and housing trends that cannot be adequately reflected by uprating methods alone. Second, by using the combined 2002-03 and 2003-04 surveys we are able to substantially increase the sample size available for the model, thus improving the accuracy of our estimates. In addition, the sample size for the SIH surveys is substantially bigger than that for the HES. The 1998-99 HES contained records for 6,892 households, compared with 10,210 households in the 2002-03 SIH and 11,361 households in the 2003-04 SIH. Finally, the SIH is conducted by the ABS every two years, whereas the HES is conducted only once every five years, so moving to an SIH base for HOUSEMOD means that more frequent updates of the base data will be possible.

Using the 2002-03 and 03-04 SIHs as the base surveys for the model benchmarking means that we have also been able to move to a more recent version of STINMOD when we apply the weights to produce estimates of housing variables and policy impacts. We now apply the weights to STINMOD version 06B, which is also based on a combination of the same two income surveys. STINMOD uses complex, well-established methodology to update numerous variables in these surveys to reflect Australian population characteristics and incomes to December 2006. Outyears versions of STINMOD/06B are also available, incorporating additional uprating, covering the years 2007–2017.

Thus the base year for HOUSEMOD output is now 2006, although it is important to note that as we still benchmark to the 2001 Census, and the SLA boundaries in the model are still based on the 2001 Australian Standard Geographical Classification (ABS 2001), any SLAs added to the ASGC after 2001 are not as yet included in the model.

## **4.2 Adjustment of projection methodology**

The first version of HOUSEMOD used 2001 as a base year and did not incorporate a forecasting dimension, so it did not require the weights to be inflated to reflect population changes. However, the second version of the model, described in (Kelly 2006), incorporated complex methods to inflate population numbers and characteristics. This second version used ABS SLA level age-by-sex population projections, combined with national labour force projections and state and capital city/balance of state household type projections as benchmarks to inflate the weights out to 2011, using the original weights calculated from the 2001 Census data as 'starting weights'.

The new set of HOUSEMOD updates described in this report has modified the projection methodology used for version two of the model, as subsequent applications of the model (McNamara 2007) revealed some conflict between the SLA-level age-by-sex population projections, and the state-level household-type projections. Further investigation of these issues led to a decision to use SLA-level age-by-sex population projections only to inflate the weights to 2006 and beyond, as the use of forecasting data not available at an SLA level introduces complexities into the process of reaching correct forecasted population totals.

Thus this version of the HOUSEMOD model uses population projections by Age/Sex and SLA available from the ABS. These population projections were derived by the ABS for NATSEM using the cohort-component method. In this method, the base population is projected forward annually by calculating the effect of births, deaths and migration within each age-sex group according to specified fertility, mortality and migration assumptions. These projections used the medium scenario (scenario B) from the ABS population projections Cat. No 3222.0 published in 2003 (ABS 2003).

Once again, as noted earlier, both the model's base year and the outyears weights still reflect ASGC boundaries as at the 2001 Census.

### 4.3 Refinement to housing costs uprating

In all versions of HOUSEMOD which incorporate a forecasting component, two uprates of housing costs are needed. One is to take costs from the survey year (in this case 2002–03 and 2003–04) to the model year (2006); and one is to project costs to the projected years.

It is easier to uprate costs to the model year as historical data on price increases is usually available from the ABS. However, projecting out increases is more difficult. In particular, projection of mortgage costs not only needs to take into account house price increases, but also interest rate projections.

#### 4.3.1 Uprating costs from 2003–04 and 2003–04 to 2006

Most of the uprating to 2006 can be done using historical data on house price and mortgage increases, so no projections are required. Table 2 in Section 4.3.3 shows how all the housing financial data has been uprated to the base model year of 2006.

#### 4.3.2 Projections of financial values

In recent applications of HOUSEMOD that focused on the financial well-being of home purchasers as well as renters (McNamara et al 2007), we trialled a more complex method of uprating mortgage repayments, based on increases in home loans and changes in interest rates.

A modified version of this revised method has been used for the forecasting component of the current HOUSEMOD update, but has been applied only to mortgages for first-home buyers who have purchased in the last three years (a group that was unable to be identified using the old base data set). This formula is shown below (Formula 1). For those who did not purchase in the last three years, the projected mortgage size has been inflated by the projected long-term headline CPI from the Commonwealth Treasury (2.5 per cent). This is the default projection factor used in NATSEM's STINMOD model. The reason for this different treatment is that recent first-home buyers are paying significantly more for a house than more long-standing home owners, and thus are more strongly affected by recent increases in house prices, so the growth rate is higher.

The increase applied to a first-home buyer's mortgage for the projection years is based on the house price changes and changes in interest rates. The mortgage size in 2007 and subsequent years is calculated as follows:

$$\begin{aligned}
 MortgageSize_t^s &= MortgageSize_{t-1}^s \times \left( 1 + \frac{HousePriceChange_t^s}{100} \right) \\
 &\times \left( 1 + \frac{InterestRate_t - InterestRate_{t-1}}{InterestRate_{t-1}} \right)
 \end{aligned}
 \tag{Formula 1}$$

where  $t$  is the year being considered, from 2007 to 2017, and  $s$  is the State/Capital City for which the value is being calculated.

The interest rate used in this formula is based on the projections used in the AHURI Intergenerational Report and is set at 7 per cent (Yates et al. 2008). The model thus assumes no interest rate change as a base case, but because the formula incorporates the interest rate a change in interest rates can easily be programmed into the model.

For this formula, the projections of house price changes are the same as those used in the AHURI Intergenerational Report (Yates et al. 2008), which is 2 per cent real and 2.5 per cent for the CPI increase, or 4.5 per cent annual. Both these figures can easily be changed for scenario modelling in Excel.

Future mortgage payments are then calculated as the repayment on the mortgage value derived from this formula, calculated using the PMT function in the SAS programming language, and the projected interest rate.

The methods for projecting for all other financial variables are shown in Table 2. In many cases they use the long-term projected increase in house prices used in the AHURI Intergenerational report (Yates, Kendig and Phillips, 2008). For public rents, we have assumed the long-term headline CPI projection from Treasury, as there are no housing cost CPI projections.

All the parameters for the projections can be easily adjusted in HOUSEMOD. In particular, interest rates, loan increases and house price increases can all be changed in a spreadsheet.

#### 4.3.3 Summary of how financial values are uprated and projected in HOUSEMOD

Table 2 shows how each of the financial values has been uprated from 2002-2003 and 2003-2004 to 2006 and then how each variable is projected in HOUSEMOD out to 2017.

**Table 2: Uprating housing financial values in HOUSEMOD**

Variable	Uprating to 2006	Projections
<b>House Prices</b>	ABS House Price Index for eight capital cities, (ABS 2008a)	Assumed to increase at 4.5 per cent per year used in IGR (Yates, Phillips and Kendig (2008)
<b>Mortgage Size</b>	ABS Housing Finance Commitments, (ABS 2008b)	For first-home buyers, projections of house price change (4.5 per cent) and projected interest rates (7 per cent) using Formula 1 above.  For non first-home buyers, projections use the long-term CPI projection from Treasury (2.5 per cent per year)
<b>Mortgage repayments</b>	2006 value calculated from Mortgage Size and 2006 Interest rate (assumed 7 per cent)	Based on mortgage size and projected interest rate (7 per cent).
<b>Public Rents</b>	Rental component of the Housing CPI (ABS 2008c)	Projections use the long-term projection of the CPI from Treasury (2.5 per cent per annum)
<b>Private Rents</b>	Rental component of the Housing CPI (ABS 2008c)	Assumed to increase at same rate as house prices, i.e. 4.5 per cent per year

## **5 IMPLEMENTING NEW SCENARIOS**

Parameters that can change within the model are now stored in an Excel workbook. These parameters are interest rates (nationwide only); house prices (by State and capital city); the change to principal outstanding on a loan (change nationwide only, but original parameters at State/Capital City level); and changes to incomes (nationwide only). Because this model is used within NATSEM, any other scenarios can be programmed using SAS, the language in which the model is written. The model is Australia-wide, and the large number of SLAs across Australia (more than 1000) means that using an Excel interface to make adjustments to the base files (as done with the ACT Land Development Agency Model) is not feasible.

The changes implemented with the workbook are either absolute values (interest rates) or changes to the assumed parameters in the model (house prices, principal outstanding and incomes). Thus, in the model, the principal outstanding on a loan is different for each state and capital city, but the percentage point change applied using the parameter spreadsheet is the same nationwide. Changes to house prices can be adjusted by state and capital city.

## 6 FUTURE WORK

The current version of HOUSEMOD now uses much more recent data and incorporates a number of important refinements to its population projection, updating and benchmarking methodology. In particular, the incorporation of more recent data provides a much larger sample size on which the benchmarking process is based, and one which can be updated at more regular intervals than was the case with the base data set used for earlier versions of the model.

All microsimulation models need continual maintenance and updating, and with additional funds, further refinements to the HOUSEMOD model could be made, such as:

- incorporation of new CRA administrative data
- incorporation of 2006 Census data
- updating to 03-04–05-06 Surveys of Income and Housing
- updating the housing cost inflation factors when new data become available, such as interest rates.

Because of funding restrictions, it was not possible to include these refinements in this model. Incorporating the new CRA data, in particular, would be a significant task, as we would want to rethink the way we benchmark to this data to give better estimates of CRA recipients.

## REFERENCES

- ABS 2001, *Australian Standard Geographic Classification (ASGC)*, 2001, 1216.0, ABS.
- ABS 2003, *Population Projections, Australia, 2002 to 2101*, 3222.0, ABS.
- ABS 2008a, *House Price Indexes: Eight capital cities, Time Series workbook, December Quarter 2007*, 6416.0, ABS.
- ABS 2008b, *Housing Finance, Australia, Jan 2008 Table 10c: Housing Finance Commitments (Owner Occupation), By Purpose: State, Original (Average Loan Size)*, 5609.0, ABS.
- ABS 2008c, *Consumer Price Index, Australia, December 2007, Table 13: CPI Groups, Sub-Groups and Expenditure Class, Index numbers by capital city*, 6401.0, ABS.
- Kelly, S., Phillips, B. and Taylor, E. 2006, *Baseline small area projections of the demand for housing assistance*, Australian Housing and Urban Research Institute, Melbourne.
- McNamara, J., Tanton, R. and Phillips, B. 2007, *The regional impact of housing costs and assistance on financial disadvantage*, Final Report, Australian Housing and Urban Research, Melbourne.
- Melhuish, T., King, A., and Taylor, E. 2004, *The regional impact of Commonwealth Rent Assistance*, Australian Housing and Urban Research Institute, Melbourne.
- Yates, J., Kendig, H. and Phillips, B. 2008, *Sustaining fair shares: the Australian housing system and intergenerational sustainability*, Final Report, Australian Housing and Urban Research Institute, Melbourne.

## **AHURI Research Centres**

Queensland Research Centre  
RMIT-NATSEM Research Centre  
Southern Research Centre  
Swinburne-Monash Research Centre  
Sydney Research Centre  
UNSW-UWS Research Centre  
Western Australia Research Centre



Australian Housing and Urban Research Institute  
Level 1 114 Flinders Street, Melbourne Victoria 3000  
Phone +61 3 9660 2300 Fax +61 3 9663 5488  
Email [information@ahuri.edu.au](mailto:information@ahuri.edu.au) Web [www.ahuri.edu.au](http://www.ahuri.edu.au)