



Modelling housing need in Australia to 2025

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Acronyms and abbreviations used in this report

ACT	Australian Capital Territory
AHURI	Australian Housing and Urban Research Institute Limited
AHWG	Affordable Housing Working Group
AIHW	Australian Institute for Health and Welfare
CHP	Community Housing Providers
CRA	Commonwealth Rent Assistance
FEM	Fixed Effects Model
GVA	Gross Value Added
HFM	Household Formation Model
HILDA	Household Income and Labour Dynamics in Australia
LGA	Local Government Area
LME	Labour Market Earnings
NGO	Non-Government Organisation
NDIS	National Disability Insurance Scheme
NHS	National Housing Strategy
NHSC	National Housing Supply Council
NRAS	National Rental Affordability Scheme
NSW	New South Wales
NT	Northern Territory
OLS	Ordinary Least Squares
QLD	Queensland
REM	Random Effects Model
SA	South Australia
SIRCA	Securities Industry Research Centre of Asia-Pacific
SLA	Statistical Local Area
TAS	Tasmania
UK	United Kingdom
US	United States of America
VIC	Victoria

WA

Western Australia

Glossary

A list of definitions for terms commonly used by AHURI is available on the AHURI website www.ahuri.edu.au/research/glossary.

Executive summary

- This research delivers, for the first time in Australia, a consistent and replicable methodology for housing need assessment that can be used to inform resource allocation and simulate the impact of policy decisions on housing outcomes.
 - Housing need is defined as: *the aggregate of households unable to access market provided housing or requiring some form of housing assistance in the private rental market to avoid a position of rental stress.*
 - The housing need simulation delivers state and territory estimates of housing need through the combination of a number of interacting models. The simulation can determine housing needs, household formation and labour market outcomes under user-defined economic and housing supply scenarios.
 - The outputs produced by the simulation model should be regarded as reflecting indicative trends in housing market conditions and housing need rather than precise annual forecasts.
 - The simulation estimates current housing need in Australia to be 1.3 million households (just under 14 % of households), and this is estimated to rise to 1.7 million households by 2025 under our baseline scenario.
 - Almost 373,000 households are currently estimated to be in housing need in New South Wales, either unable to form or requiring some form of assistance to avoid a position of rental stress, rising to 678,000 in 2025. In Victoria, housing need is estimated to rise from 291,000 to 462,000 over the eight year period.
 - The results reveal the extent of the shortfall in affordable housing, now and moving forward, and the additional pressure placed on the housing assistance budget due to the growth in households requiring support in the private rental market.
 - Further development of the econometric aspects of the simulation model combined with new census data could deliver estimates of housing need at the local government area level.
-

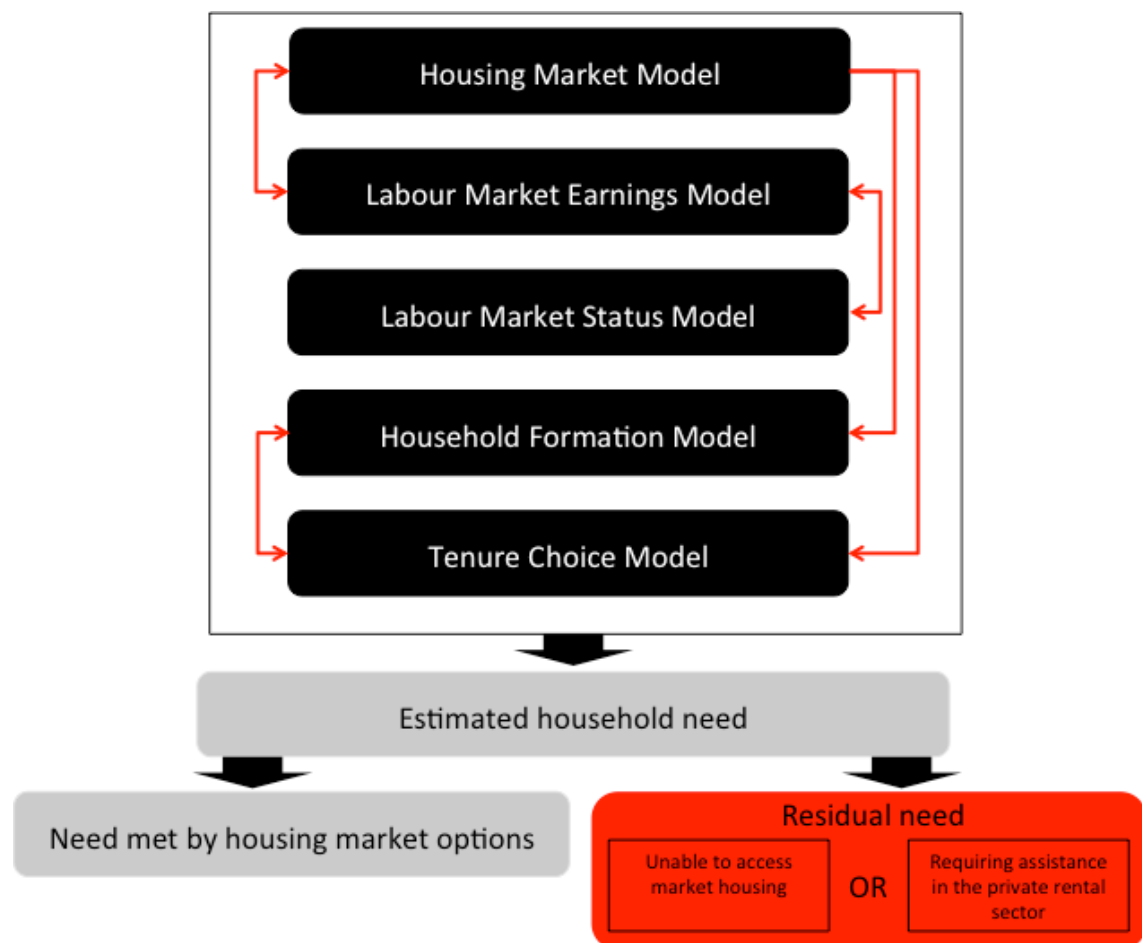
Key findings

- This research develops a housing need simulation to quantify housing need. Housing need estimates have a number of uses for policy-makers including resource allocation, market monitoring, setting affordable housing targets, housing assistance budgeting and evidence for affordable housing contributions via planning policy. The simulation identifies the supply required to meet broad affordable housing demand rather than individualised forms of housing assistance required to meet need.
- For the purposes of this report we adopt the following definition of housing need: *The aggregate of households unable to access market provided housing or requiring some form of housing assistance in the private rental market to avoid a position of rental stress.* This

definition is easy to understand and covers households requiring public and community housing, subsidised affordable rental housing and the majority of those requiring Commonwealth Rent Assistance (CRA) in the private rental market.

- The simulation estimates housing need as: 1) the number of households predicted to form, but unable to access market housing, and 2) the number of households predicted to form, but who will expend such a significant proportion of household income that they require some form of assistance to avoid a position of rental stress. The simulation indicates the affordable housing supply necessary to meet the broad housing needs (not individual) of those households unable to access market housing (ownership or rental) and also quantifies those able to access the private rental market but placed under financial stress in order to do so. Many of these will be low-income households and therefore eligible for CRA.
- Previous housing need/demand work in Australia has generally delivered supply-based estimates of need. Various studies have adopted different approaches with different aims and objectives. This report details a consistent methodology to estimate housing need at the state level which could be further developed to deliver localised estimates of housing need.
- Housing need arises from the interaction of demographic effects (population projections combined with propensities of different groups of people to form new households) with the labour market and housing system. The housing need simulation consists of five interrelated models of the housing market, labour market, labour market earnings, household formation and tenure choice with the simulation model described in the diagram below.

Figure 1: Simulation structure



- The Housing Market Model identifies the main housing demand drivers as growth in the mean wage rate and mortgage interest rates. The model coefficients suggest a strong link between state level growth in earnings and house price growth, but a weak link between interest rates and price growth. Higher levels of housing supply reduce price growth, but the effect is very small and suggests that new supply is a limited policy lever to reduce general price levels. Local government area (LGA) house prices do not appear to be directly related to the odds of home ownership, as households in the highest cost LGAs are only slightly less likely to be home owners than in less expensive local areas.
- The simulation model estimates that there are around 140,000 households unable to access market housing in New South Wales and a further 233,000 households requiring rent assistance to alleviate a position of rental stress. Equivalent figures are 110,000 and 181,000 in Victoria, 150,000 and 232,000 in Queensland, 59,000 and 73,000 in Western Australia with 14,000 and 17,000 in Tasmania.
- Under the definition adopted in this study, there are currently over 373,000 households estimated to be in housing need in New South Wales, rising to 678,000 in 2025. For Victoria the equivalent figures are 291,000 and 462,000. In Queensland the number of household in housing need is predicted to fall from 381,000 to 331,000 by 2025.
- Housing need in Australia is estimated at 1.3 million households, or around 14 per cent of the total number of households predicted in the simulation, rising to 1.7 million, or around 16 per cent, in 2025.

- The outputs produced by the simulation model should be regarded as reflecting indicative trends in housing market conditions and housing need, rather than providing precise annual forecasts.
- The number of households in need is greatly dependent on assumptions around national and regional economic conditions. This calls for flexibility in any policy response at a national level. In particular, the number of affordable dwellings required at state level will need to be continuously recalculated, perhaps every 2–3 years, rather than enshrined in rigid targets over an extended forward simulation period.
- The results show the scale of affordable housing necessary to meet need, and the challenge faced by state and local government to deliver such housing.
- The simulation model is a major step forward in the development of a robust and consistent methodology for affordable housing assessment, allowing the user to estimate housing need under a variety of economic and housing supply scenarios, delivering significant potential to simulate policy outcomes. Additional development would see the model extended to deliver estimates at the local government level.

Policy development options

The simulation model allows comparisons of housing need figures across states which will help state governments and the Australian Government plan affordable housing supply. The methodology involves harnessing a number of models (both aggregate and micro-econometric) of demographic, labour market and housing system processes, and allows the coefficients from several models to interact with exogenous and endogenous variables, producing state level estimates of housing need. Households unable to access market housing, and those who could access the private rental sector but have insufficient income to avoid a position of rental stress, are identified. Some of these households would be eligible for CRA, but not all. Various economic scenarios can be specified and the simulation produces a series of outputs based on these economic assumptions.

The housing need simulation performs well at the state level and further development will improve performance for smaller scale geographies including territories, and enable local governments across Australia to utilise the model to deliver local estimates of housing need under a consistent methodology. Such a methodology will identify areas most in need of affordable housing, track housing need changes over time, avoid the costly commissioning of individual studies, and simulate the impact of various policies on housing need. A further developed model using updated data from the Australian Bureau of Statistics (ABS) 2016 census is required.

States can use the estimates for affordable housing need as evidence in setting statewide supply targets and to negotiate funding for affordable housing. The community housing sector could also use the figures in developing their state-wide strategies.

The results show the extent of housing need in Australia, with 1.3 million households in housing need in 2017—either unable to access market housing (around 525,000) or able to access the private rental market, but requiring support to avoid rental stress (800,000). The greatest need is in New South Wales, Victoria and Queensland and the results reveal the extent of the affordable housing shortfall, providing evidence to support an increase in resources for the delivery of affordable housing, be it direct through government, in partnership with the private sector, via planning requirements, or by the community housing sector.

While there is still work to do on the simulation, this research presents a major step forward in the assessment of housing need in Australia by achieving:

- A consistent and repeatable methodology.
- A broad assessment of affordable housing supply necessary to meet household need at the national and state level.
- Delivery of housing need outcomes under a variety of user-defined economic conditions.
- Delivery of household formation and labour market outcomes under a variety of user-defined economic conditions.
- Identification of the impact of a variable speed economy housing need, household formation and labour market outcomes.
- A robust base for future model development.

We have based this work on research by key UK researchers such as Glen Bramley and Geoff Meen and applied the principles to an Australian context. Continued development incorporating new ABS Census data will enable development at a finer spatial scale.

The study

The study developed a simulation model consisting of five interrelated models (*housing market, labour market, labour market earnings, household formation and tenure choice*) to estimate housing need in Australia to 2025. It delivers housing need estimates at the national and state level and addresses the following research questions:

- 1 Using Australian and international studies, how can housing need be conceptualised to deliver an approach that can accurately measure housing assistance to 2025?
- 2 How can we use available Australian data to develop a robust and accurate methodology for assessing housing need?
- 3 What is the annual level of housing need in Australia to 2025 and how does it vary spatially?

We define housing need as the aggregate of households unable to access market-provided housing or requiring some form of housing assistance in the private rental market to avoid rental stress. The simulation delivers housing need figures for both categories. Affordable housing is defined as housing provided subject to access and affordability requirements set by government and includes rental housing priced at below market rents and earmarked for eligible low- to moderate-income households and owner-occupied housing for eligible households provided under a subsidised loan or shared equity arrangement and/or is legally encumbered with covenants that impose an affordability requirement. Such subsidised housing is necessary to meet the needs of those households unable to access market housing and those struggling to meet housing costs in the private rental market.

The simulation delivers a complex methodology for the calculation of need and delivers consistent estimates across states, providing a way of comparing need at a broad spatial scale and over time. The five interacting models use data from Household Income and Labour Dynamics in Australia (HILDA), demographic and labour market data from ABS and housing market data from CoreLogic RPdata within a series of econometric equations to provide the coefficients for the simulation. Additional detail will be provided in a technical report following further model development.

As well as delivering base housing need estimates the model is able to simulate, using different economic and housing supply scenarios, the impact of different policy measures on housing market outcomes, and thus has considerable potential to support housing research.

1 Introduction

- Housing affordability continues to decline in numerous locations with many households unable to afford access to market housing or requiring housing assistance to sustain private rental tenancies. In order to address the cost of housing assistance and estimate the quantity of affordable housing supply required to meet demand, it is vital to assess the extent of housing need in Australia over time.
 - Affordable housing is defined in this project as rental housing priced at below market rents and earmarked for eligible low to moderate-income households and owner-occupied housing for eligible households that is provided under a subsidised loan or shared equity arrangement and/or is legally encumbered with covenants that impose an affordability requirement (Milligan, Martin et al. 2016).
 - Housing need arises from the interaction of demographic effects (population projections combined with propensities of different groups of people to form new households) with the labour market and housing system.
 - This research develops a simulation to quantify housing need which draws on research from the UK. The simulation concentrates on the supply required to meet affordable housing demand, rather than the housing assistance requirements of individuals.
 - The simulation estimates housing need at the state and territory level. Further work will produce more robust estimates at the territory level and eventually a model that can deliver LGA level estimates.
-

1.1 Policy context

Housing affordability is a major issue in Australia. Young Australians are struggling to enter the housing market (Duncan, James et al. 2016) while more and more older Australians are paying mortgages or rents into retirement (Productivity Commission 2015). House prices and rents continue to rise in some areas while easing in others, with patterns of unemployment and wage growth varying significantly across the country.

Research has shown how access to affordable housing is critical for economic productivity (Van Den Nouwelant, Crommelin et al. 2016, Gurran, Phibbs et al. 2015) but resources are scarce so affordable housing must be allocated where it will be most effective. Debate around the private sector provision of affordable housing is intensifying, particularly in NSW, with some arguing for affordable housing targets at local government level (Gilbert, Gurran et al. 2016). To support affordable housing delivery, evidence of the demand for such housing is essential.

Consistent with recent AHURI research we adopt the following definition of 'affordable housing' as:

*Housing provided subject to access and affordability requirements set by government.
This includes:*

- *Rental housing priced at below market rents and earmarked for eligible low to moderate-income households.*
- *Owner-occupied housing for eligible households provided under a subsidised loan or shared equity arrangement and/or is legally encumbered with covenants that impose an affordability requirement. (Milligan et al. 2016).*

This definition distinguishes affordable housing from low cost market housing, which may be termed affordable to low and moderate-income earners through some benchmark of housing costs to income.

This report also considers affordability in the private rental market, namely those households considered to be in rental stress, many of which will rely on Commonwealth Rent Assistance (CRA) to manage housing costs. Although such a tenure is not under the definition of affordable housing above, many households are dependent on the Commonwealth subsidy in the private rental sector. Falling out of the private rental sector leaves affordable housing as the only option outside homelessness.

'Housing need' is a complex term and is often used to describe the housing needs of individuals being assessed for public housing (e.g. Housing Tasmania's assessment of housing need policy or the South Australian Government's eligibility and housing needs assessment document). This interaction with individuals to identify their specific housing needs is not something that can be modelled effectively.

This report places housing need in the context of the affordable housing supply necessary to meet this need. Understanding the extent of demand for affordable housing is the first step in delivering solutions. Research highlights how states and territories are limited in their efforts to provide housing assistance by a lack of affordable housing supply (Jacobs, Hulse et al. 2016).

Resources for the delivery of affordable housing, be it public or community housing or subsidised rental, are scarce. In order to allocate these limited resources effectively, evidence of how much, of what type and where affordable housing should be delivered is required. Various policy documents have called for the delivery of robust housing needs studies to inform the delivery of future affordable housing supply, e.g. the WA Social Housing Taskforce report of 2009:

Understanding the need for social and affordable housing across Western Australia is complex and multi-faceted, yet it is essential to guide the nature and size of supply responses in Western Australia. (Social Housing Taskforce 2009)

Government and non-government organisations are increasingly highlighting the importance of housing need evidence. The recent housing industry strategy released by the New South Wales Federation of Housing Associations (2015) called for a 'consistent and robust methodology for the assessment of housing needs'. At the 2015 National Housing Conference there was a session dedicated to estimating housing need and affordable housing demand, which saw presentations from the NSW Department of Family and Community Services, the WA Housing Authority and the Victorian Department of Health and Community Services, who each adopted very different approaches.

Chapter 2 of this report refers to some examples of housing need and housing demand studies commissioned by state and local government. What is lacking is a consistent methodology to assess this need uniformly across Australia and this is the gap addressed by this research. We adopt a complex simulation/modelling approach, based on UK research, to identify, at the state level (also included are territories but with caveats), the number of households unable to access market housing and those new households requiring support in the private rental market to avoid rental stress.

Our housing need simulation breaks down the demand for housing necessary to meet future need into 1) households that cannot access market housing (ownership or rental) and therefore require affordable housing (public and community housing and subsidised private rental e.g. NRAS) and 2) those households that can access the private rental sector but would be in a position of rental stress when doing so (with the majority of such households being eligible for, and relying on, CRA).

To assess the extent of demand for affordable housing and consequently the level of housing assistance (new affordable housing and CRA) required to meet this demand, a housing needs model must be developed at a defined, policy-relevant spatial scale. The defined period for assessing housing needs under this research is 2015–25, although we report only results for 2017–25. The research addresses the following:

- 1 Using Australian and international studies, how can housing need be conceptualised to deliver an approach that can accurately measure housing assistance to 2025?
- 2 How can we use available Australian data to develop a robust and accurate methodology for assessing housing need?
- 3 What is the annual level of housing need in Australia to 2025 and how does it vary spatially?

1.2 Existing research

Housing need can be defined as the aggregate minimum housing requirements (as defined by policy) of a nation or region that are unlikely to be satisfied through market-provided housing. The extent of housing need is therefore conditioned by the government's definition of what are minimum acceptable housing circumstances. Such normative judgements determine the acceptable size, quality and cost of housing for a given household. Logically, housing need is also conditioned by labour and housing market outcomes, including employment opportunities, unemployment, earnings levels, stability of income, house prices, rents, and perhaps also mortgage finance availability. Human behaviour is also a factor. Individuals may make rational trade-off decisions to choose to consume poor quality or overcrowded housing, or low cost housing that may have poor access to amenities or labour market opportunities. Others may choose to over consume housing with respect to the household's minimum needs, or available income. All these factors make estimating housing need at a population level a challenge.

As noted, there is no single accepted definition or method of measuring housing need in Australia. In this project we propose a methodology, and demonstrate empirical findings, that might be used to provide a common approach to measuring housing need at the national level as well as at smaller spatial scales. We begin by looking at the UK research, which is better developed in this area, though still containing ambiguities as well as difficulties in adaptation to the Australian context.

Perhaps the most accepted statistical approach to predicting housing need in the UK is by Bramley et al. (2010). He uses the UK government definition of four main categories of housing need: lacking own secure tenure, unsuitability of current accommodation, poor housing conditions, and social needs. This definition demonstrates how potentially wide-ranging the concept of being in housing need is, by including people who are:

- homeless
- desiring to form a household but unable to afford access to housing
- living in financially unsustainable / unaffordable housing, such as those on the edge of home ownership or struggling to sustain a private rental tenancy
- living in over-crowded or poor quality accommodation

- requiring specific care or part of other specific, vulnerable groups
- living under condition of harassment such as domestic violence.

Bramley notes that few published academic studies exist, even in the UK context, but there is general agreement that four principal drivers are important when modelling need:

- demographics
- the economy and the labour market
- the housing market
- social and cultural factors.

The Bramley approach is the main alternative to the simplistic net stock/projections method of estimating housing need, and can be seen as a refinement of the behavioural modelling approaches characterised by Meen, Andrew et al. (2008) or Leishman, Gibb et al. (2008). It is a more sophisticated and statistically orientated approach than used in a number of directly commissioned but smaller scale (sub-regional) housing needs projects in the 1980s and 1990s, which involved intensive survey data collection at local or sub-regional levels, with associated high production costs and non-portability of results. This prompted government to move housing need studies away from primary data collection and towards an analysis of secondary data sources.

The central element of housing need in the Bramley approach is derived by modelling the demand side of the system. In contrast to the Baker and Beer (2007) methodology, this involves estimating income distributions and household formation for sub-regional areas, and taking the price or rent distribution as a given, assessing the number of households unlikely to be able to access market provided housing. This is the broad approach adopted, refined and reported in our research.

Recent advances in modelling the relationship between housing supply and affordability in the UK have explicitly recognised the endogeneity of household formation with respect to economic conditions, including the availability and cost of housing (Meen 2011).

The long run housing supply and affordability approach emphasises the role of land supply, housing completions, and economic conditions in determining housing affordability. Although associated with policy-orientated simulation models, the approach is strongly associated with modelling outcomes at national and regional levels. Only in Scotland (Leishman et al. 2008), has this approach been used to simulate housing and labour market outcomes at the sub-regional level.

In addition to the endogeneity between housing costs and household formation (i.e. high housing costs suppress household formation), there are several other relevant endogenous relationships. Using the HILDA dataset, the Australian research community has advanced knowledge of housing affordability considerably in recent years. Insights from recent HILDA-centred studies include Buddelmeyer, Lee et al. (2010), who found that workers in low-paid employment are not at higher risk of unemployment than higher paid workers, and Feeny, Ong et al. (2012) who reported that housing assistance payments had little or no impact on individuals' employment outcomes. Lodewijks (2011) found that financial constraints and low levels of wealth boosted the incidence of job moves for men under the age of 40 and argued that this was a wage growth strategy. It is obvious that the quality of labour market opportunities, and the likelihood for these to transition to better opportunities, varies with the deprivation of the area and the degree of casualisation within an industry (Watson 2013). Meanwhile, the positive influence on earnings of additional educational attainment during working life is being increasingly recognised (Chesters 2015).

There have also been advances in our understanding of the endogeneity of health and labour market outcomes. For example, the positive impacts of health on labour market participation propensities, and on earnings, in Australia have been well documented (Cai 2009a, 2009b; Cai and Kalb 2006).

More recently, HILDA data has been used to better understand housing system behaviour. For example, the two-way relationship between adverse health and unaffordable housing circumstances has been recognised by Baker, Beer et al. (2014). Ong, Wood et al. (2015) found that older Australians exiting home ownership have a higher propensity to require housing assistance than those living as long-term private renters. Housing equity plays a pivotal role in ensuring welfare post retirement for many Australians—hitherto, primarily by ensuring near nil housing costs and thereby protecting post-retirement income. Some commentators have questioned whether housing assets might be converted to additional income streams for retirees (Johnson, Worthington et al. 2015).

1.3 Spatial scale

This study develops a methodology for estimating future housing need in Australia at a state and territory level. Although reporting results at a territory level, there are problems in delivering estimates for relatively sparsely populated areas. Housing need is simulated through a complex equation of interacting models (Chapter 3). For new households, a labour market model determines household income, which in turn determines household formation and housing tenure choice. Added to this are existing households that fall into housing need through changes to income or other circumstances, for example marriage breakup. The ability of households to access appropriate housing is determined by rents and prices, but also by existing stock (both private and public), and new supply flows.

Given availability of the finely grained data required to model household formation, tenure choice and housing market behaviour, most of the econometric modelling work is applied at the state (and territory) level. The core geography for estimating future housing need is therefore the state. However, this report also explores the scope for applying the methodology at Local Government Area (LGA) level. Applying econometric results obtained from analyses at one spatial unit, to smaller spatial units, for which many variables are unavailable, presents obvious conceptual and empirical difficulties, and therefore this aspect of the project and reporting is necessarily cautious.

The housing need estimates at the state and territory level can be combined to deliver an overall estimate of housing need for Australia to 2025. Hundreds of hours have gone into the development of the model using data from HILDA, the ABS and SIRCA. We believe estimates at the state level are robust. Figures for the territories are more volatile because many of the estimates are made at the national level greatly influencing outcomes at the much less populated territory scale. It is envisaged development of the simulation will continue over time and the release of the 2016 census data will improve the model's calibration. These new data will also help develop the simulation in such a way that it can eventually deliver LGA level estimates. There is a lot of work still to do, but this research is a major advance in the development of a consistent methodology for the estimation of housing need in Australia.

2 Conceptualising housing need

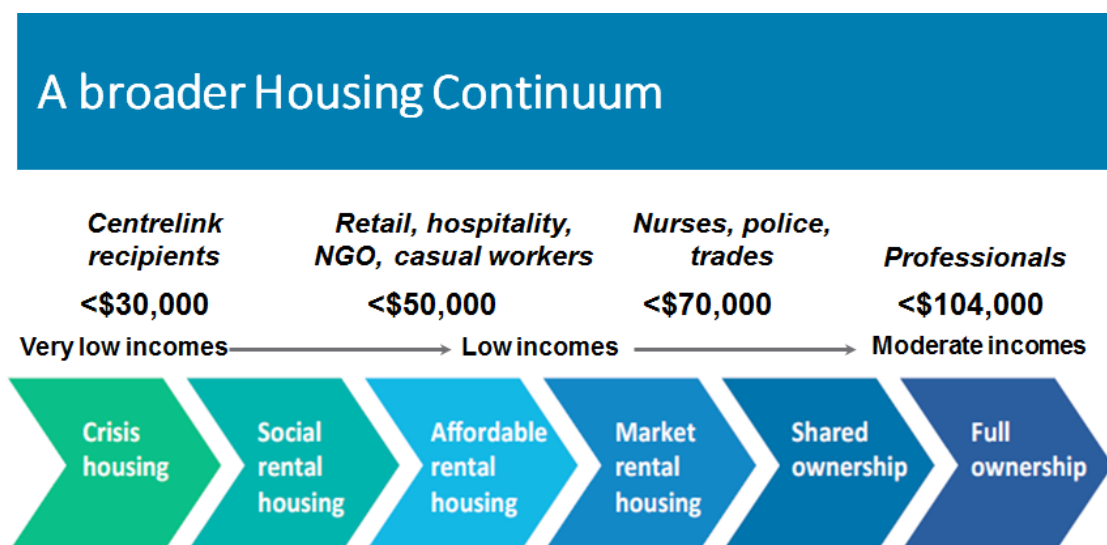
- This report defines housing need as the aggregate of households unable to access market provided housing or requiring some form of housing assistance in the private rental market to avoid a position of rental stress.
 - This definition relates to affordable housing supply and housing assistance required to meet need and not specific housing solutions required to deliver individual housing assistance solutions. It is focussed on future arising need rather than existing need.
 - Previous housing need/demand model work has generally delivered supply based estimates of need. Various studies have adopted different approaches and used inconsistent methodologies, therefore results are not comparable.
 - Housing need estimates have a number of uses for policy-makers including resource allocation, market monitoring, housing targets, housing assistance budgeting and evidence for affordable housing contributions via planning policy.
-

2.1 Introduction

The housing continuum (Figure 2) is a useful first step in conceptualising housing need. Various tenures are required by households of different circumstances, notably income. Need assessments are commonly employed to calculate the affordable housing supply required on the left hand side of the continuum. These are the tenures requiring the greatest depth of subsidy. Delivering more housing in the middle part of the continuum enables existing households to transition out of public and social housing. However, if you do not know the extent of the demand for affordable housing it is impossible to assess the supply required across the continuum to meet this need.

In this report we employ complex modelling techniques to calculate the number of households likely to form, split between those that can access market housing (home ownership and the private rental sector) and those that cannot, requiring support through CRA and subsidised tenures such as public and community housing. Government backed low deposit loans (e.g. Keystart in WA or Homestart in SA) and shared equity/ownership products which can bridge the gap between renting and home ownership fall under the definition of affordable housing used here because they contain income eligibility limits, and would be an important part of any strategy addressing housing need. They are only accessible to households able to access market housing, but in a position of rental stress. Such products are not explicitly factored into the supply side of this housing need simulation, however, there is potential to do this in the future because a significant new supply of this type of product would address demand from some of those considered in need.

Figure 2: A typical housing continuum



Source: Adapted from the Housing Authority of Western Australia (2010).

2.2 Housing 'need'

In 2008 AHURI published *Reconceptualising housing need in the context of 21st century Australian housing policy* (Seelig, Milligan et al. 2008) which reviewed previous work and delivered 60 pages of detailed research, but failed to set out a clear definition of housing need. The paper highlights the complexities involved in defining need and the normative judgements typically applied in discussing the differences between needs and preferences.

... while the terminology is of 'housing need', the meanings of this conceptually are at best implied, and commonly without any theoretical underpinning. Perhaps more confusingly, 'need' is frequently used in the policy and practice discourse to mean quite different things from the 'needs' which have been discussed in chapter 3, and are often about housing supply, assessment processes and broad responses and outcomes, rather than basic human or housing need. (Seelig, Milligan et al. 2008:36).

Seelig, Milligan et al. identified three applications of housing need studies, the application being dependent upon the methodology. First, to inform decisions about the share of new housing supply or funding required to meet identified need at a specific spatial scale; second, and linked to the first, the generation of local housing needs studies; third, the assessment of individual applicants for housing assistance such as the allocation of public housing. This research focuses on the first two applications.

The distinction between broad and individual housing need is an important one. The majority of housing need studies focus more on the supply of housing; tenure, size type, required to meet identified need for specific groups; income, age etc. rather than the housing requirements of individuals. Such needs can only be effectively delivered after consultation with the individual. For broader housing need studies, the scale is often local government area, sometimes region, and the outcome is typically a quantification of the housing required to accommodate household growth over a defined period.

For broader needs studies, normative judgements are made about what is appropriate housing to meet needs in terms of affordability, quality and size. Judgements relate to what is considered affordable and tend to be based around the 30 per cent of gross income benchmark, while quality and size often relate to the number of persons per dwelling with assumptions made

that new dwellings equal acceptable quality. These are standard (normative) assumptions of what is considered appropriate by those conducting the studies or under specific government policy or adopted guidance. These assumptions differ from the housing 'needs' of individuals which are often far more complex and impossible to model. Therefore broad need assessments are useful in quantifying how much housing is required to meet the housing needs of specific income groups, for example underpinning resource allocation decisions and delivering evidence for housing targets, but much less useful in determining individual housing requirements to meet specific needs (an NDIS model).

Housing need includes future need and existing (including hidden) need. Typical housing need studies use data such as waiting lists and homelessness to address existing need, with future need determined through assumptions about future population growth and household sizes over a defined period.

Existing need relates to the characteristics of households and their current housing circumstances including:

- Unaffordable housing—housing costs too high for the household income. Benchmark may be related to standard affordability assumption or a residual income measure.
- Poor quality housing— impact on health, childhood wellbeing etc.
- Overcrowding—number of persons per bedroom exceeding defined minimum standards.
- Concealed households—potential households unable to form due to a lack of income.
- Homelessness—lack of stable housing.
- Trapped households—individuals living in inappropriate circumstances but without the resources and support to change their circumstances, such as domestic violence, marriage breakdown.
- Involuntary sharing—individuals sharing accommodation due to financial constraints.

A major problem with measuring existing need is the quality and availability of data covering these circumstances. Data sources such as public housing waiting lists and homelessness surveys are useful but have their limitations. It is more practical to calculate the housing required to meet need arising from new household formation. Affordable housing over and above estimates of annual need can filter down to address existing need. If new affordable housing supply cannot meet future need then existing need will continue to grow.

Newly arising need stems from new household formation which results from:

- Population growth—overseas and interstate.
- Natural formation—creation of a new household, for example through a young adult forming their own household or two young adults forming a new couple household;
- Change in household circumstances—a single household splitting into two, forced change in tenure etc.

Modelling household formation is challenging and it is necessary to make some broad assumptions, which must be supported by evidence from reliable data sources. For this simulation we rely on the analysis of HILDA, ABS, AIHW and SIRCA data.

For the purposes of this report and the housing need simulation we adopt the following definition of housing need:

The aggregate of households unable to access market provided housing or requiring some form of housing assistance in the private rental market to avoid a position of rental stress.

This definition covers households requiring public and community housing, subsidised affordable rental housing and the majority of those requiring CRA in the private rental market. It helps determine the affordable housing supply necessary to meet the broad housing needs of those households unable to access market housing (ownership or rental) and also quantifies those able to access the private rental market but placed under financial stress in order to do so (many of these will be eligible for CRA).

This definition follows the UK use of the term, being related to the aggregate affordable housing supply and housing assistance required to meet this need at a defined geographical level, rather than the specific housing requirements of individuals. The summation of housing need at a state and territory level delivers the Australia-wide estimate of housing need.

2.3 Australian examples of modelling housing need

Housing need assessments and housing demand models typically deliver similar outcomes adopting broadly similar approaches; a quantification of future housing requirements through the use of housing market and demographic data. Assumptions are made about future rates of population growth, household formation rates, household income and household size and the figures compared with likely housing supply, with the shortfall identified as need. However, many of the studies are very sensitive to assumptions made around household formation, tenure choice and future incomes, and how these vary over time depending upon economic conditions. Our research uses a modelling approach based on nationally representative data to generate robust, evidence-based outcomes.

An earlier review of needs-based approaches to allocating housing was undertaken by Seelig, Milligan et al. (2008) beginning with state housing authority guidance and discussing the work of the National Housing Strategy (NHS), adopted in the 1990s, which set need benchmarks in terms of affordability, appropriateness and security (National Housing Strategy 1991; 1992). Gabriel, Jacobs et al. (2005:30) reviewed work by the Australian Institute of Health and Welfare (AIHW) who used a residual income approach in the 1990s to develop a model of housing need. Households were considered to be in housing need if their current housing costs were above a defined benchmark and/or they were overcrowded. The Standing Committee on Indigenous Housing set out a multi-measure of housing need incorporating homelessness, overcrowding, affordability, and condition of dwelling and amenities (Gabriel, Jacobs et al. 2005:31).

Local housing need studies and guidance emerged in the 1980s and Seelig, Milligan et al. (2008:46) provide a brief review.

In 2006 Housing NSW commissioned a local government housing toolkit to help local governments assess housing markets and develop housing strategies (Housing NSW 2006). It contained detailed guidance on the use of Census datasets and housing market data to enable local governments to develop a consistent approach to assessing housing markets and quantify the level of supply required to meet housing demand.

The Housing Kit Database provides basic data inputs for the analysis of local housing markets, enabling the user to access basic demographic data that will assist in assessing the emerging relationship between housing needs and demands and housing supply, to identify various housing trends and to assess housing affordability. (Housing NSW 2006)

Baker and Beer (2007), reporting on work commissioned by the SA Government, examined the spatial mismatch between housing need and the supply of private and publicly provided low cost housing at the Statistical Local Area (SLA) level. The work created a simple Spatial Decision Support tool, which used widely available, repeatable, and robust datasets to identify

areas requiring policy priority. The analysis modelled spatial housing need priority across South Australia by identifying SLAs of high potential demand for affordable or government assisted housing, and corresponding low supply of such housing. Because the analysis focussed on demand for low cost accommodation for a high housing need population, it considered the distribution of the population experiencing housing affordability stress, older renters, the population with a disability, and the Indigenous population in classifying the spatial pattern of demand for housing. SLAs were then assessed for their relative ranking of both need and supply.

Akbar, Rolfe et al. (2008) developed a housing demand forecasting model for the Bowen basin designed to determine specific housing needs (demand), again relating to forecasts of supply necessary to meet this need. The model included outcomes related to public housing need, and made assumptions based on ABS and local government demographic and housing variables, assuming these variables would increase linearly over time.

A housing needs assessment was conducted for Moreton Bay in 2011 in response to obligations under the Queensland State Planning Policy.

The study was designed to identify housing demand and the range of housing options necessary to respond to identified housing needs. These needs were identified from the usual ABS demographic data and housing market variables projecting household growth, occupancy rates, dwelling preferences, special housing needs (particularly for older households) and likely supply outcomes. An affordable housing supply target was calculated based on the number of households in housing stress plus the demand for social housing. (Moreton Bay Regional Council 2011)

The National Housing Supply Council produced housing supply estimates in their state of supply reports (NHSC 2010; 2011) attempting to identify the extent of over or undersupply relative to underlying housing demand. The reports noted a lack of reliable data to quantify the demand/supply balance across housing submarkets, and the complexity of such modelling even if data were available. Their modelling was based on an estimate of unmet need using population projections and assumptions of household size with adjustments made for unoccupied dwellings.

SGS Economics delivered a housing need assessment for the City of Ballarat in 2013 (SGS Economics 2013). The assessment was based on the propensity of households to form and reside in particular dwellings using population projections, demographic data and household formation structures. This demand side was then compared to a number of projected supply scenarios to identify a gap.

Finally, the WA Housing Authority developed a housing demand model to estimate the need for public and affordable housing for those on very low to moderate incomes (Considine and Mewett 2015). Using population projections and other demographic and housing market variables the model was designed to identify the scale of affordable housing demand, the locations where this demand was concentrated and changes to demand over time. The model used a scoring system to rank LGAs in terms of demand to aid decisions in the location of new affordable housing units.

The studies above all used very similar data but adopted different methodologies to analyse these data and had slightly different aims and objectives. As a result the model outcomes are different and make it difficult to compare housing needs across the locations. This lack of consistency is inevitable in the absence of a single, defined approach.

2.4 Defining need for policy

This review shows how local and state governments focus on need/demand models that attempt to identify the supply of housing necessary to meet affordable housing demand, which is assessed using population and household projections. Such models are useful in identifying resources required to meet need or to identify priority areas for limited resources. Studies of individual needs are rare, an exception being work by the Department of Health and Human Services Victoria (Dordevic 2015), because they relate to the specific needs of individuals so are very resource intensive.

Existing studies use different methodologies but broadly employ the same data. They tend to be commissioned by state or local government, are expensive and extremely reliant on up-to-date census data. They are also very sensitive to assumptions about household sizes and formation rates.

Australia lacks a consistent methodology for addressing housing needs. A robust, accurate and consistent housing need simulation model would have the following applications:

- Identifying affordable housing targets at a given spatial scale.
- Allowing planning for housing assistance budgets by identifying new households in need of assistance.
- Annual monitoring of housing need.
- Simulating the impact of policy on housing need, household formation and labour market outcomes.
- Delivering evidence to support local housing and planning policy such as inclusionary zoning in high needs areas.
- Delivering evidence to support the development decisions of community housing providers.

At a national level, identifying housing need across states and territories using a consistent methodology would allow the identification of priority areas for expenditure and measurement of how states are performing in meeting housing need targets. From a state government perspective it would offer a number of advantages around resource allocation and setting specific housing targets. Affordable housing targets could be apportioned across LGAs using a defined methodology (see Chapter 5).

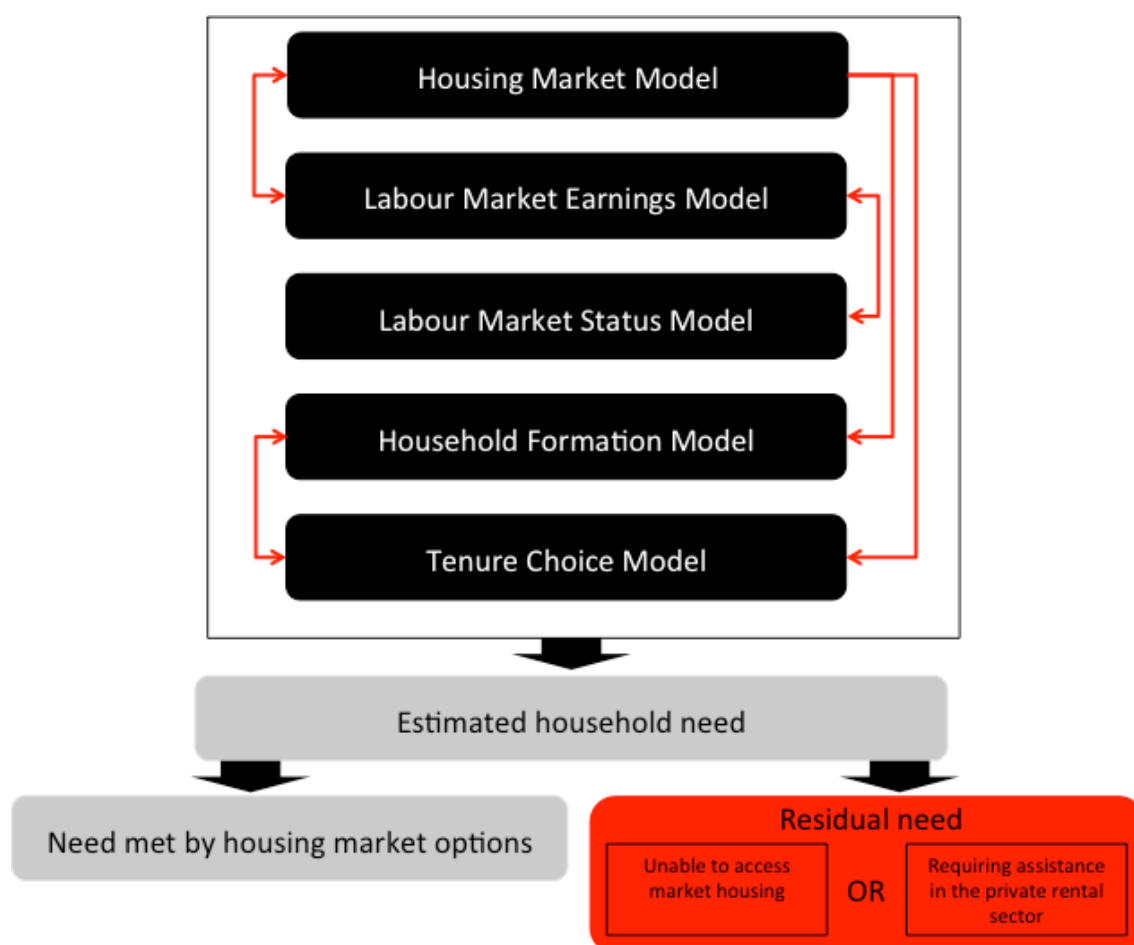
3 Modelling housing need

- The housing need simulation consists of five interrelated models of the housing market, labour market, labour market earnings, household formation and tenure choice.
 - The model estimates housing need as: 1) the number of households predicted to form, but unable to access market housing, and 2) households predicted to form, but expend such a significant proportion of household income on rent that they require some form of assistance to avoid a position of rental stress.
 - The simulation can predict rates of median house price change for a given set of assumptions for interest rates, housing waiting lists and assumed new supply, and therefore it can produce likely housing costs in addition to labour market earnings—key variables in the assessment of housing affordability and hence housing need.
 - The Housing Market Model shows the main demand shifters are growth in the mean wage rate and mortgage interest rates. The coefficients suggest a strong link between state level growth in earnings and house price growth, but a weak link between interest rates and price growth.
 - The Housing Market Model determined that higher levels of housing supply reduces price growth, but the effect is small and suggests that new supply is a limited policy lever to reduce general price levels.
 - Across the models, having a long-term disability or health condition appears to have a surprisingly limited influence in determining predisposition to housing need. Receipt of inheritance and familial financial gifts were associated with a 40 to 70 per cent increase in the odds of home ownership.
 - Local government area (LGA) house prices do not appear to be directly related to the odds of homeownership, i.e. households in the highest cost LGAs are only slightly less likely to be home owners than in less expensive local areas.
-

3.1 The simulation process

Our approach to modelling housing need is based on each of the interacting models shown below.

Figure 3: Simulation structure



Source: Authors.

The modelling strategy involves an estimation of a number of semi-independent but interrelated models (equations) using econometric approaches. The first set of equations deals with the setting of housing costs. We model house price change as a function of changes in mortgage interest rates, household incomes, the ratio of house prices to incomes, the ratio of households to dwellings, the weighting of the population towards the more housing market active age groups, and some econometric terms designed to capture spatial interactions.

The second set of equations focuses upon the labour market. Employment and the ability of individuals to generate income from employment is a key driver of household formation and demand in the housing market. We are interested in two dimensions:

- The labour market choices that people make, and clearly these are conditional on employment opportunities in their local labour market.
- Wage levels that people can expect when choosing or accepting a labour market status.

These dimensions vary by state, gender and employment status. The underlying logic is that choice of labour market status is a combination of demographic factors, including age, gender, educational attainment, and prevailing labour market conditions, including unemployment rate and wage rates.

The second labour market equation concerns the determination of wage rates. We estimate the total expenditure on wages in each state and economic sector to yield median income. The main predictors in the labour market earnings equation are Gross Value Added (GVA) at state

and economic sector level, unemployment rate, economic inactivity rate, interest rates, national economic growth, the level of international and interstate labour market migration, and the extent of international trade linkages.

The next set of equations captures the household formation decision for newly forming households, and their tenure choices (i.e. home ownership, private rental). We estimate these equations using two different approaches, reflecting the two leading alternatives documented. Household formation is defined as the process by which individuals become heads of new households in their own right. For young people this process involves reaching adulthood, and then is subject to further delay as they attain education qualifications, income, savings and relationships. In addition to their own income, the income of the parent household may be important. This equation deals with households forming for the first time, but the simulation model also captures other housing market processes including households moving from one home to another, and change in housing consumption following divorce, separation, widowhood, and death (household dissolutions).

The tenure choice model is estimated separately. This model calculates the likelihood that, at the point of residential change, a household will stay or remain in different parts of the housing tenure market, either purchasing housing or securing public or private rental accommodation.

Using a set of five interrelated econometric models to capture the behaviour of individuals relating to the housing system is complex, and given that some models are macro or time series in nature, and others are micro-economic, they are not easy to integrate in a conventional way, such as within a statistics software package. The coefficients from the various estimations, and the datasets to which these relate, are therefore contained within a series of interlinked Excel spreadsheets. This permits assumptions to be made about key variables of policy interest, including macro-economic variables. The simulation necessitates making numerous simplifying assumptions and precludes the possibility of providing confidence intervals or estimated forecast errors. Additional detail will be provided in a technical report following further model development.

The simulation calculates the impact of changes to these key variables within each of the econometric models, and takes account of interactions between the models. This is important because the dependent variable in a given model may be an explanatory variable in a different model, so there are many interactions. For example the state level wage rate helps to explain labour market participation and employment. These are choices made by individuals, yet the wage rate itself is modelled with respect to national and state level economic variables.

The full range of data used within each of the models is shown in Appendix 1, sourced from robust national collections, including:

- The Household, Income and Labour Dynamics in Australia (HILDA) dataset
- ABS population and household formation projections (state and LGA)
- ABS labour market data
- ABS time series modellers' database
(<http://www.abs.gov.au/ausstats/abs@.nsf/mf/1364.0.15.003>)
- SIRCA – CoreLogic RPData – LGA monthly median house prices and rents.

3.2 The component models

3.2.1 Household Formation Model

The Household Formation Model allows us to estimate the number of households likely to form in each year, in each state. As noted, the simulation draws together the predictions of the demographic, labour market and housing market models to provide a state level prediction of earnings and housing cost distributions for a forward time period. The model provides a bridge between population projections, which are readily available, and the number of households that will require housing. The latter is more important in the context of housing demand, affordability and need because dwellings are occupied by households, which in turn are composed of individuals. In some cases single, childless people will live alone, and so there is perfect alignment between the individual as a labour market participant, and as a household member. In the majority of cases, households comprise more than one adult, and household members may or may not be active labour market participants.

This model is also important because it reflects the endogeneity between housing and labour market conditions on one hand, and demographic decisions on the other. We might expect, for example, that periods of buoyant labour market earnings and plentiful housing supply will be associated with earlier decisions by younger adults to leave the parental home and establish new households. Conversely, periods of weak labour market earnings and/or poor housing supply and affordability are likely to lead younger adults to postpone household formation and entry to the housing system as a new, independent household.

The estimates are derived from a logit panel model calculating the relative likelihood of being a household head, dependent on key locational, social, demographic and economic characteristics. The dependent variable in the model is *Household Head*, which is defined as the person within the household with the highest gross regular income, and where this was the same for more than one individual, we classified by age (allocating headship to the oldest household member). This definition is similar to that used by the Australian Institute of Health and Welfare (2016).

Explanatory variables were selected based on previous work (Leishman, Gibb et al. 2008), and empirical analysis was undertaken to explore the strength of their association with the likelihood of being a household head. The selected explanatory variables captured sex, age, country of birth, income, education, employment, partnership status and change, long-term health condition, house prices, and presence of child(ren) and these are detailed in Table A2.

House price data is used within the model to reflect both rents and local house prices. This was driven by the requirement for data availability and replicability, and the finding of a high correlation (85%) between house prices and rents suggests that house price data is a successful proxy for local rents. An additional explanatory variable was defined using the interaction term between household disposable income and the median house price within each LGA. This was included in the model as a proxy for the relative affordability of housing within local markets. It can be seen as a methodological innovation in that it explicitly links the household formation decision with the housing costs and earnings level of a local area. While the top four house price quintile LGAs have a general pattern of slightly decreasing odds of being a household head with increasing household income, people living in the lowest house price LGAs have rapidly decreasing odds. This indicates that there is some interaction occurring between household income and local house prices affecting the relative likelihood of being a household head (Table A2).

The models are estimated for the total population, and also for males and females separately. This is based upon our understanding that the factors affecting the propensity to be a head of household are known to be different for men and women (Kupke, Rossini et al. 2014). The

likelihood of household headship was modelled using a longitudinal logistic random effects regression, with robust estimators to calculate standard errors.

We note the following limitations and point the reader to the potential for future development detailed in Section 5.2. Attrition bias is a potential limitation of longitudinal studies, but loss to follow-up in HILDA has been low each year (<10% in most waves) (Summerfield, Dunn et al. 2011). Furthermore, to induce bias of our estimates of association, attrition must be related both to future change in household head formation and future change in our explanatory variables. The attrition that has occurred has resulted in disproportionate loss of people of younger age, born outside Australia, who are unemployed or in low-skilled occupations. The dataset includes imputed values for household income (Little and Su 1987), and we have used these in our analyses as approximately 20 per cent of observations have missing income data. To guard against any possible selection bias and improve generalisability to the wider Australian population we have used the imputed income data in the main analysis. Finally, confounding from unmeasured variables cannot be discounted. This is a common potential source of bias to the estimated interaction term (VandeWeele and Knol 2014).

Results are presented in Table A2. The stratified analysis for males and females shows distinct differences. Overall, females are substantially less likely (about 80%) to be head of a household, and household headship becomes increasingly likely with age. People born overseas, especially from non-English speaking countries are significantly less likely to be household heads. There is a linear relationship between the likelihood of being a household head and level of education, that is, people with high school education are less likely than people with university education to be a household head. This relationship is unsurprisingly similar for employment, where people with full-time employment are more likely to be a household head than people who are not in the labour force. This is a relevant finding when we consider that the analytical sample is restricted to a working age population.

The findings for partnership change show that compared to people who remain in a couple, people who become single are 15 times more likely to be the head of a household. This is different for men and women, notably because women are less likely to be a household head. Long-term health conditions appear to only influence slightly the likelihood of being a household head.

3.2.2 Labour Market Status Model

This model examines individual labour market status in terms of participation and employment. The output is important for the simulation because it assesses likely labour market participation and employment outcomes for individuals, and these are key determinants of the ability to purchase or rent within the housing market.

We model labour force participation (versus not in the labour force) and the likelihood of being employed (versus unemployed) as a two-step sample selection process (Heckman 1979; Verbeek and Nijman 1996; Vella 1998; Vella and Verbeek 1999) using a probit panel data approach.

Sample selection bias occurs naturally in labour supply modelling as the probability of being employed if in the labour force and of being a labour force participant are interrelated. Potential bias arises from the exclusion of non-participating individuals from the sample when estimating the probability of being employed versus unemployed. Consequently, econometric model-based estimates of coefficients may be biased and inconsistent (i.e. the size and statistical significance of individual model estimates or coefficients may lead to false conclusions and poor policy prescription or advice).

Since Heckman (1979), it has been commonplace in econometric analysis to correct for sample selection bias when estimating labour supply models through a two-step procedure. In the first

step, a 'reduced form', or secondary, equation is specified. Outcomes from the reduced form equation are then used to construct a selection bias 'correction term' that is incorporated into the second step, a 'structural', or primary, equation which accounts for the non-randomness of the sub-sample and controls for selection bias.

That is, the estimates of an employment equation are obtained via an equation which determines the selection rule—the probability of being a labour force participant.

The Mundlak specification of the Random Effects panel model allows for potential correlation between the individual specific effects and explanatory variables (Chamberlain 1980; Mundlak 1978). To implement the Mundlak 'corrections' the individual (over time) means for each of the time-varying explanatory variables are included as additional explanatory variables in the model. Once the correction is made the RE panel estimator is unbiased, consistent and efficient.

Results are presented as marginal effects (Table A3) which are interpreted as increased or decreased probability of being a labour force participant, compared to each reference category. The likelihood of participation in the labour force gradually increases from youth through to middle age, peaking between the ages of 45 and 50. These results show that young adults aged between 25 and 30 years are substantially less likely to participate in the labour force. Enrolment in education and training is likely to be a central explanation of this difference. While not as influential as age, educational qualifications also influence the likelihood of participation in the labour force—in general, university level qualifications are associated with higher participation. The presence of small children is negatively related to employment participation.

The likelihood of being employed (versus unemployed) appears much less influenced by the demographic and household characteristics in the model. This would be expected, because employment is much more dependent on external factors, such as the availability of jobs in the accessible labour market.

3.2.3 Labour Market Earnings Model

Having made choices concerning labour market participation and employment (subject to personal circumstances and market conditions), individuals living in households face the prospect of earnings governed by a range of macro, regional and local economic factors. The economic and demographic forces that combine to create these outcomes are complex, and it is necessary to simplify them somewhat within the context of the housing needs simulation model. In particular, it would be impractical to recognise explicitly that the supply of labour to a regional labour market represents an aggregation of individuals' labour market participation choices. Instead, the regional (state level) wage rate is treated as exogenous in the labour market participation and employment models. In this section, we ask what factors combine to determine the wages expected by an individual having decided to participate, and having secured employment. Thus, the supply of labour is, in essence, treated as exogenous in this model.

The model does not seek to explain wage differences between states, but accepts these as a given. Instead, the model is of growth in the median wage rate over time which then determines the ability of an individual to access housing along the continuum. Although the equation is estimated as a population averaged panel, the intention is to explain (as much as possible) variation in wage growth over time with respect to time series economic variables. This follows a broadly similar approach to that used by Bramley (2010) in the UK, but marks a clear departure from regional labour market models concerned with explaining differences between states or regions (e.g. Meen 1999).

The specification of the model was subject to substantial experimentation with respect to numerous time series economic variables available from ABS—particularly the time series

modellers' database (Appendix 1). The results summarised in Table A4 reveal a range of theoretically plausible and 'correctly' signed partial determinants of wage growth. Growth in service sector and retail sector GVA, at national level, are important predictors but operate in opposite directions. Although variables measuring GVA in all other main economic sectors were entered in early specifications, none proved statistically significant. Growth in corporation tax take is another national variable. This is positively signed, suggesting that as corporate profits, and hence government tax revenues, rise then there is a positive knock-on impact to labour market earnings. The other variables are measured at state rather than national level. The male unemployment rate, and change in the female inactivity rate are significant and correctly signed. Tourism and the value of exports from the state are also significant, positive predictors of wage growth. Finally, the natural log of median wages in the preceding time period is significant, though with a very small coefficient. This variable can be viewed as a proxy for path dependency or persistence in wage growth.

The labour market earnings equation is specified and estimated in order to allow the simulation model, overall, to have the capability of responding to a range of macro (national and state level) economic scenarios. Given that state level exports and two measures of gross value added are statistically significant, the model attains this requirement. In addition, statistically significant unemployment / inactivity variables mean that predicted labour market earnings are not isolated from the micro-econometric dimension of the simulation model. In other words, if economic and demographic variables were to conspire to produce higher or lower than currently prevailing unemployment or inactivity, then this would feed through to the predicted rate of change in median labour market earnings in the simulation model itself.

Although adjusted R square statistics are not available for Stata's population averaged panel estimator, it can be noted that an R square over 0.40 is produced when an OLS random effects estimator is used. For a model estimated in differences, this can be regarded as quite a strong empirical performance.

3.2.4 Housing Market Model

The Housing Market Model predicts annual change in median house prices. Since the mid-1990s, modelling approaches that emphasise the relationship between the size and quality of the housing stock, and demand for housing, have become dominant (Meen 2005; Meen 2008; 2011; Leishman, Gibb et al. 2008). Contemporary behavioural housing market models generally reflect a tendency for housing costs to rise persistently when there is a mismatch between stock and demand, but also attempt to capture short-run effects such as shocks created by changes in labour market conditions, earnings, the cost of borrowing, or simply peoples' expectations about future likely rates of price appreciation. The latter may be important as a result of the dual function of owner occupied housing as a consumer good (or asset capable of generating a flow of consumable housing services), and an investment asset.

Housing market models estimated at smaller spatial scales tend to emphasise processes such as migratory flows between localities and housing market areas and the interaction between the boundaries of local labour markets and housing systems. There is a clear connection between decisions about where to work, where to live, and whether to commute between locations or migrate between localities / areas. Work in the UK has also emphasised the role of the planning system in supplying land and facilitating development, and the interaction between new-build housing supply and migration (Bramley and Leishman 2005).

Yet the dynamics of local housing systems may be very complex, and difficult to capture adequately in econometric models. For example, Bramley and Leishman (2005) have shown that boosting land supply gives rise to higher housing completions, but not proportionately, and that higher rates of migration rather than real price effects may result. Meanwhile, the

interactions between labour market and housing systems choices combine to make housing affordability and need an inherently spatial policy problem.

The modelling approach adopted here emphasises the state level as the primary spatial unit in which national and regional economic forces combine with demography and the housing system. These interactions give rise to the need for housing (through the number of households) and the ability of those households to meet those needs by accessing market provided housing. Some groups of households actively participating in the labour market may be unable to meet their housing needs in the private market through a combination of low earnings, the composition of the household, and/or the high cost of housing, while those outside the labour market will often require social housing.

The data on housing market transactions and prices were provided by CoreLogic and were used to construct median price series at state/territory level. One driver of this decision was the fact that the same data could be used in the future to construct price series at LGA level. The CoreLogic dataset is finely grained, but is not provided at the level of the individual transaction. There were more than 200,000 records in the original dataset, and each of these relates to the number and median price of dwellings sold in a particular calendar month. The dataset also distinguishes between houses and units. In other words, for each LGA there are 24 records for each calendar year—12 cell counts and 12 median prices for houses, and another 12 cell counts and 12 median prices for units. By totalling the sum of these cell/price products and dividing by the total number of transactions, an approximate median annual price series was created for each state and territory, covering the period 2000–15.

The model specification is shown in Appendix 3. Although the model is quite simple, it performs well in empirical terms (an OLS estimation yields an adjusted R square of approximately 0.59, which is not inconsiderable for a model estimated in differences, see Table A6). The main demand shifters are growth in the mean wage rate, which has a large coefficient and is positively signed, and mortgage interest rates. The coefficients suggest a strong link between state level growth in earnings and house price growth, but a weak link between interest rates and price growth. The ratio of house prices to earnings is significant, but the coefficient is small. The interpretation is that this ratio would have to become very large before significant downward pressure on prices were to result.

The model also includes indicators of unmet need (waiting list and change in waiting list levels). These coefficients are worth a mention because they have different signs. The interpretation might be that states with higher waiting lists have slightly lower rates of price growth, but that growth in waiting lists leads to further pressure on market housing, hence higher price growth. However, it is notable that these coefficients are very small, so these interactions between demand for non-market housing and house price change seem weak.

A number of limitations should be noted in relation to the Housing Market Model. Perhaps the most serious is that the time series is quite short. There are 15 annual observations for the eight geographical units, but this falls to 12 after taking differences in logs of some variables, including lags and accounting for unavailability of wage rates for the last year of the estimation period. In addition, the model is very simple. Although a great deal of preliminary modelling work was done, and this involved some experimentation and optimisation, no statistically significant link could be found between the number of households, dwellings, or the ratio of these, and house price change. In other words, the partial adjustment modelling approach was found to be unviable. This means that our Housing Market Model emphasises flows of demanders, and housing market activity, rather than price adjustment as a function of disequilibrium in the ratio of households to housing stock. Thus, the model is more akin to the 'inverted demand function' models of housing prices popular in the UK/US literature in the 1980s and 1990s. However, the annual volume of new housing completions is significant when expressed as a ratio to the number of people aged 18–39 (this category of population was

chosen as representative of the likely most active groups in the housing system). The coefficient is statistically significant and negative, suggesting that higher levels of housing supply reduce price growth, but the effect is also very small and suggests that new supply is a limited policy lever to reduce general price levels.

For the simulation overall, the Housing Market Model means that the simulation has the capability to reflect economic and demographic effects not just in terms of likely labour market outcomes, but in terms of likely housing costs. For a given set of assumptions concerning interest rates, housing waiting lists, assumed new supply, and the endogenous variables, the simulation can predict rates of median house price change, and therefore it can produce likely housing costs in addition to labour market earnings—key variables in the assessment of housing affordability, and hence housing need.

3.2.5 Tenure Choice Model

The Tenure Choice Model allows us to estimate the number of households who, after a change in residence, occupy one of four tenure types (owner, private rental, public housing or other forms of tenure) in each year, in each state. The estimates are derived from a multinomial logistic regression model calculating the relative odds of owning, being in public housing or another tenure arrangement, compared to the odds of renting privately (the base case), when people made a residential move between annual survey waves within HILDA (the results are detailed in Table A6). Estimates are adjusted for key social, demographic and economic characteristics.

The dependent variable in the model is *tenure type* of the household: owner (includes outright owners and mortgage holders), private renters (households renting from a private landlord), public renters (households renting government provided housing at a fixed cost of rental relative to their household's income), or all other rental type tenure arrangements (including community and cooperative housing, employer provided housing and caravan parks).

The Tenure Choice Model is an important part of the overall simulation model because it allows us to estimate the likelihood that, at the point of residential change, a household will remain in different parts of the housing tenure market, either purchasing housing or securing public, private, or other rental accommodation. It allows us to infer the scale of housing demand within each of these tenure sectors.

In modelling tenure choice, explanatory variables were selected to reflect known demographic, employment and income related influences over household tenure outcomes, alongside local housing costs (Bourassa 1995) and the user cost of capital (Wood, Watson et al. 2006). The empirical analysis was designed to explore whether these variables could be linked to the likelihood of occupying a particular tenure type after a change of residence in the dataset. Explanatory variables captured sex, age, country of birth, educational attainment, children in the household, inheritance, long-term illness or disability, user cost of capital, local level property taxation and depreciation, income, and a series of variables describing the local area (LGA). The selected explanatory variables and results are detailed in Table A5. Multinomial longitudinal logistic random effects regression modelling was undertaken, using robust estimators to calculate standard errors. Limitations of this modelling strategy and the underlying dataset have been summarised in Section 3.2.1.

Table A6 shows that women are more likely to be owners rather than private renters compared to men. People are more likely to occupy a tenure other than private rental as they age (e.g. people who are 55–64 years of age are over five times more likely to be owners). Migrants to Australia from an English speaking country are more likely to be in private rental tenure while no difference in tenure was found between people born in Australia and people from non-English speaking countries.

People with higher levels of education were more likely to be owners than private renters and people with the lowest level of education were more likely to be in public rental than private rental. People with a long-term disability were more likely to be in public housing and less likely to be home owners. Increasing user cost of capital and income were associated with substantially increased likelihood of ownership. Receipt of inheritance and familial financial gifts were, perhaps unsurprisingly, associated with a 40 to 70 per cent increase in the odds of home ownership.

Looking to the characteristics of the LGA, house prices do not appear to be directly related to the odds of home ownership, that is, households in the highest cost LGAs are only slightly less likely to be home owners than in less expensive local areas. Compared to private renters, home owners are less likely to live in areas where the rental costs are high. In areas of the highest population density, households are much less likely to be in home ownership, consistent with ownership patterns within apartment developments.

Appendix 2 provides more detail on the five component models.

3.3 The simulation approach

The simulation utilises the models described above and is designed to produce an estimate of the number of households falling into housing need. This is broken down into 1) the number of households predicted to form, but unable to access market housing, and 2) households predicted to form, but expend such a significant proportion of household income on rent that they require some form of assistance to avoid rental stress. However, the simulation also produces a wealth of other outputs. Some of these are calculated in order to facilitate the final estimates of housing need, but remain of potential interest in their own right, such as income distributions/income inequality, unemployment rates, economic inactivity rates, median house prices and median private rents.

The simulation permits interactions between many of the estimated equations or modules, however it cannot be viewed as a straightforward sequence of calculations that lead to the predicted outcomes. Some of the interactions are subtle, so to simplify, and for the purpose of illustration, let us suppose that the simulation works according to the following sequence:

- 1** The user specifies economic scenarios at the level of Australia, and each state or territory economy. This means setting the assumed values for a number of economic variables including interest rates, volume of tourist visitors and corporation tax levels at the national level. The user also sets assumed rates of growth of gross value added (GVA) in the service and retail sectors at state level, and the rate of growth in state export volume. These are the principal drivers of house prices at the macro-economic level, and of growth in labour market earnings at state level. The user also has the ability to set assumptions for the volume of newly developed housing completions, and the level of waiting lists for social rented housing. These variables have a statistically significant but modest influence on rates of house price growth, hence house price levels, predicted by the simulation.
- 2** The labour market earnings equation within the simulation takes the assumed macro-economic and state variables set by the user and predicts median labour market earnings at the state level. The predicted medians are then used to derive median earnings for each of a range of labour market groups based on age and qualification level.
- 3** The house price change equation makes a prediction based partly on the macro / state variables set by the user. Past values of significant variables (e.g. the price to earnings ratio) also play a part. Finally, the predicted rates of change in labour market earnings arising from (2) above feed into the predicted house price change figures. As mentioned, assumptions about new housing completions and waiting lists play a minor role in these predictions.

- 4 Population projections for each age (from ABS) are combined with the household formation module to produce a predicted number of household heads at state level. These estimates are produced for each combination of gender, age group, qualification level and disposable income quintile.
- 5 The simulation produces a final household number estimate from (4) above by assuming that past patterns of cohabitation continue into the future. We know from our analysis of HILDA what proportion of quintile 2 male household heads cohabit with, for example, quintile 1 females. Of course, the household head is assumed to be the person with the highest predicted labour market income irrespective of gender.
- 6 The simulation creates an income distribution at national level. Given that we have a predicted number of households for each state, and for each combination of cohabitation by income quintile (or singles), the number of cells or categories in Australia is quite large. Each cell or category has a different predicted total household income level.
- 7 The tenure choice module predicts the most likely tenure choice of individuals within each population group. Given the progressively more detailed definition of a group that arises as we move from 4 to 5, then 6, above, the number of groups or household types being predicted is very large. There is a distinct group for each age band, qualification type, gender of household head, and household disposable income (note that the simulation is no longer using income quintiles by this stage but is predicting probability of tenure choice with respect to the predicted household level disposable income in monetary terms). The tenure choice model predicts, for each group, a probability of entering home ownership, and a probability of entering private rental. Where the probability of entering home ownership or private rental is very low, all households in that group are assumed to be unable to access market provided housing.
- 8 The simulated disposable incomes of households predicted as entering private rental are examined and, if they fall below a threshold, those households are assumed to be private renters requiring rent assistance. This threshold is not constant but varies between states. However, the model predicts that households may require rent assistance if more than 30 per cent of gross disposable income needs to be paid to meet housing costs. The housing costs assumed in this calculation are those predicted by the housing market module described in (3) above.

There are a number of significant limitations to the simulation approach adopted in our method to estimating housing need. Many of these stem from the need to make assumptions to simplify economic and demographic processes in order to allow the simulation to be tractable. Other limitations reflect data quality or availability. The leading limitations and aspects calling for further development are:

- Several of the equations have been estimated using either national data, or panel datasets comprising state and territory data with relatively short time series. While such approaches make it possible to estimate the parameters governing relationships between key housing and labour market variables, there is a danger that important heterogeneities are ignored or minimised. For example, propensities to form a household for a given age group might vary between states. Alternatively, the desirability of entering home ownership may vary between states or other units of geography, perhaps in relation to insufficiently well understood cultural or historical factors. These are two simple examples—there are many other unexplored causes of heterogeneity that are simply beyond the current data availability to examine or test for.
- Simulation models necessarily assume that key relationships between variables remain unchanged in the future. However, structural breaks can arise for many different reasons. For example, it is widely accepted that historically low levels of interest rates and liberal

lending policies fundamentally altered the behaviour of the housing system from the late 1990s. We cannot predict future structural breaks, when they might occur, or the form that they might take. Inevitably, any system of econometric results used to predict or forecast any more than one or two years into the future will run the risk of generating significant errors.

- The simulation itself rests on a large number of assumptions. Generally, these assumptions are 'safe' in the sense that ratios between important variables are assumed to remain at the values observed in the estimation period or base period. For example, the ratio of median earnings for university graduates to median earnings overall is assumed fixed. Indeed, the ratios between each labour market group defined by age group and qualification type, is assumed fixed relative to median earnings. In reality, these ratios are likely to evolve over time, and are likely to evolve differently in each state, depending on the structure of the regional economy.
- Although the simulation was designed to calibrate to the best available estimates of housing need in a base period, the reality is that there are no regularly produced and methodologically consistent estimates of housing need in Australia—and the dearth of data is particularly acute at LGA level. This provided a great deal of the justification for this research project, but also means that confirming and validating the estimates produced by the model is problematic.

4 Simulation model outputs

- The simulation produces an estimate of the number of households requiring assistance with their housing costs, and an estimate of the number of households attempting to form, but without the resources to enter home ownership or private renting, thus requiring social housing or some form of subsidised affordable rental.
 - Future levels of housing need depend on economic conditions—particularly labour market earnings and status—in addition to demographic and housing market factors.
 - The model predicts increasing price to income ratios for all states post 2017.
 - The model predicts big increases in the number of households in housing need in NSW and Victoria. Numbers remain relatively stable in the other states with slight declines in SA and WA.
 - Over 370,000 households are estimated to be in housing need in NSW, rising to 678,000 in 2025. For Victoria the figures are 291,000 and 462,000. In Queensland the number of household in housing need is predicted to fall from 381,000 to 331,000 by 2025.
 - Housing need in Australia is estimated at 1.3 million rising to 1.7 million in 2025. That is around 14 per cent of the total number of households predicted by the simulation, rising to over 16 per cent in 2025.
 - In practical terms, the outputs produced by the simulation model should be regarded as setting indicative trends in housing market conditions and housing need rather than precise annual forecasts.
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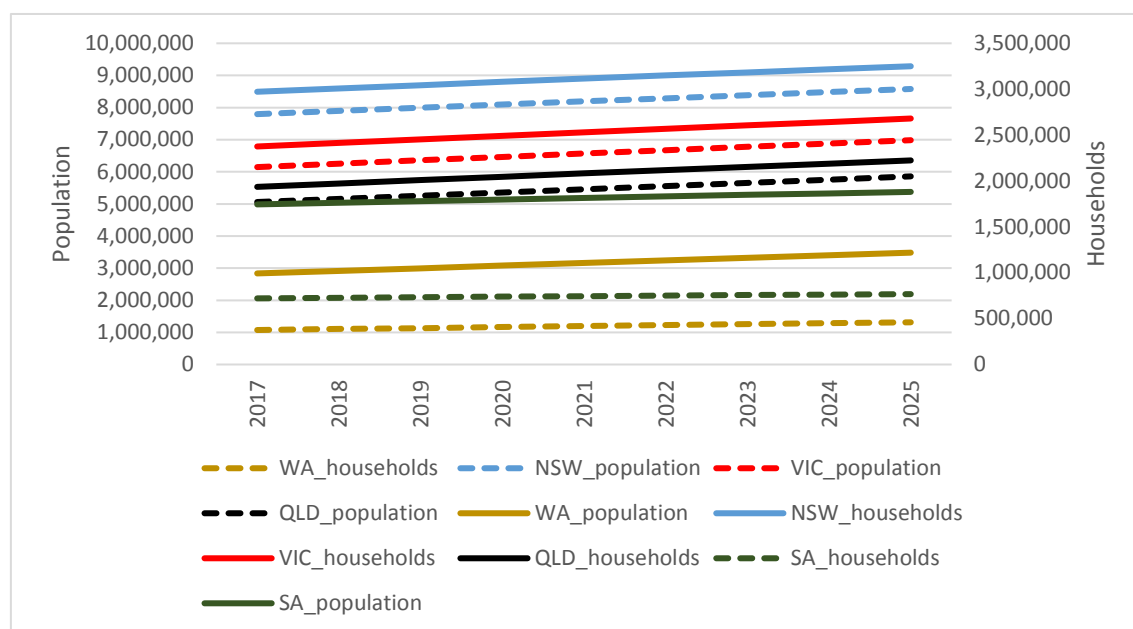
A variety of demographic, labour market and housing system outcomes can be estimated by the housing need simulation in response to alternative macro and regional economic scenarios. Assumptions concerning variables such as sectoral GVA growth, regional value of exports, tourism, interest rates and taxation levels all influence the expected labour market outcomes in each state and territory. In practice, the most powerful predictor of labour market status (aside from demographic and educational variables) is the level of expected labour market earnings for an individual. Meanwhile, the most powerful predictors of change in labour market earnings are change in sectoral GVA and in the value of state level exports. In this chapter, we examine the various economic and housing system outcomes that could arise from a number of economic scenarios, simulating future levels of housing need that arise from economic scenarios for the period 2017–25.

4.1 Population projections

The simulation model uses ABS population projections as a starting point. These projections are multiplied with coefficients from the Household Formation Model (HFM) and housing/labour market variables (housing costs and labour market earnings), producing a predicted number of households. These estimates are based on the state/territory level. In theory, it would be

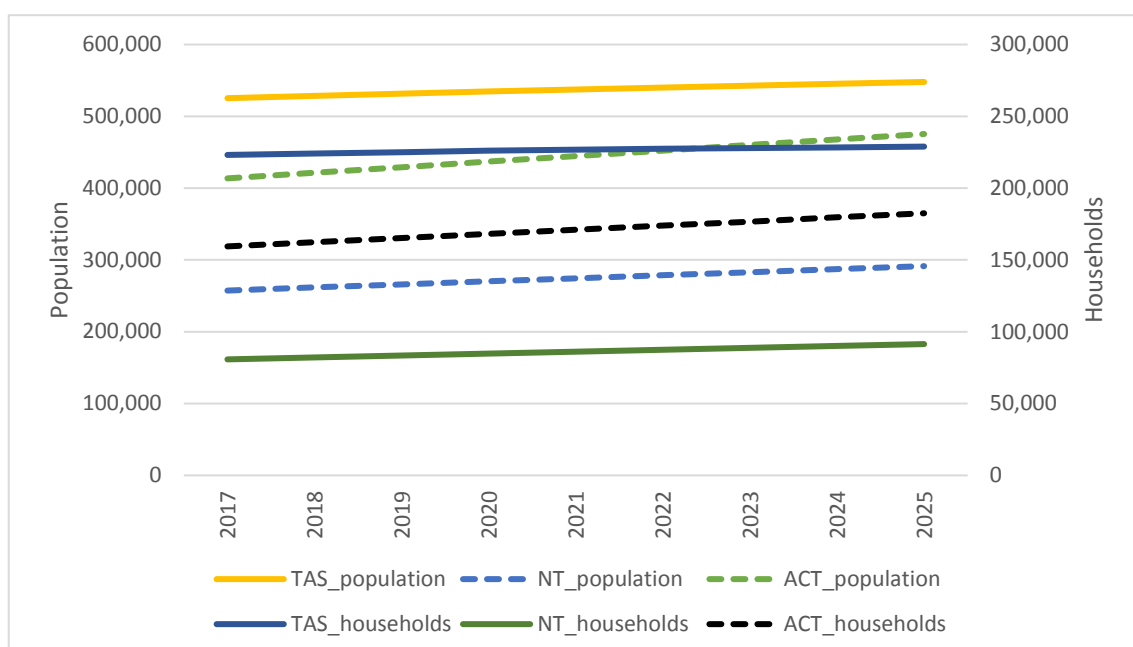
possible to produce estimates at other units of geography, including the local government area, should sufficiently up-to-date, finely grained data on population projections and other supporting data become available at this level. Figures 4 and 5 show the projected populations (from ABS) and projected number of households produced by the simulation for states and territories (plus Tasmania) respectively.

Figure 4: Population and households for states



Source: Authors.

Figure 5: Population and households for Tasmania and the territories

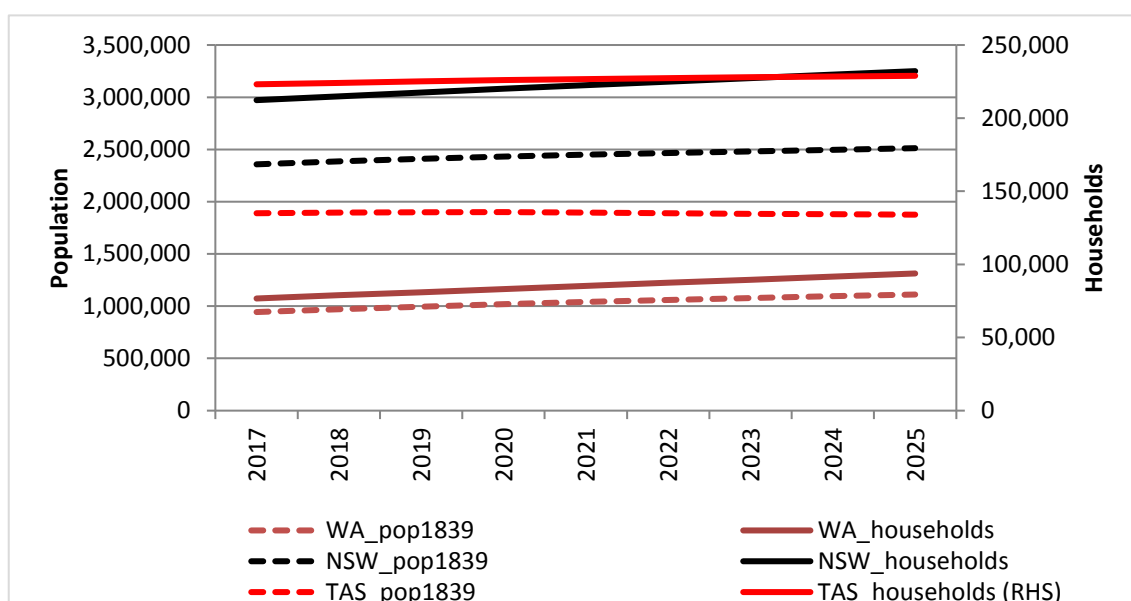


Source: Authors.

The simulation produces a different household number estimate for each state or territory as economic assumptions change. However, the sensitivity of the simulation to economic variables is subtle. The charts reveal that some states (notably New South Wales and Victoria) have a higher rate of household growth than population growth, albeit the difference is small. The projections and predictions summarised in Figure 4 and 5 apply to the baseline economic scenario.

It is accepted in housing economics that the level of housing market activity demonstrated by individuals varies over their lifetime, and consequently, the age profile of the population in a housing market has a bearing on the level of housing market activity, and also on the level of house prices and private rents. Studies based on 1980s and 1990s data suggested that the population in the 20–29 age group had a disproportionate impact on housing system outcomes. As housing affordability has deteriorated over the past 20 years, the definition of the population groups most active in the housing system has been revised repeatedly. However, it is likely that the size of the working age population will continue to have a disproportionate influence on the evolution of house prices and private rents, and hence on the level of housing need. Figure 6 shows, for selected states, the relationship between populations in the 18–39 age group to the number of households predicted by the HFM. The projections show differences in the growth rates of households to population measured on this basis in New South Wales but not in Western Australia or Tasmania. This suggests that new households will increasingly be slightly older in NSW compared to other states as younger households struggle to form due to high house prices and rents.

Figure 6: Working age population and households for selected states



Source: Authors

4.2 Wage rate projections

The simulation produces forecast median wage rates for each state and territory, driven by the labour market earnings (LME) equation. The median wage rate is retained as a pivotal endogenous variable in the simulation, and it is instrumental in calculating typical wage rates for each combination of age group and qualification level (none, certificate, diploma, bachelors, masters+). The ratios of earnings in each of the population sub-groups to overall median labour market earnings are assumed constant. The LME equation therefore predicts changes to the

median wage rate, and these changes automatically filter through to all age band/qualification level sub-groups in the simulation.

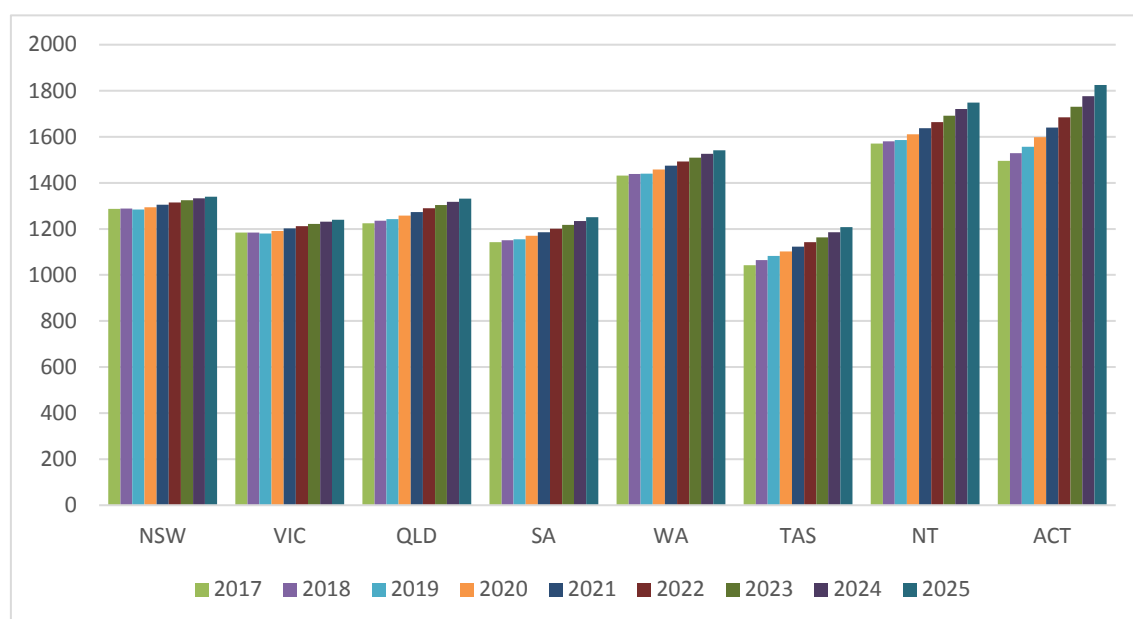
Forecasting regional (state/territory) economies is clearly a highly specialised pursuit, and outside the scope of this project. However, because economic variables have a significant impact on labour market outcomes, hence earnings and levels of housing need, our approach attempts to forecast regional economies to produce housing need estimates. The following table summarises the assumptions made for key economic variables in the baseline scenario. The baseline figures are a representation of past values (2005–15) for these variables. The alternative scenarios are a common-sense variation on these baselines.

Table 1: Baseline economic forecast assumptions for each state and territory

Variable	NSW	VIC	QLD	SA	WA	TAS	NT	ACT
Exports	2.50%	2.50%	1.25%	1.25%	1.25%	1.25%	2.50%	2.5%
GVA retail	2.25%	2.63%	2%	1.88%	2.25%	0.75%	2.63%	2%
GVA services	3.00%	3.50%	2.00%	2.50%	3.00%	1.00%	3.50%	2.00%

Source: Authors.

Figure 7: Wages for all states and territories



Source: Authors.

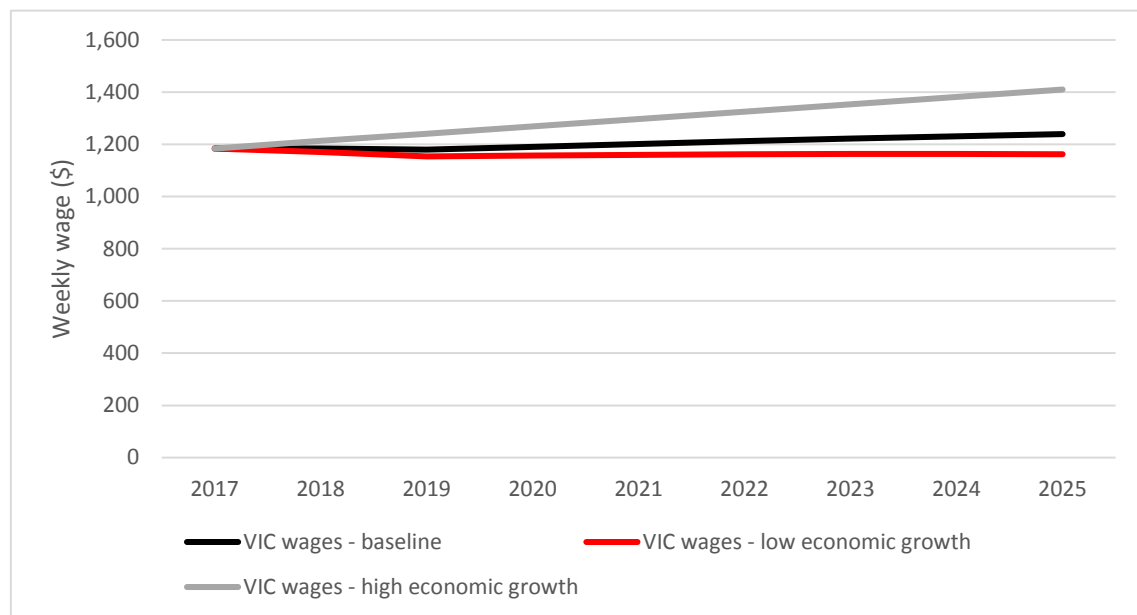
Of course, there is no guarantee that future economic or labour market outcomes will mirror those witnessed in the past. Therefore, the model allows the user to vary assumptions, with these assumptions having an enormous bearing on the simulation model outcomes. Assuming that the next 10 years will be much like the last 10 (an assumption made for the purposes of reporting model outcomes), the simulation shows that labour market earnings will grow at a much higher rate in the Northern Territory and Australian Capital Territory than most other states, and that growth will be somewhat lower in Western Australia, Queensland and Tasmania. New South Wales shows growth over the period of around 3 per cent per annum with WA less than 2 per cent (Figure 7). These figures are consistent with wage price growth recorded by the ABS.

4.3 Labour market outcomes

The housing need numbers are predicted partly through demographic projections, and partly through interaction of housing system variables (prices, rents) with labour market variables (labour market status, earnings). Assumptions about national and regional economic variables have a significant impact on predictions on labour market status and earnings. Figure 8 shows the spread of median wages produced by the simulation for Victoria.

It is important to remember that the simulation model outputs will vary in relation to assumptions about the labour market/demographic distribution of economic scenarios. For example, the simulation user might assume that an economic boom will affect higher labour market earners proportionately more than lower labour market earners, or that more (or less) people will enter education and attain qualifications in the forward simulation period, and this will affect predictions of labour market status and earnings for population sub-groups. However, in the simulation results reported here, none of these assumptions have been made— economic scenarios are assumed to affect all population sub-groups equally, and the distribution of qualifications by age band and gender is assumed to remain constant in the forward simulation period. The model offers significant potential to predict how changes to educational outcomes could affect labour market and housing need outcomes.

Figure 8: The impact of macro-economic scenarios on wages rates in Victoria



Source: Authors.

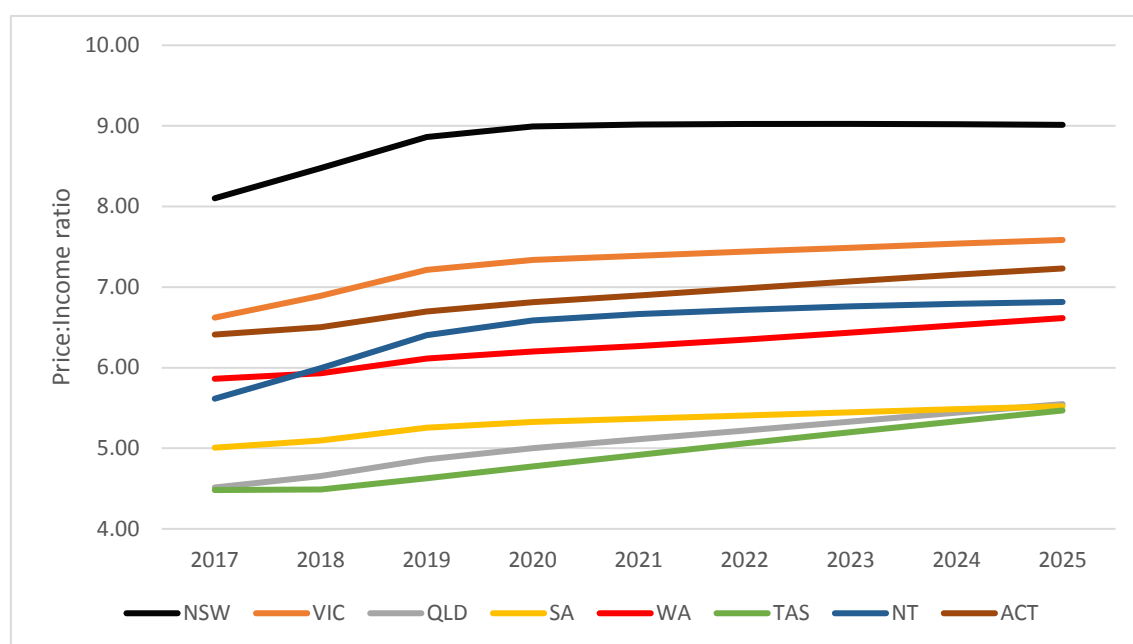
The simulation results summarised in Figure 8 show that the median wage rates produced by the model are very sensitive to economic assumptions. Median wages might range between \$1,000 and \$1,700 by 2025 in real terms in Victoria, depending on the assumptions made. Predictions about labour market status (which amalgamate to predictions of unemployment rates) are much less sensitive.

4.4 House price projections

Figure 9 summarises the ratio of median house prices to median annual wages produced by the simulation in the forward period under the baseline set of assumptions. The behaviour of the simulation is, of course, heavily conditioned by the data observed in the estimation period, and it

predicts significant growth in real wages, house prices and rents even at the baseline set of assumptions.

Figure 9: House price to income ratio for all states and territories



Source: Authors.

The simulation predicts an initial fall in the price to income ratio between around 2015 and 2017 in all states and territories other than New South Wales. This could be due to wages rising faster than prices in some states and territories rather than simply a fall in prices. Note these are state level prices not capital city prices, hence trends are different from the capital city medians.

The prediction for the remainder of the forward simulation period is one of deteriorating affordability at the middle of the price and income distributions. Given the long forward time period under consideration, it would be prudent to emphasise the predictions in the first half of the simulation period rather than the latter years. The simulation indicates that if economic variables over the next few years follow similar values to the estimation period, then house prices will continue to rise at a greater rate than wages to 2020. While the simulation suggests that these trends continue to 2025, caution must be used when using econometric results to forecast or simulate outcomes for more than a few years ahead. One of the model's strengths is the ability to simulate the outcomes of price to income ratios under a variety of economic and housing supply scenarios.

4.5 Housing need estimates

The simulation produces an estimate of the number of households likely to enter private renting and requiring assistance with their housing costs (e.g. CRA), and an estimate of the number of households attempting to form, but without the resources to enter home ownership or the private rental market, thus requiring social housing or some form of subsidised affordable rental such as NRAS. Adding these two estimates produces an overall estimate of housing need. The estimates are summarised, for the baseline scenario, in Tables 2 and 3 (figures have been rounded to the nearest 100). The results are also shown in Figures 10 and 11 where the residual refers to the number of households unable to enter market housing. Total need figures are presented in Table 4.

Table 2: Households unable to enter market housing: composite scenario

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	Australia
2017	139,600	110,400	149,600	46,100	59,000	14,000	3,300	5,400	527,400
2018	134,200	112,400	135,100	45,100	57,600	13,700	3,400	5,500	507,000
2019	130,100	113,800	126,100	44,500	55,900	13,500	3,500	5,500	492,900
2020	151,600	116,500	120,900	44,100	61,000	13,400	3,500	5,600	516,600
2021	183,500	120,600	119,700	44,100	62,800	13,400	3,600	5,700	553,400
2022	221,700	126,300	120,000	44,300	60,700	12,700	3,600	5,800	595,100
2023	242,200	136,600	120,500	44,600	51,100	12,100	3,700	5,900	616,700
2024	252,600	151,800	124,200	45,000	48,600	11,400	3,700	6,000	643,300
2025	255,100	171,700	129,600	45,900	53,700	12,100	4,100	6,100	678,300

Source: Authors.

Table 3: Households requiring rent assistance to avoid rental stress: composite scenario

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	Australia
2017	233,300	181,000	231,700	57,600	73,000	17,400	4,900	7,200	806,100
2018	224,700	185,000	209,200	56,600	71,400	17,100	5,000	7,400	776,400
2019	218,000	187,900	195,400	56,100	69,600	16,900	5,100	7,600	756,600
2020	253,400	193,200	187,800	55,800	76,700	16,900	5,200	7,700	796,700
2021	305,700	200,700	186,400	56,100	79,300	17,000	5,200	7,800	858,200
2022	368,200	210,900	187,100	56,400	76,800	16,200	5,300	7,900	928,800
2023	401,500	229,000	187,900	56,800	64,200	15,300	5,400	8,100	968,200
2024	418,500	255,400	193,500	57,200	60,900	14,400	5,500	8,200	1,013,600
2025	422,400	290,200	201,800	58,400	67,600	15,300	6,100	8,300	1,070,100

Source: Authors.

Table 4: Total housing need estimates: composite scenario

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	Australia
2017	372,900	291,400	381,300	103,700	132,000	31,400	8,200	12,600	1,333,500
2018	358,900	297,400	344,300	101,700	129,000	30,800	8,400	12,900	1,283,400
2019	348,100	301,700	321,500	100,600	125,500	30,400	8,600	13,100	1,249,500
2020	405,000	309,700	308,700	99,900	137,700	30,300	8,700	13,300	1,313,300
2021	489,200	321,300	306,100	100,200	142,100	30,400	8,800	13,500	1,411,600
2022	589,900	337,200	307,100	100,700	137,500	28,900	8,900	13,700	1,523,900
2023	643,700	365,600	308,400	101,400	115,300	27,400	9,100	14,000	1,584,900
2024	671,100	407,200	317,700	102,200	109,500	25,800	9,200	14,200	1,656,900
2025	677,500	461,900	331,400	104,300	121,300	27,400	10,200	14,400	1,748,400

Source: Authors.

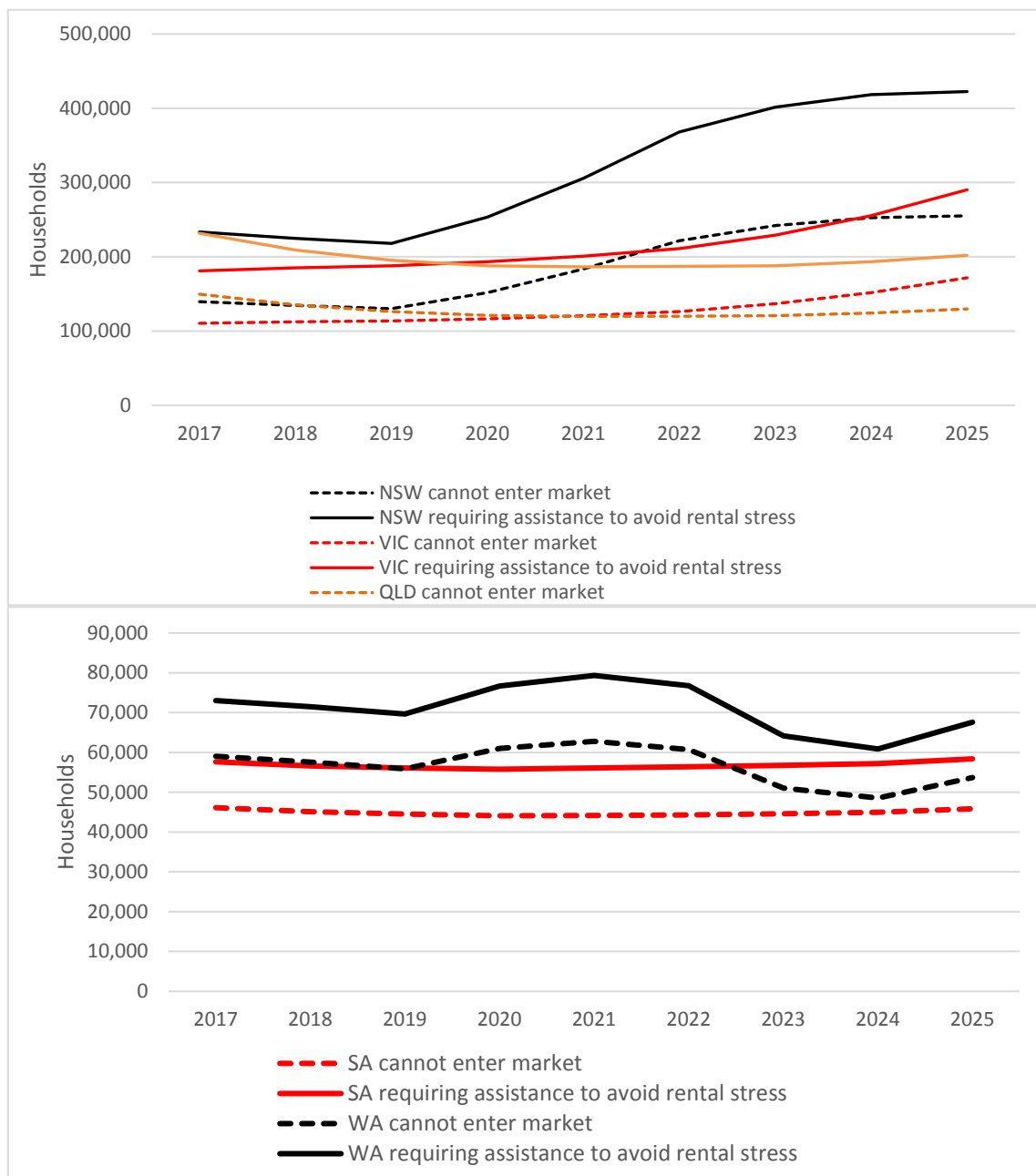
While the housing need figures undoubtedly reflect demographic factors above all else, a clearer understanding of the contribution of labour and housing market factors can be gained if we examine annual change in predicted housing need relative to annual change in the number of households. Table 5 presents the annual ratio of projected households and households in housing need to allow a comparison by state/territory. Caution is advised if adopting such annual figures as the simulation currently displays some volatility for annual figures which are smoothed over a longer projection period. The table does reveal the state/territories with the most pressing cases for policy intervention.

Table 5: Ratio of projected households and projected housing need by state and territory: composite scenario

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	Australia
2017	13%	12%	20%	14%	12%	14%	10%	8%	14%
2018	12%	12%	17%	14%	12%	14%	10%	8%	13%
2019	11%	12%	16%	14%	11%	14%	10%	8%	13%
2020	13%	12%	15%	14%	12%	13%	10%	8%	13%
2021	16%	13%	15%	13%	12%	13%	10%	8%	14%
2022	19%	13%	15%	13%	11%	13%	10%	8%	15%
2023	20%	14%	14%	13%	9%	12%	10%	8%	15%
2024	21%	15%	15%	13%	9%	11%	10%	8%	16%
2025	21%	17%	15%	14%	9%	12%	11%	8%	16%

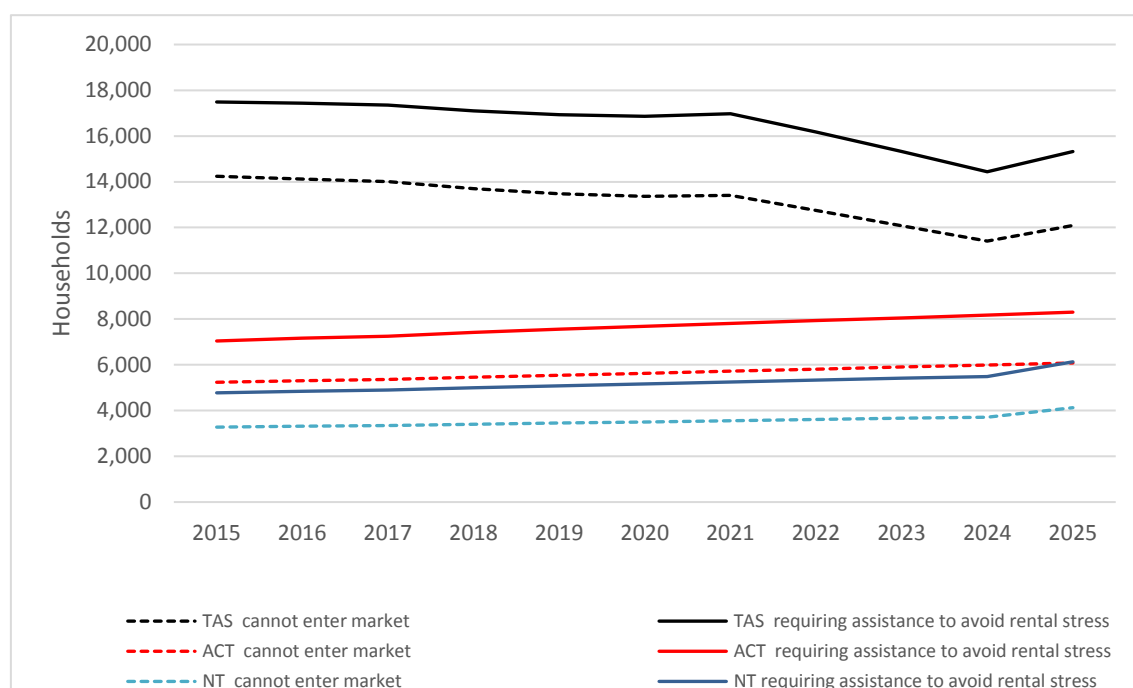
Source: Authors.

Figure 10: Simulated housing need figures: composite scenario (States)



Source: Authors.

Figure 11: Simulated housing need figures: composite scenario (territories and Tasmania)



Source: Authors.

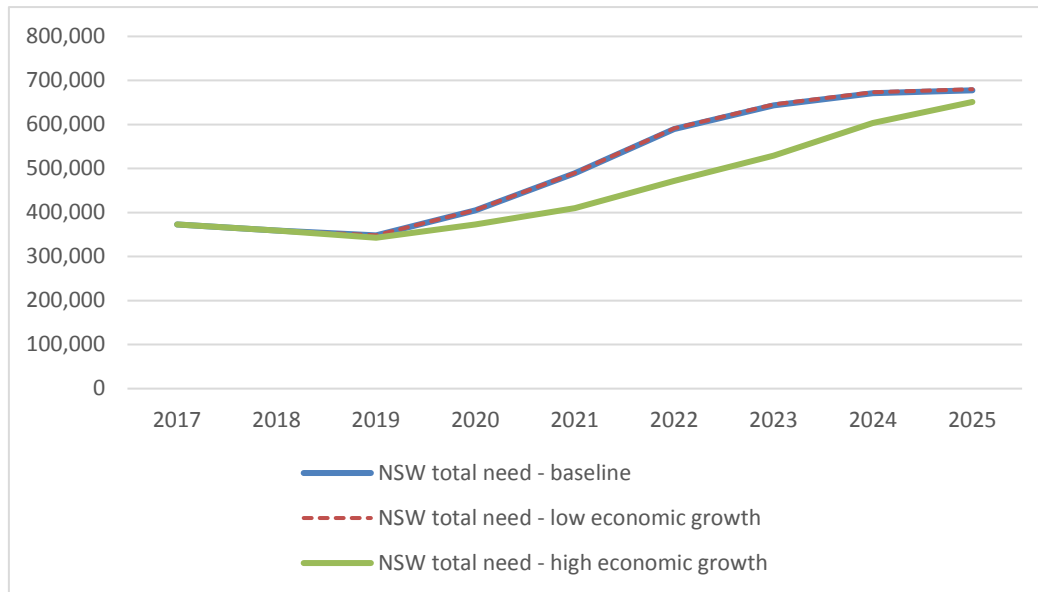
The simulation produces a predicted number of households for each state/territory, but these are calculated 'fresh' each year, on the basis of population projections and coefficients. In other words, the outcomes in one year do not feed through to affect the predictions in following years. The only way to accomplish this would be to maintain a database of all known individuals and households, including predictions about labour market status and earnings, housing consumption and housing costs. The implication is that the number of households predicted by the simulation might rise and fall repeatedly between years in the forward simulation (although this does not happen in practice). But when the predicted number of households interacts with the housing, labour market and tenure choice equations, the resulting prediction of housing need is more volatile than the predicted number of households. This is an important limitation, and the ramifications are evident from an examination of the figures in Tables 2 and 3. This means the outputs produced by the simulation model should be regarded as setting indicative trends in housing market conditions and housing need rather than precise annual forecasts.

A second noticeable feature of the housing need estimates produced by the simulation is that they appear more stable for states than for the territories. This is because income quintiles are calculated at the Australian level, rather than state or territory level, in the Labour Market Status and Household Formation models—therefore the coefficients in these models are dominated by outcomes in the larger states. What appears to be happening in the simulation model is that relatively minor changes in income distribution in the territories (ACT and NT) result in disproportionately large consequences on predicted housing need. Further econometric work is needed to improve this aspect of the model further.

We now consider the significance of the economic scenarios in relation to the estimates of housing need produced by the simulation model. To do this, we examine the total housing need estimates arising from the baseline, plus two other economic scenarios which involve feeding in more pessimistic/optimistic values for state level export value, retail sector GVA and service sector GVA. Although a number of other macro and regional economic variables are available

to the simulation user, the three variables chosen are the most powerful predictors in the labour market equations.

Figure 12: Simulated total housing need figures in NSW under three scenarios



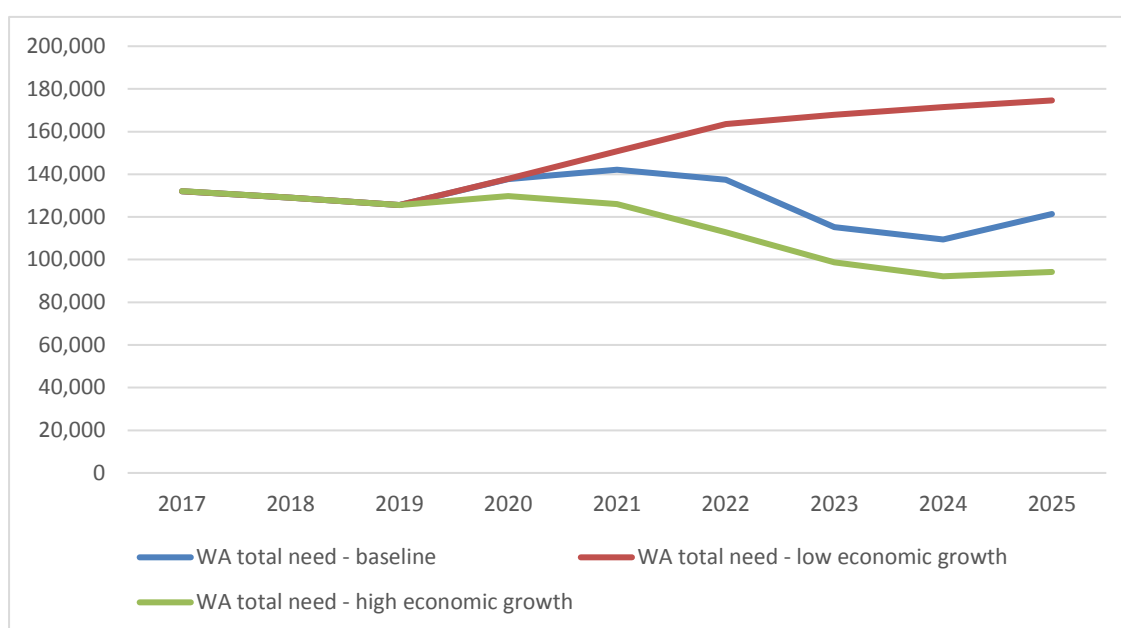
Source: Authors.

Figure 11 demonstrates the potentially substantial differences in housing need estimates that can occur through a variation in the assumptions about economic growth. It can be seen that despite changing economic input variables from 2017 onwards, outcomes do not begin to diverge until 2019–20. This is primarily because of time lags between inputs and predicted change in labour market earnings, and between change in the latter and predicted house price change. Figure 12 shows outcomes in NSW, but it is important to note that all other states and territories remain at the baseline economic scenario. The simulation shows how low economic growth affects labour market earnings and thus a household's ability to form. High economic growth increases labour market earnings but also house prices and rents, which tends to cancel out such earnings growth.

For WA (Figure 13) it takes some time for variable economic conditions to affect housing need, but post 2019 high economic growth reduces the number in housing need as labour market earnings outpace predicted house price growth. However, low economic growth has a significant negative, long term impact on housing need.

For both NSW and WA the simulations suggest that the number of households in housing need could vary by around 100,000 by the end of the simulation period, depending on macro and regional (state) level economic performance. While further analysis on future macro and regional economic scenarios is needed, the analysis so far suggests that the number of households in need is greatly dependent on these assumptions and scenarios. This calls for flexibility in any policy response—in particular, the number of affordable dwellings required at state level will need to be continuously recalculated, perhaps every two to three years, rather than enshrined in rigid targets over an extended forward simulation period.

Figure 13: Simulated total housing need figures in WA under three scenarios



Source: Authors.

4.6 Summary

The simulation results demonstrate the significant demand for more affordable housing to meet need identified in 2015 and beyond. In NSW there are estimated to be around 140,000 potential households unable to access market housing (ownership and private rental). Some of these will be accommodated when affordable housing options become available through new supply or if an existing tenant transitions into market housing, but most of these households will remain unformed unless new affordable housing becomes available. In 2015 there were around 47,500 total dwelling completions in NSW (ABS 2016). If 10 per cent of these were affordable it would take decades to meet the demand for affordable housing, assuming it remained constant.

In Western Australia, with total completions around 30,000 and affordable housing demand estimated at 59,000, it would take 20 years to meet this demand if 10 per cent of all completions were affordable housing.

The simulation results reveal the potential of the model to illustrate the impact of changing economic circumstances on housing need outcomes, and also provide a broad assessment of the likely level of housing need that might arise in each state and territory over a forward 10 year period. The results indicate that New South Wales and Victoria are likely to experience the most acute increases in housing need. Meanwhile, the scenarios tested for a range of regions reveal that future levels of housing need are likely to depend on economic conditions—particularly labour market earnings and status—in addition to demographic and housing market factors.

It is important to note the model has a number of applications not reported here. For example, the design of the model makes it possible to alter assumptions about the proportion of each age group attaining each significant qualification level in the labour market models (diploma, certificate, degree, masters). In addition, the ratio of labour market earnings for each age/qualification group to median earnings is assumed constant, however this may change in the future, in response to policy or simply as society progresses.

5 Policy development options

- Australia lacks a consistent methodology to estimate the housing need of its population and quantify the supply of affordable housing necessary to meet this need.
 - The simulation model delivers a broad assessment of affordable housing supply necessary to meet housing need, demonstrating that Australia needs to increase dramatically the rate of affordable housing delivery.
 - The simulation model produces housing need, household formation and labour market outcomes under a variety of user-defined economic conditions and allows comparisons of housing need figures across states. There is significant potential for further development.
 - The lack of data at sub regional or LGA level is the main impediment to further development of the simulation model.
-

With the affordability of housing in Australia continuing to be a major policy issue, state and local governments are under pressure to deliver affordable housing, however, governments are currently unable to quantify the amount of affordable housing necessary to meet the housing needs of a growing population. Various housing need and housing demand models have been commissioned by state and local governments to assess the supply required to meet housing need but, while using similar data, all adopt different methodologies so the results are not comparable. Australia lacks a consistent methodology to estimate the housing need of its population and quantify the supply of affordable housing necessary to meet this need, and the housing assistance budget necessary to support low-income households in the private rental sector.

The simulation model in this report involves harnessing a number of models (both aggregate and micro-econometric) of demographic, labour market and housing system processes, and allows the coefficients from several models to interact with exogenous and endogenous variables, to produce state level estimates of housing need. For example, those households unable to access market housing and those who could access the private rental sector but have insufficient income to avoid a position of rental stress. Various economic scenarios can be set and the simulation produces a series of outputs based on these economic assumptions.

5.1 State level housing need for policy development

Following the disbanding of the National Housing Supply Council (NHSC) there has been a gap in reporting housing supply requirements. While the methodology adopted by NHSC has been debated (Wilkinson 2011) it did deliver figures that were comparable across states and territories, which is essential to make decisions relating to resource allocation. The simulation presented here allows comparisons of housing need figures across states, which will help both states and the Australian Government plan affordable housing supply.

The figures produced are broken down into households that cannot access market housing and those that can access market housing but need some form of rental assistance to avoid being in a position of rental stress. The former figure (Table 2) reflects the demand for subsidised affordable housing while the latter (Table 3) reflects those that would require some form of housing assistance to make private rental affordable (under a normative assumption of what is

affordable). States can examine the figures to make decisions about the level of subsidised affordable housing required to meet need, and use them as evidence in setting state wide supply targets, and in negotiating funding for affordable housing. The community housing sector could also use the figures in developing state-wide strategies.

Housing need is predicted to increase substantially in New South Wales and Victoria. Housing need in New South Wales is forecast to rise from 140,000 households unable to access market housing to over 255,000 in 2025. While South Australia and Western Australia see less growth in the number of households unable to access market housing, the estimated current totals, 46,000 and 59,000, are significant. The number of households able to access the private rental market but under financial pressure as a result are also predicted to rise sharply in many states. The figures deliver evidence of the extent of affordable rental housing required to meet need (substantial in all areas) and the potential growth in the CRA budget.

There is still work to do on the simulation, and continued development incorporating new census data will enable development at a finer spatial scale, however the simulation currently achieves:

- A consistent and repeatable methodology.
- A broad assessment of affordable housing supply necessary to meet household need at the national and state level.
- Delivery of housing need outcomes under a variety of user-defined economic conditions.
- Delivery of household formation and labour market outcomes under a variety of user-defined economic conditions.
- Identification of the impact of a variable speed economy housing need, household formation and labour market outcomes.
- A robust base for future model development.

5.2 Road map to future model development

There is significant potential for taking the methodology further in future developments of the model, in particular, applying the model at a more finely grained spatial level of aggregation.

The simulation is designed not only to deal with interactions between endogenous processes in the labour and housing systems, but to produce estimates over a forward time period (10 years in this case). These properties of the simulation model reduce its stability when we attempt to apply it below state level. Also, datasets such as HILDA are designed to be representative at national level, and attempting to produce estimates at state level or below, is problematic. There is no ability to model demographic or labour market processes at a local government level.

To estimate housing need at sub-regional or local government levels, the state level outputs produced by the simulation model can be taken as indicative of broad trends in housing need over the forward period considered. A methodology is then needed to distribute the state level aggregate predicted outcomes to sub-regional or local government levels.

One approach might be to model the distribution of need within each state. We might assume that the spatial distribution of housing need within each state is driven by the spatial distribution of related variables, including proportion of individuals or households with low incomes, without qualifications, in poverty or deprivation.

A second approach might attempt to explain change in the number of households in need at sub-regional or LGA level by using two or more time periods, with an observed estimate of the number of households in need in each of these time periods. The advantage of this approach

would be a more convincing link between change in the level of housing need at the sub-regional or local level, and change in the underlying causes. Thus, the simulation model would produce the overall state level trend in expected housing need over a forward period, but the lower level model would not assume a constant ratio between a given sub-region or LGA's housing need and the state level total. Such a model could be specified as Difference-in-Difference (DiD) model.

The simulation could be refined further by including consideration of the relative cost of owning versus renting or some acknowledgement of variation in borrowing constraints in the Tenure Choice Model.

The obvious impediment to the further development of a consistent model of housing need at sub-regional or local level is the poor data availability. Analysts would require access to a number of datasets, measured at local (LGA) level, not hitherto available, including:

- A rich, cross-sectional dataset describing deprivation, remoteness/sparsity, distribution of low income people and households, age, and educational attainment.
- Detailed population/demographic data on the number of individuals, with year of age or age group, gender, and qualification level.
- Cross-sectional, census or survey derived, data on labour market earnings, household composition, tenure and housing costs.
- Behavioural data on housing tenure choice, housing consumption and labour market participation.

The next step in simulation development is to improve the existing state/territory level by incorporating 2016 census data and refining the econometric models and the way these interact within the simulation. Then work can commence exploring how to adapt a state level model to a finer spatial scale for example LGA. This will involve complex spatial modelling, recognising LGAs are not standalone housing markets, as well as the collection of additional, LGA-level data.

It is also worth noting that the estimates of housing need produced are based on the number of households and do not identify the type or tenure of housing required. Further development of the simulation is necessary to identify the income levels of new households in order to align with tenure, and the potential household sizes necessary to estimate the type of housing required.

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Appendix 1: Data

Table A 1: Data sources

Household formation model	Data source
Sex	HILDA
Age	HILDA
Country of Birth	HILDA
Disposable household income	HILDA
Highest education level	HILDA
Employment status	HILDA
Partnership status and change	HILDA
Long term health condition	HILDA
Median LGA house price	CoreLogic RPData
Year	HILDA
Children under 14 in household	HILDA
Labour market status model	
Sex	HILDA
Age	HILDA
Highest education level	HILDA
Children in household	HILDA
Mental health index	HILDA
General health index	HILDA
Long term health condition	HILDA
Wave acquired highest educational level	HILDA
Wave acquired first child	HILDA
Wave acquired current partner / spouse	HILDA
Wave lost partner / spouse	HILDA
Wave separated from partner / spouse	HILDA
Age Squared	HILDA
Wage (mean state)	HILDA
Labour market earnings model	
Log of real wage rate, state	ABS
Male unemployment rate, state	ABS
Log of tourist visitors to state	ABS
Log of export value, state	ABS
Log of retail sector GVA, state	ABS
Log of service sector GVA, state	ABS
Log of female inactivity rate, state	ABS

Log of corporate tax total take, national	ABS
Housing market	
Average real house prices, state	ABS
Log of mean wage, state	CoreLogic RPData
Log of waiting list level	Derived from Productivity Commission reporting of AIHW data
Growth of log of waiting list	Derived from Productivity Commission reporting of AIHW data
Housing completions per 1000 people aged 18-39	ABS
Mortgage interest rate index	RBA
Log of median house price	CoreLogic RPData
Median house price divided by (2*household income)	CoreLogic RPData
Tenure choice model	
Sex	HILDA
Age	HILDA
Country of Birth	HILDA
Highest education level	HILDA
Number of children under 4 years	HILDA
Family assistance with housing	HILDA
Long term disability or health condition	HILDA
User Cost of Capital	Derived
Gross household income	ABS
Medial LGA house price	CoreLogic RPData
Medial LGA rental cost	CoreLogic RPData
LGA employment density	ABS
LGA dwelling density	ABS
LGA population density	ABS
Relative locational remoteness	HILDA

Appendix 2: Methodological notes and detailed output tables from the component models

Table A 2: Household Formation Model: Summary Odds Ratios describing likelihood of household headship

	Total Population			OR	Males		OR	Females	
	Lower 95% CI	Upper 95% CI	Lower 95% CI		Upper 95% CI	Lower 95% CI		Upper 95% CI	
Sex	OR	CI	CI	OR	CI	CI	OR	CI	CI
Male	1.00								
Female	0.20	0.19	0.22						
Age									
25-29	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.02	0.03
30-34	0.22	0.20	0.24	0.23	0.20	0.27	0.23	0.20	0.27
35-39	1.00			1.00			1.00		
40-44	2.07	1.87	2.29	2.41	2.09	2.79	1.62	1.41	1.86
45-49	2.96	2.67	3.28	3.34	2.87	3.88	2.14	1.86	2.47
50-54	3.44	3.08	3.83	3.52	3.01	4.11	2.55	2.19	2.96
55-59	3.71	3.33	4.14	3.76	3.20	4.41	2.56	2.20	2.98
Country of birth									
Australia	1.00			1.00			1.00		
English speaking	0.93	0.81	1.07	0.84	0.70	1.02	0.94	0.77	1.15
Non-English speaking	0.57	0.51	0.65	0.55	0.46	0.65	0.61	0.51	0.72
Education									
Bachelor or higher	1.00			1.00			1.00		
Diploma or certificate	0.60	0.53	0.66	0.62	0.53	0.72	0.51	0.44	0.59
Year 12	0.46	0.41	0.52	0.53	0.44	0.63	0.42	0.36	0.49
Year 11 or lower	0.32	0.28	0.36	0.33	0.27	0.39	0.31	0.27	0.36
Employment									
FT	1.00			1.00			1.00		
PT	0.22	0.20	0.23	0.24	0.21	0.27	0.25	0.23	0.28
Unemployed	0.15	0.13	0.17	0.19	0.16	0.23	0.15	0.12	0.18
NILF	0.11	0.10	0.12	0.13	0.12	0.15	0.12	0.11	0.13
Partnership status and change									
Couple to couple	1.00			1.00			1.00		
Single to single	7.01	6.47	7.59	1.83	1.63	2.05	19.08	17.07	21.32
Single to couple	2.55	2.26	2.87	1.38	1.16	1.64	3.99	3.39	4.70
Couple to single	15.28	11.93	19.57	3.89	2.65	5.71	34.89	25.29	48.13

	Total Population			Males			Females		
	OR	Lower 95% CI	Upper 95% CI	OR	Lower 95% CI	Upper 95% CI	OR	Lower 95% CI	Upper 95% CI
Child(ren) under 14									
No	1.00			1.00			1.00		
Yes	0.91	0.85	0.97	1.13	1.03	1.25	0.65	0.60	0.72
Long term health condition									
Yes	1.05	0.99	1.11	1.19	1.09	1.30	1.01	0.92	1.10
No	1.00			1.00			1.00		

Figure A 1: Household Formation Model: Interaction between household income and median house price (by LGA)

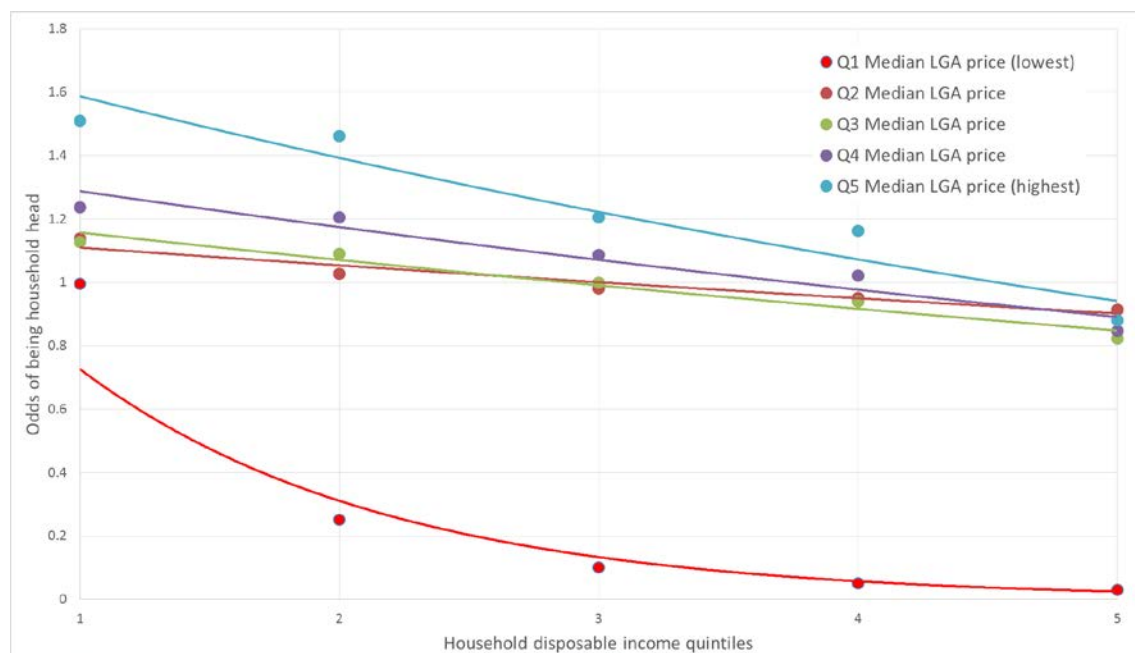


Table A 3: Labour Market Status Model: Probability of participation and employment

		Participation			Employment		
		% Influence	Z-statistic	P> z	% Influence	Z-statistic	P> z
Sex							
Female		REF					
Male		3.4	14.59	0.000	-1.6	-7.75	0.000
Highest educational qual.							
Not completed High school		REF					
Certificate		3.9	12.24	0.000	0.4	1.47	0.141
Degree		5.4	14.20	0.000	1.3	3.79	0.000
Diploma		3.7	8.77	0.000	0.8	2.34	0.019
Postgraduate		6.5	15.00	0.000	1.0	2.39	0.017
High School		3.5	10.73	0.000	0.8	2.88	0.004
Age							
50 – 64		REF					
16 – 19		-16.5	-26.81	0.000	1.7	2.10	0.036
20 – 24		-11.7	-19.48	0.000	1.2	1.92	0.055
25 – 29		-10.0	-16.94	0.000	1.4	2.49	0.013
30 – 34		-6.6	-12.96	0.000	0.8	1.94	0.052
35 – 39		-4.1	-8.65	0.000	0.6	1.82	0.068
40 – 44		-1.4	-3.53	0.000	0.4	1.55	0.121
45 – 49		0.7	1.96	0.050	0.3	1.04	0.301
Number of children in h'hold							
No children		REF					
Aged <2 years		-7.0	-14.98	0.000	0.3	0.71	0.478
Aged <4 years		-4.8	-12.09	0.000	0.9	2.58	0.010
Mental health index		0.0	5.58	0.000	0.0	6.16	0.000
General health index		0.0	1.23	0.218	0.0	-3.62	0.000
Long-term illness or disability							
No		REF					
Yes		-4.0	-17.28	0.000	-0.7	-3.01	0.003
Labour force status (t-1)							
Unemployed		REF					
Full time		20.3	55.19	0.000	7.2	7.35	0.000
Not in the labour force		-10.6	-27.92	0.000	0.9	1.68	0.092
Part time		12.7	36.45	0.000	6.3	9.50	0.000

	Participation			Employment		
	% Influence	Z-statistic	P> z	% Influence	Z-statistic	P> z
Household head income	2.5	11.65	0.000	0.1	0.82	0.412
In previous wave, acquired ...						
Highest level of education	8.2	13.57	0.000	-0.6	-1.26	0.209
First child	-3.5	-1.76	0.078	-1.3	-1.13	0.260
Partner or spouse	1.8	2.46	0.014	-1.0	-3.06	0.002
Lost partner	-2.0	-2.21	0.027	0.4	0.66	0.508
Separated	0.9	1.68	0.093	-1.3	-4.21	0.000
Age Squared	-0.7	-16.32	0.000	0.0	0.44	0.663
Wage (mean state)	0.9	0.62	0.536	0.8	0.68	0.496

Table A 4: Labour Market Earnings Model: summary results

Variable	Coefficient	Sig.
log of real wage rate, t-1	0.0084	***
male unemployment rate, t-1	-0.0002	**
difference in logs of tourist visitors to state, t-1	0.3607	*
difference in logs of export value, t-1	0.0616	***
difference in logs of retail sector GVA, t-1	-0.3663	**
difference in logs of service sector GVA, t-1	0.2539	**
difference in logs of female inactivity rate, t-1	-0.3735	***
Australia level, diff. in log corporation tax total take, t-1	0.0912	***
Wald Chi-sq	14852.75	***
Groups	7	
Obs per group	12	

Note: ** denotes significant at 1%; * significant at 5%

The figures below summarise observed and fitted wage inflation in three state examples. They show that the equation captures the turning points well, with two distinct peaks and one or two troughs evident in the data for each State. The performance is rather better for New South Wales and Queensland than for Western Australia or Northern Territories. In particular, a very high wage growth rate in 2005 for Northern Territories is not predicted by the model. A similar phenomenon affects Western Australia—the turning points are captured but the model does not reproduce the enormous rates of wage growth in some sectors of the labour market during the 2000s mining boom.

Figure A 2: Observed and fitted wage inflation in New South Wales

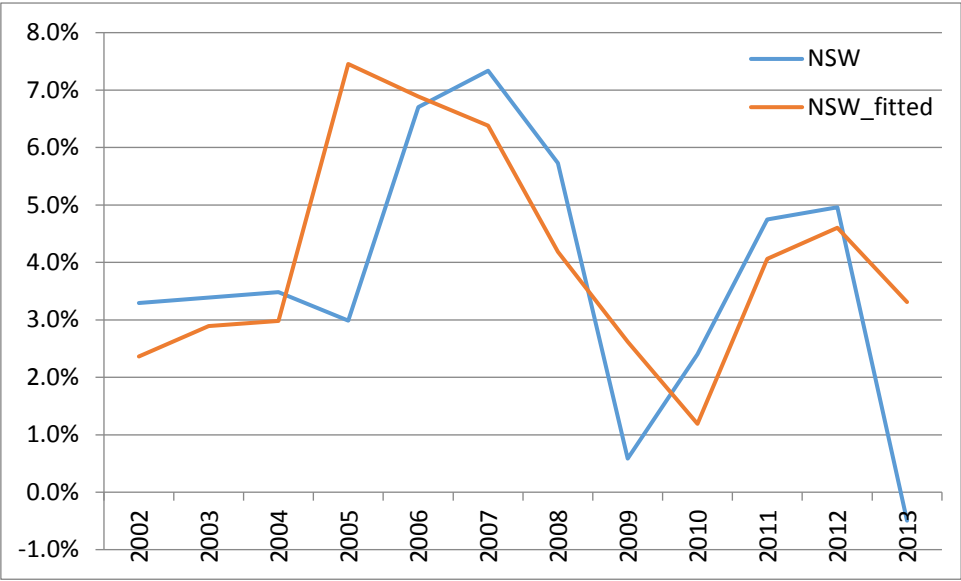


Figure A 3: Observed and fitted wage inflation in Queensland

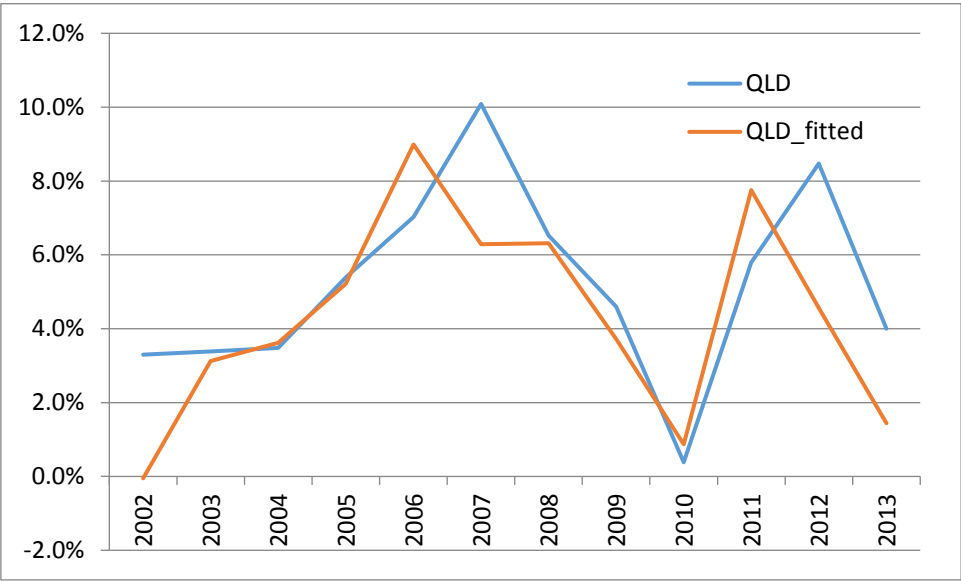


Figure A 4: Observed and fitted wage inflation in North Territories

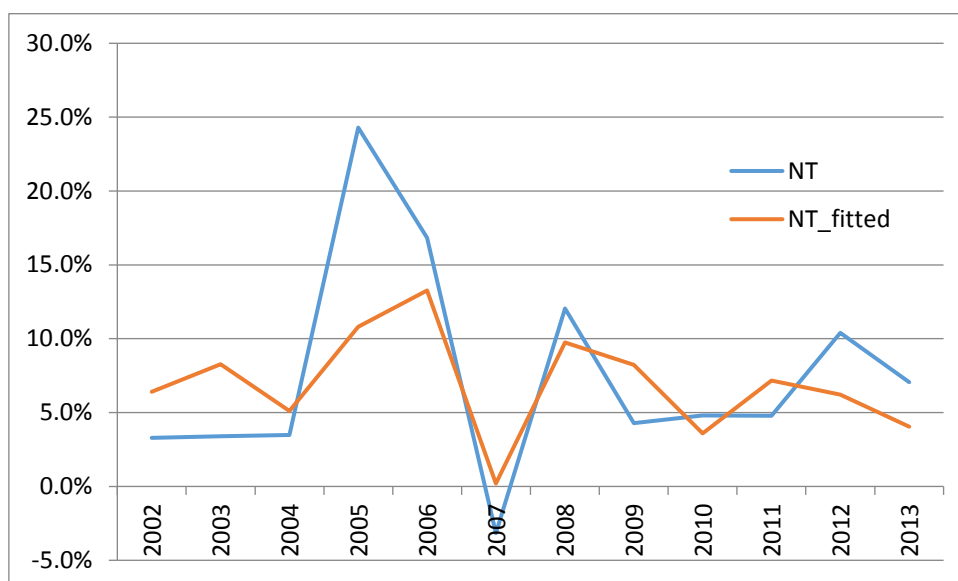


Table A 5: Housing Market Model: estimation results

Description	Coefficient	Sig.
	0.225070	**
Difference in logs of mean wage, t-1	0.617428	**
Natural log of waiting list level	-0.017918	**
Difference in logs (growth) of waiting list level	0.022360	*
Housing completions per 1000 people aged 18-39, t-1	-0.000122	**
Mortgage interest rate index, t-1	-0.001076	**
Difference in logs of median house price, t-1	0.430940	**
Median house price divided by (2×household income), t-1	-0.008314	**
Wald Chi_sq	16687.67	**
N	96	
Groups	8	

Note: ** denotes significant at 1%; * significant at 5%

Table A 6: Tenure Choice Model: Relative tenure likelihoods compared to private rental

	Owner			Public renter			Other		
	Odds	Lower 95% CI	Upper 95% CI	Odds	Lower 95% CI	Upper 95% CI	Odds	Lower 95% CI	Upper 95% CI
Sex									
Male	REF			REF			REF		
Female	1.14	1.05	1.24	0.91	0.72	1.15	1.09	0.95	1.26
Age									
Less than 25	REF			REF			REF		
25 – 34	1.52	1.36	1.71	1.00	0.73	1.37	1.31	1.09	1.58

	Owner			Public renter			Other		
	Odds	Lower 95% CI	Upper 95% CI	Odds	Lower 95% CI	Upper 95% CI	Odds	Lower 95% CI	Upper 95% CI
35 – 44	2.19	1.92	2.50	1.43	1.01	2.03	1.32	1.05	1.66
45 – 54	2.61	2.24	3.03	1.77	1.22	2.58	1.46	1.14	1.87
55 – 64	5.02	4.17	6.05	1.81	1.13	2.90	2.35	1.76	3.15
Country of birth									
Australia	REF			REF			REF		
English speaking	0.82	0.70	0.95	0.51	0.28	0.91	0.61	0.44	0.83
Non-English speaking	1.01	0.87	1.16	0.73	0.44	1.19	1.11	0.87	1.41
Education									
Certificate or Year 12	REF			REF			REF		
Postgraduate	1.49	1.21	1.84	0.44	0.13	1.45	0.93	0.59	1.45
Bachelor or diploma	1.45	1.31	1.61	0.48	0.31	0.75	0.93	0.77	1.11
Year 11 or lower	0.87	0.78	0.97	1.88	1.47	2.40	0.93	0.79	1.10
Number of children aged under 4									
None	REF			REF			REF		
1	0.99	0.88	1.12	1.02	0.74	1.43	0.60	0.48	0.76
2	1.34	1.14	1.58	2.77	1.95	3.95	0.72	0.53	0.99
3	1.17	0.70	1.96	6.34	3.03	13.27	1.04	0.46	2.34
4+	0.95	0.17	5.40	0.00	0.00	0.00	0.00	0.00	0.00
Family Assistance									
	REF			REF			REF		
Parental gift	1.43	1.23	1.65	0.78	0.51	1.20	0.83	0.64	1.09
Inheritance	1.72	1.25	2.36	0.99	0.31	3.19	0.66	0.30	1.46
Long term disability									
No	REF			REF			REF		
Yes	0.81	0.72	0.90	1.88	1.49	2.38	1.13	0.96	1.34
User Cost of Capital (Quintiles)									
1 (lowest)	REF			REF			REF		
2	0.91	0.82	1.02	1.09	0.81	1.46	1.18	0.98	1.42
3	1.17	1.04	1.31	1.06	0.78	1.44	1.12	0.92	1.37
4	1.29	1.14	1.47	1.33	0.94	1.88	1.30	1.04	1.62
5 (highest)	1.27	1.06	1.52	0.79	0.45	1.39	1.55	1.18	2.04
Gross household income (Quintiles)									
1 (lowest)	REF			REF			REF		
2	0.66	0.50	0.87	0.96	0.53	1.76	0.86	0.57	1.31

	Owner			Public renter			Other		
	Odds	Lower 95% CI	Upper 95% CI	Odds	Lower 95% CI	Upper 95% CI	Odds	Lower 95% CI	Upper 95% CI
3	0.36	0.28	0.48	0.79	0.45	1.41	0.62	0.41	0.93
4	0.48	0.37	0.63	0.39	0.21	0.71	0.46	0.30	0.70
5 (highest)	0.86	0.65	1.13	0.35	0.18	0.69	0.66	0.43	1.03
Median LGA house price (Quintiles)									
1 (lowest)	REF			REF			REF		
2	1.40	1.17	1.68	0.72	0.47	1.11	0.85	0.65	1.12
3	1.65	1.32	2.05	0.48	0.29	0.82	1.21	0.86	1.72
4	1.50	1.18	1.90	0.43	0.25	0.76	1.15	0.79	1.68
5 (highest)	1.27	0.97	1.68	0.28	0.14	0.58	0.90	0.57	1.40
Median LGA rental cost (Quintiles)									
1 (lowest)	REF			REF			REF		
2	0.62	0.53	0.72	1.07	0.74	1.53	0.72	0.55	0.93
3	0.64	0.54	0.76	0.84	0.52	1.35	0.96	0.71	1.30
4	0.61	0.51	0.74	1.51	0.95	2.41	0.95	0.68	1.33
5 (highest)	0.68	0.55	0.85	1.51	0.84	2.71	1.14	0.79	1.65
LGA employment density (Quintiles)									
1 (lowest)	REF			REF			REF		
2	1.05	0.78	1.40	1.02	0.55	1.87	0.50	0.29	0.86
3	0.59	0.41	0.85	1.75	0.72	4.22	0.48	0.23	1.00
4	0.66	0.46	0.96	2.20	0.86	5.62	0.43	0.21	0.91
5 (highest)	0.70	0.49	1.00	1.64	0.67	4.01	0.52	0.25	1.06
LGA dwelling density (Quintiles)									
1 (lowest)	REF			REF			REF		
2	1.10	0.82	1.48	0.85	0.45	1.60	1.70	1.05	2.76
3	1.19	0.84	1.69	0.96	0.41	2.23	1.87	1.01	3.47
4	1.63	1.12	2.36	0.75	0.30	1.89	2.44	1.26	4.70
5 (highest)	1.09	0.74	1.61	0.76	0.29	2.00	1.44	0.73	2.83
LGA population density (Quintiles)									
1 (lowest)	REF			REF			REF		
2	0.83	0.66	1.03	0.89	0.53	1.50	0.63	0.44	0.92
3	0.79	0.61	1.04	0.77	0.38	1.54	0.47	0.29	0.75
4	0.86	0.64	1.17	0.96	0.47	1.97	0.62	0.36	1.06
5 (highest)	0.57	0.41	0.80	0.87	0.37	2.04	0.40	0.23	0.73
Remoteness									
0 (lowest)	REF			REF			REF		

	Owner			Public renter			Other		
	Odds	Lower 95% CI	Upper 95% CI	Odds	Lower 95% CI	Upper 95% CI	Odds	Lower 95% CI	Upper 95% CI
Inner regional	1.08	0.94	1.25	1.46	0.99	2.15	0.97	0.74	1.25
Outer regional	0.86	0.69	1.06	1.48	0.86	2.54	1.61	1.16	2.24
Remote	0.52	0.35	0.77	2.03	0.89	4.64	2.81	1.85	4.27
Very remote	3.50	1.11	11.02	5.92	0.75	46.66	10.62	3.18	35.44

Appendix 3: Housing Market Model—background

The general form of the house price models estimated for the UK's regions was as follows:

$$\ln(\Delta PH_j) = \beta_1 \Delta HS_j + \beta_2 \Delta HH_j + \beta_3 W_j + \beta_4 R_j + \beta_5 M_j + \beta_6 \Delta SE_j \quad (3)$$

Where,

PH_j Index of average real house prices in j th region.

HS_j Housing stock in j th region.

HH_j Households in j th region.

W_j Median real earnings in j th region.

R_j Rental index in j th region.

M_j An indicator of mortgage credit restrictions.

SE_j Index of house prices in the South East region

In fact, the equation above is a significant simplification of Meen's modelling approach. In particular, the impact of house price change in the South East (seen as the 'leading' region), varies between region. Furthermore, the term is designed to allow spatial spillover of price change from surrounding regions.

Given the much larger spatial scale of Australian states compared to UK regions, and the weaker conceptual argument that there should be a system of leading and lagging states, the modelling approach dispenses with complex arrangements for spatial spillovers. Instead, the state level house price model is estimated using a panel dataset—8 states, observed over a 16 year period 2000–15. A population average estimator is used in Stata (xtreg, pa), producing the results above.

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