

Macro drivers of Australian housing affordability, 1985-2010 An autoregressive distributed lag approach

Author

Worthington, A, Higgs, H

Published

2013

Journal Title

Studies in Economics and Finance

DOI

[10.1108/SEF-07-2012-0078](https://doi.org/10.1108/SEF-07-2012-0078)

Rights statement

© 2013 Emerald. This is the author-manuscript version of this paper. Reproduced in accordance with the copyright policy of the publisher. Please refer to the journal's website for access to the definitive, published version.

Downloaded from

<http://hdl.handle.net/10072/58395>

Griffith Research Online

<https://research-repository.griffith.edu.au>

Macro drivers of Australian housing affordability, 1985–2010: An autoregressive distributed lag approach

Andrew Worthington and Helen Higgs
*Department of Accounting, Finance and Economics,
Griffith University, Nathan, Australia*

Abstract

Purpose – Model the drivers of Australian housing affordability and forecast equilibrium affordability.

Design/methodology/approach – Uses autoregressive distributed lag (ARDL) approach to model housing affordability measured by the Housing Industry Association's Housing Affordability Index (HAI) and the housing price–earnings multiplier (HPE). Six sets of explanatory variables, including housing finance, housing construction activity and costs, economic growth, population, alternative investments and taxation.

Findings – Primary long-run drivers are housing finance, dwelling approvals and financial assets. Economic and population growth only have a short-run influence, while housing taxation has limited impact in long run. Forecasts indicate long-run HAI equilibrium values of 109 (above the historical minimum of 107) and a HPE of 7 (below the recent historical maximum of 8.2).

Research limitations/implications – Reduced form model encompassing both demand and supply factors involves complicated interpretation given direct and indirect effects on affordability. Analysis at national level ignores regional impacts that may also affect housing affordability.

Practical implications – The impact of the low rate of new dwelling approvals (public and private sector in the long run and public sector in the short run) points to a persistent structural gap between the demand and supply of housing. Strong economic and population growth often blamed for the worsening of housing affordability, at least in the 2000s, has no impact at the aggregate national level.

Originality/value – Only known paper to provide quantitative estimates of macro drivers of Australian housing affordability over a long period using alternative measures of relative housing affordability.

Keywords: Housing affordability, affordability drivers, housing policy

Paper type: Research paper

1. Introduction

Housing affordability has represented a continuing policy challenge in Australia since at least the 1970s. Starting with inquiries into housing costs by the Priority Review Staff (1975) and the Committee of Inquiry into Housing Costs (1978), it has subsequently manifested itself in the National Housing Strategy (1991), Affordable Housing National Research Consortium (2001) and the Prime Minister's Home Ownership Task Force (Bor and Moloney 2003; Caplin *et al.*, 2003; Gans and King, 2003). More recently, it includes a Productivity Commission (PC) (2004) report on first-home ownership, the creation of a framework for

national action on affordable housing by a joint meeting of the Housing, Local Government and Planning Ministers (2005), and a Senate Select Committee on Housing Affordability in Australia (SCHAA) (2008).

These national government initiatives, of course, exclude the many separate efforts taken by state and local governments combined with industry, consumer, and welfare groups to also focus attention on housing affordability in Australia. These include an on-going National Affordable Housing Summit, various industry reports [see, for instance, Urban Development Institute of Australia (2007)], and successive publications from the Australian Housing and Urban Research Institute (AHURI) [see, for example, Chapman (2006), Berry (2006a, 2006b), Gabriel *et al.* (2006), Yates and Gabriel (2006), Gurran *et al.* (2007), Lawson and Milligan (2007), Yates (2007a, 2007b, 2007c), and Yates *et al.* (2004, 2005, 2007)]. It also includes regular contributions by the Reserve Bank of Australia (RBA) as the financial system regulator concerned with the economic welfare and prosperity of Australians [see RBA (2003), Richards (2008; 2009a; 2009b) and Ellis (2010)]. Predictably, some academic work is also in evidence [see, most recently, Beer *et al.* (2007), Yates, (2008), Gurran (2008), Marks and Sedgwick (2008) and Abelson (2009)].

Reasons for this interest in Australian housing affordability are not hard to find after drawing upon international comparisons. By all accounts, not only are Australian houses now among the world's largest [an average 186m² for new homes, compared with 76m² in the UK and 200m² in the US (SCHAA 2008)], but also the most expensive. In evidence, between 1997 and 2010, Australian house prices increased nationally by 220%, compared with 181% in Britain, 129% in Ireland, 70% in the US, 141% in France, 70% in Canada, 157% in Spain, -37% in Japan, 18% in Singapore, and 108% in New Zealand (Anonymous, 2010). More ominously, calculations of the long-run price-to-rent ratio by *The Economist* magazine (Anonymous, 2010) indicate Australia has the world's most overvalued (63.2%) housing market, well ahead of the US (10.6%), Canada (23.9%), Britain (32.0%), and New Zealand (20.2%). In yet other international evidence, housing in Australia is also the most unaffordable, with 96% of its urban and regional submarkets ranked severely unaffordable, compared with 63% in New Zealand, 58% in the UK, and just 18% and 6% in Canada and the US, respectively (Cox and Pavletich, 2010).

The relative deterioration in Australian housing affordability is equally alarming in domestic terms. Consider the quarterly housing price-earnings multiple (HPE) (the ratio of housing prices to household earnings) constructed using Australian Bureau of Statistics (ABS) data from September 1985 to June 2010 shown in Table I. During this period, median

house prices increased substantially, from A\$65,900 in the September quarter of 1986 to A\$534,800 in the June quarter of 2010, an eightfold increase representing an annual growth rate of some 8.9%. However, during the same period, average annual full-time earnings increased from only A\$20,191 to A\$65,114, a slightly better than threefold increase at an annual average growth rate of 4.8%. As a result, the housing price–earnings multiple increased from just 3.3 in September 1985 to 8.2 in June 2010, suggesting a substantial generational worsening of housing affordability. The persistent increase observed during the period 1985–2010 in the housing price–earnings multiple is consistent with other studies in this area and over time. For example, Merrett (2000) concludes that from the 1880s to the 1930s the price–earnings multiple in Australia was about 5, while Yates (2007a) suggests a multiple of 3–4 in the late 1950s, increasing fourfold between 1960 and 2006. Similar sorts of figures are given by the Committee of Inquiry into Housing Costs (1978) in the 1970s, while the PC (2004) estimated that the multiple had increased from 6 in the mid-1990s to about 9 at the time of its report.

In alternative terms, the record is no better. The Housing Industry Association’s (HIA) Housing Affordability Index (HAI) plotted in Figure 1 records the ratio of average household disposable income to the ‘qualifying’ income required for a ‘typical’ first home loan. Qualifying income here is the assumption that the repayments on a 25-year loan for 80% of the price of a ‘typical’ property purchased by a first homebuyer are equal to 30% of household income. That is, when the index equals 100, housing costs account for the industry maximum of 30% of disposable income). In September 1985, the index stood at 191.0, well below the maximum share of disposable income.

<FIGURE I HERE>

However, in the intervening period, the index has trended down by about 0.8 points per quarter and housing affordability as a result has worsened, such that by June 2010, the index was at 108.3, slightly above the record low of 107.1 in March 2008, and now close to the point where housing costs will exceed 30% of disposable income. All the same, even this sophisticated measure likely understates the actual level of housing affordability in that concern lies only in the direct costs of housing purchase. It therefore ignores the on-going costs of ownership, including property rates, depreciation and maintenance, and the indirect costs of acquisition (including stamp duty, real estate agency fees and charges, furniture removal, transport, etc.).

The lack of affordable housing in Australia has many worrying implications. Apart from meeting the basic need for shelter, affordable housing also provides a foundation for family and social stability, and contributes to improved health, educational, social and economic outcomes (Gabriel *et al.*, 2006; PC, 2004). Homeowners also may have a relatively stronger incentive for civic involvement, their typically longer residential tenure suggests minimal disruption to social networks and children's education, and the enhancement of self-esteem through homeownership can potentially reduce the incidence of socially disruptive behaviour and promote physical wellbeing (SCHAA, 2008). Yet other work points out the benefits of homeownership for access to disability and aged services and the reduction in welfare dependency. Somewhat more prosaically, homeownership also serves as a tax effective, low risk, stable return, and long-term investment for household portfolios.

Of course, the many inquiries, reports, and commentaries concerning the deterioration of housing affordability in Australia have not only addressed its measurement but also its purported drivers, including strong economic growth and changing population dynamics, cheap and readily-accessible housing finance, changes in government policy, and a generally favourable tax environment. There is also discussion of the several government responses, including direct and indirect assistance in the form of concessions on stamp duty, grants and more recently subsidised home-saving accounts and funds to promote reforms in planning and building approvals. However, it is surprising to find that none of this is of a quantitative nature, with very few details on the specific contribution of the myriad drivers of housing affordability or any assessment of their interaction in a multifactor framework.

Accordingly, the primary purpose of this paper is to estimate and interpret a model of housing affordability and its determinants in Australia over the past quarter century. This will permit a more exact understanding of the drivers of housing affordability and place the policy efforts of the very many interested stakeholders on a more solid empirical footing. The remainder of the paper comprises five sections. Section 2 discusses the main drivers of housing affordability. Section 3 presents the data and variable specification and Section 4 the estimation method and model. Section 5 provides the results. The paper ends with some concluding remarks in Section 6.

2. Macro drivers of housing affordability

As shown in Figure II, the primary components of all measures of housing affordability are housing prices, household incomes and/or interest rates. Each of these as a price in its own right has its own demand and supply factors, with some being 'cyclical', with their effects felt

primarily in the short term, and others ‘structural’, and therefore influencing prices over the medium to longer term. Moreover, each of the components of housing affordability affects the remaining components. For example, interest rates and household incomes influence housing affordability both directly, through their impact on housing affordability measures that typically include adjustments for income and interest rates, and indirectly through their effect on housing demand and thence housing prices.

<FIGURE II HERE>

Fundamentally, we can trace some of the reasons for the persistent decline in housing affordability in Australia to its earliest colonial beginnings. From the start, and almost incongruously given the close association of Australians with ‘the bush’, Australia has always had one of the world’s most urbanised populations. Moreover, the populations in the several Australian colonies (states following Federation in 1901), were concentrated in just a single capital, and so even in comparison with other settler colonies like the US, Canada and New Zealand, Australia has relatively few major urban concentrations. For instance, 57% of the population now call one of Australia’s five-largest cities home, compared with 18% in the US and 27% in the UK (Callaghan, 2010).

Other long-held inherited factors determining housing demand include the strong cultural preference of Australians for detached dwellings on large suburban blocks and the high rate of owner-occupation [comparable to the US and UK at about 70% but as there significantly higher than elsewhere in the OECD (SCHAA, 2008)]. The implications of these factors are that a few increasingly congested capital city markets spread over very large geographic areas, with correspondingly severe infrastructure and planning requirements dominating the issue of housing affordability in Australia.

Outside these factors and in terms of the quarter century that is the focus of this paper, strong housing demand and limited and slow to react housing supply are the most obvious and cited reason for the increase in housing prices and the deterioration in housing affordability. Underlying this market behaviour are several drivers repeatedly cited in the various government and nongovernment inquiries and reports. On the demand side, these include the cost of housing finance, economic growth and population dynamics, and changes in government policy and tax incentives

First, the PC (2004), the SCHAA (2008) and the OECD (2011) all conclude that cheaper and more accessible housing finance is a central part of the story. Mortgage interest rates fell

over much of the 1990s and remained at relatively low levels throughout the 2000s. At the same time, increased competition between housing lenders (including the rise of non-bank mortgage originators and brokers) has made it easier for many borrowers to obtain loans, and has also contributed to lower interest costs by reducing lending margins. This has also flowed through to investor housing, where expectations of rising housing prices and a favourable tax environment has seen a doubling of the proportion of taxpayers with an investment property and the proportion of new housing loan commitments for investment purposes in just the last decade. Problematically, while changes in interest rate regimes are conventionally only a cyclical influence on housing affordability, the SCHAA (2008, p. 54) argues that as housing prices are 'sticky', vendors are reluctant to accept low bids, even with rising interest rates, and that affordability will only be restored by the gradual increase in incomes.

Second, economic growth and population dynamics have also had a role to play (PC, 2004; SCHAA, 2008). In terms of economic growth, strong productivity gains in the 1990s from deregulation and microeconomic reform and the sustained 'resources boom' of the 2000s has increased household income and wealth and part of this has been diverted into increasing the overall quality of owner-occupied housing and the demand for investor housing. The influence of the mining boom itself on house prices is especially noticeable in regional areas of the major mining states (Western Australia and Queensland, but also New South Wales and South Australia). As for population growth, the Australian population of 22.342 million is now growing at its fastest rate since the 1960s (currently 1.7% per year with 43% from natural increase and 57% from net overseas migration). This is also partly fuelled by the mining boom (with higher rates of population growth in the mining states), with immigration an important contributor to the growth in underlying demand, especially in Sydney and Melbourne, and interstate migration a major contributor in Queensland, particularly in the rapidly growing southeast. Accompanying this has been the long but still increasing trend to smaller, often single-occupancy, households and the pressures this places on housing demand.

The final demand driver for housing prices is the changes in government policy and the favourable tax environment for both owner-occupied and investor housing that has prevailed and increased over much of the last twenty-five years. In terms of owner-occupied housing, owners are exempt from capital gains tax (CGT) and land tax while the means-tested public pension excludes the family home. For investor housing, investors benefit from concessional capital gains tax treatment and generous negative gearing (since October 1987) and allowances for depreciation. Overall, SCHAA (2008: 62) suggests that the tax treatment of

both owner-occupied and investor housing in Australia is relatively favourable when compared with other OECD economies. For its part, the PC (2008, p. 75) considers that “...aspects of the personal taxation regime—including negative gearing rules, ‘capital works’ deductions, the 1999 change to capital gains tax, and high marginal income tax rates—have combined to magnify the attractiveness of investing in residential property during the recent upswing in house prices, thereby adding to price pressures”.

Apart from government policy as it relates to taxation, there is also direct government assistance to households to purchase their own home. Of these, the First Home Owner Scheme, notionally introduced to compensate first-home buyers for the introduction of the goods and services tax (GST) in 2000, is the most noteworthy. For its part, the PC (2004) argues that this scheme has not been well targeted, with among other things, the cap on price eligibility set too high such that as with other forms of demand-orientated direct assistance, it has placed pressure on house prices. The details of the housing assistance schemes available vary by state.

Using NSW as an example, first-home benefits of up to A\$24,990 are currently available, comprising a \$7,000 First Home Owner Grant and a duty exemption of up to A\$17,990 under the First Home Plus Scheme, with a house price cap for eligibility set at A\$835,000. This involves a substantial amount of cost subsidisation to first homebuyers, with the scheme providing the more than thirty thousand purchasers with direct assistance of \$636 million in 2010 alone (NSW Office of State Revenue, 2011). Most recently, in 2008 the Federal government established First Home Saver Accounts to assist first-home buyers (Australian Government Treasury 2011). Under this arrangement, the government contributes 17% on the first A\$5,000 (indexed) of individual contributions made each year. In these accounts, investment earnings (or interest) accruing in the accounts are taxed at a concessional 15 per cent whereas withdrawals are tax free when used to purchase an owner-occupied home.

A widely held view is that the inflexibility of the supply side response has also aggravated affordability outcomes. In evidence, the OECD (2011) concludes that while the price elasticity of housing supply in Australia is about average for the OECD, it is relatively low when compared with countries with a similar population density, such as the US and Canada. This means that increases in the demand for housing involves significant increases in housing prices and that the nature of housing development and construction means that it may take some time for short and medium-term supply–demand imbalances to be resolved. Once again, part of the problem in Australia is that inherent geographical and demographic conditions, including physical limitations on land for development and the degree of

urbanisation, restrict housing supply in certain areas and open up differences in regional housing affordability.

However, government policy also affects the supply of housing as it relates to both land and housing planning, regulation and taxation. One complication in the Australian situation is, of course, the presence of a three-tier system of government where all tiers of government are heavily involved with the housing sector. State and territory governments, for instance, have extensive responsibilities related to land release and zoning, establishment of charges for (and in some cases, provision of) housing-related infrastructure, and implementation and enforcement of building and environmental regulations. Likewise, local government functions typically include the supervision of land development, the administration of planning requirements, and the supply of some infrastructure. Finally, while most of the taxation related to housing is at the state and local level (including stamp duty and land taxes for the former and property rates for the latter), the GST, CGT and allowances for income deductibility at the federal levels also have a role to play.

On this, and further to the discussion of tax policy as a demand driver, the PC (2004, p. 83) concluded that "...although international comparisons of taxation arrangements can be difficult, Australia's reliance on specific property taxation seems high compared with many other countries. Such taxation accounted for about 9 per cent of total taxation revenue for Australia in 2001, compared with a range from below 2 per cent to 12 per cent in a selection of overseas countries". Together, these various taxes and charges can add significantly to both the cost of acquiring and holding housing, and hence reduce the level of affordability. These also influence the overall transaction costs of acquiring and disposing of housing, with the OECD (2011) providing evidence that transaction costs (on both buyers and sellers) in Australia account for about 14% of the property value (fourth-highest in the OECD after Belgium, France and Greece). However, it is noteworthy that few measures of affordability, including those discussed earlier, incorporate any of the indirect costs of housing, including taxation and transaction costs.

Putting taxation aside, the capacity of state and local governments to influence housing markets through zoning and development plans and thereby contribute to housing price pressures through new dwelling commencements and redevelopment in existing areas. This is particularly important because of the presence of an argued structural gap between the demand and supply of housing (Stuchbury, 2010) and the oft-heard argument by industry that slow and restrictive building and development approvals and onerous infrastructure charges are one of the main reasons for the increase in housing costs (Carter, 1990). However, the

actual position of Australia in terms of the planning and regulation of housing and development is unclear. This ambiguity is perhaps best reflected in the PC's (2004, p. 123) argument that "...because recent price increases have been due mainly to the surge in demand in established areas, improvements to land release policies or planning approval processes could not have greatly alleviated them". Confusingly, in the same report, "...urban consolidation policies that introduce constraints on fringe development, including through 'urban growth boundaries', are likely to increase the scarcity value of land" (PC 2004, p. 123).

Overall, the PC (2004) concludes that planning processes have not contributed in any significant way to the housing affordability problem (Beer *et al.*, 2007). Nevertheless, there remains general agreement inside both Australia and the OECD (2011) that the housing supply in Australia could be more responsive by designing and enforcing efficient land-use regulations, providing infrastructure and other services along with housing, and using well-designed taxes to encourage the appropriate use of land for residential purposes. In terms of pertinent evidence, McLaughlin (2011) uses quarterly data from five Australian capital cities to estimate the supply elasticities and effects of metropolitan growth policy on new housing approvals. The findings indicate that in contrast to other studies in Australia, housing supply is elastic and hence indicative of a functioning housing market, though the elasticities of supply are less than 70–80 per cent of comparable US estimates with a longer adjustment period. McLaughlin (2011) also argues that established growth policies (such as urban growth boundaries and urban consolidation) have a greater impact on new housing approvals than the adoption of new-style growth policies (including development corporations and infrastructure levies), though both effectively decrease the supply of new housing.

There is some recognition of this problem in the recent creation of the Commonwealth government's \$512 million Housing Affordability Fund (FAHCSIA, 2008), expressions of interest (by state and local governments) in which closed in January 2010. The stated aims of this fund are "...to make housing more affordable by encouraging best practice in...residential development assessments, speeding up development assessment processes to reduce the holding costs for developers...and reducing the burden of infrastructure charges on developers, in order to generate savings for purchasers of new, moderately priced homes". However, while this scheme is yet unimplemented, there are already some concerns over its ability to alter the supply of housing, with the suggestion that subsidies targeted directly at low-income first homebuyer households may be a more efficient and simpler way to improve

housing affordability, with less distortion and more allowance for household choice (Abelson 2009).

3. Data and variable specification

Drawing on the above discussion, we hypothesise that housing affordability is a function of a set of economic, demographic, financial and other factors as follows. To start with, we proxy housing affordability as the dependent variable using two alternative quarterly measures over the period September 1985 to June 2010: (i) the Housing Affordability Index (*HAI*), provided by the Housing Industry Association (2011), and (ii) the inverse of the housing price–earnings multiple (*HPE*), constructed using ABS data on median housing prices and annual full-time earnings.

The main distinction between these measures is that *HPE* represents only the cost of housing relative to income while *HAI* also incorporates the costs of housing finance given assumptions on leverage and maturity. Nonetheless, an increase (decrease) in both measures as constructed represents an improvement (worsening) of housing affordability, i.e. housing becomes more (less) affordable. One key benefit of these alternative measures of housing affordability is that it permits us to undertake sensitivity analysis of the main results, thereby improving the robustness of our findings. One key limitation is that neither index makes allowance for the changes in the quality of housing over time. This implies that the median housing price used in their construction may overstate price increases as it incorporates both price change and quality adjustments. Unfortunately, the only ‘quality-adjusted’ housing index available in Australia, the RP Data–Rismark Daily Home Value Index, is only available after 1995.

<TABLE I HERE>

Table I provides selected descriptive statistics for *HAI* and *HPE*. As shown, while both measures have varied throughout the sample period, *HPE* is generally more volatile with a coefficient of variation of 26% compared to 21% for *HAI*. As a rule, for most mortgage-holding households, we expect that *HPE* offers a better medium-to-long term perspective on housing affordability (relative to household incomes), while *HAI* places relatively greater emphasis on short-term changes in affordability (relative to interest rates) for highly-g geared (80% loan-to-valuation ratio) first-home and investor (25-year maturity) buyers. However, while this at first suggests the *HAI* should be the more volatile measure (given incomes as the denominator in the *HPE* increase at a relatively stable rate), the record indicates that interest

rates have for the most part moderated the impact on housing affordability of the increase in housing costs. For example, while in the late 1980s and early 1990s high interest rates substantially worsened the impact of rising housing prices, from the mid-1990s right through to the mid-2000s, overall affordability benefited from relatively low interest rates, with housing prices rising at much the same rate as earlier. This is consistent with the findings of other work that the worsening housing affordability found in Australia is a generally tale of housing costs not housing finance costs.

We employ six sets of variables to proxy the economic, demographic, financial, social and other factors that influence housing affordability. All regressor data is also of quarterly frequency over the period September 1985 to June 2010. The first set relates to the market for housing finance and its influence on housing affordability. The first variable, the standard variable bank mortgage rate (*SVM*), represents the price of housing finance. As *HAI* already includes mortgage interest rates in its construction, we would expect the estimated coefficient to be insignificant when *HAI* is specified as the regressand. However, with *HPE*, higher (lower) interest rates will result in a decrease (increase) in demand for housing, house prices will fall (increase) and affordability as measured by *HPE* should improve. A positive coefficient is hypothesised. The second variable, housing debt to housing assets (*DTA*), is a measure of leverage. In general, deregulation of the Australian financial system has meant that aggregate leverage has increased such that more households can access suitable levels of housing finance to purchase homes. This may exert upward pressure on housing prices, thereby worsening affordability: a negative coefficient is hypothesised.

The third variable, housing interest payments to disposable income (*RTD*), is an indicator of debt servicing. All other things being equal, a higher level of debt servicing implies a worsening in housing affordability through increasing financial stress in mortgage-holding households. Potentially, this could also be followed by a decrease in the demand for housing, falling housing prices and improved affordability. Nonetheless, we expect a negative coefficient overall. Finally, lending commitments (proxied by the share of investor housing) (*LIN*) reflects the availability of housing finance for investment purposes as against those of owner occupiers. It is sometimes argued that one negative side effect of financial deregulation has been an easing of the availability of finance to investors and that this has increased prices in strong housing markets and so worsened housing affordability. A negative coefficient is hypothesised for both regressands.

The second set of explanatory variables relate to housing construction activity and costs. The first of these is the producer price index for housing construction (*PPH*). All other things

being equal, higher costs of supply should contract the supply of housing and increase house prices, thereby worsening affordability, and so would expect a negative coefficient when affordability is regressed against the price of housing. The next two variables also reflect the supply of housing via the approval of new dwellings, made available through both the private (*DHP*) and public sector (*DHG*). As a rule, increases in housing supply should again lower house prices and improve affordability: positive coefficients are hypothesised.

The third set of variables concerns economic growth. As discussed, it is often argued that Australia's strong economic growth has increased household income and wealth and part of this has been diverted into increasing the demand for more and higher quality housing, resulting in increasing housing prices and a deterioration in affordability. Gross domestic product (*GDP*) proxies for this effect for which we hypothesise a negative coefficient. However, with *HPE* the increase in incomes associated with strong economic growth should also increase incomes relative to housing prices, thereby improving housing affordability, for which a positive coefficient could also be hypothesised. The sign will then depend on the relative strength of these competing effects.

The second economic growth variable employs an index of mining production (*MIN*) to proxy for the impact on the demand for housing of the resources boom of the 2000s. Certainly, the impact of the mining boom is most acute in small mining towns, where the smaller housing stock accentuates the impact of the increase in housing demand for miner accommodation on house prices (see Moranbah in Queensland, Boggabri in New South Wales, and Karratha in Western Australia). However, there is also a wider impact when miners invest in housing in desirable nearby coastal locations (for example, Mackay and Rockhampton in relation to the Bowen Basin in Queensland) or further afield, and then become part of a significant fly-in fly-out (FIFO) long-shift workforce accommodated in temporary work camps. A negative coefficient is hypothesised.

The fourth set of variables relate to demographics. As discussed, the rapidly growing Australian population (*POP*) is argued to exert a considerable influence on the rate of household formation and the demand for housing, thereby increasing house prices and worsening affordability (a negative coefficient is hypothesised). The labour participation rate (*PAR*) is also likely to have an influence with a higher participation rate increasing household incomes and pushing prices up and affordability down. We again hypothesise a negative coefficient.

The fifth set of explanatory variables address financial market conditions. In this regard, we specify two variables, the Australian Securities Exchange (ASX) All Ordinaries Index

(*ASX*) and the nominal yield on 10-year Commonwealth government bonds (*BND*), as indicators of the financial returns available on alternative investments to real assets in the form of residential housing. In both cases, this would infer a positive coefficient as relatively higher yields on these investments would reduce the demand for housing investment, thereby causing house prices to fall and affordability to improve. However, it is also possible that in much the same manner that earned income from higher GDP increases the demand for housing, returns from financial assets could also be diverted into real assets such as residential housing. This would imply a positive coefficient.

Similarly, in the same set of variables we include the real yield on indexed Commonwealth government bonds (*INB*). As the regression also includes the nominal yield on government bonds, an increase in the real rate relative to the nominal rate implies a decrease in the expected rate of inflation. In general, higher expected inflation brings forward consumption decisions and this should increase the demand for housing and with it housing prices (worsening affordability). However, when we consider housing finance as a component of the demand for housing, the increase in expected inflation (and interest rates) also causes some households to substitute away from housing toward current and future non-housing consumption. Accordingly, we hypothesise no particular a priori sign on the estimated coefficients for these financial variables.

The final set of explanatory variables concern the taxation environment as it relates to residential housing. Three of these, the (relatively high) marginal personal tax rate at average earnings (*TAX*), the reintroduction of negative gearing (*NEG*) and the 1999 changes to capital gains tax (*CGT*) have been argued by the PC (2004) to have magnified the attractiveness of investing in residential property during the recent upswing in house prices, thereby adding to price pressures and worsening affordability. We hypothesise negative coefficients when these variables serve as regressors for housing affordability. The fourth variable, identifying the introduction of the goods and services tax (*GST*) and concomitantly higher construction costs, would be normally associated with a contraction in housing supply and worsening affordability. However, we consider that the impact of the GST is offset by the introduction at the same time of the first-home owners grant (*FHOG*) as compensation, as was the policy intent. No particular sign is thus hypothesised.

4. Estimation method

The method we employ to investigate the short- and long-run relationships between the housing affordability measures as regressands and the housing finance, housing construction

and activity, economic growth, demographic, alternative investment and taxation variables as regressors is the bounds test and autoregressive distributed lag (ARDL) cointegration procedure developed by Pesaran *et al.* (2001) with recent empirical applications (but not in housing) in De Vita and Abbott (2004), Narayan (2005), Narayan and Smyth (2005), Fosu and Magnus (2006), Pahlavani and Rahimi (2009) and Sakyi (2011). This approach has three main advantages over earlier cointegration techniques when applied to the aggregate data in our study. First, it is relatively simple compared with the Johansen and Juselius (1990) multivariate cointegration technique as ARDL permits the cointegration relationship to be estimated using ordinary least squares (OLS) once the lag order of the model has been identified.

Second, the chosen approach is applicable irrespective of whether the regressors are purely stationary without any trend—and thus integrated of order zero or I(0)]—or with a unit root (a random walk)—and therefore integrated of order one or I(1)]—or mutually cointegrated. Nevertheless, it will produce spurious results for I(2) or higher series so differencing is still required to reduce these to I(1). Finally, the technique is more efficient for the small sample size found with our data set, a situation where both the Engle and Granger (1987) and Johansen (1988; 1991) cointegration methods are considered unreliable.

The ARDL including bounds test comprises three steps. The first step is to estimate a standard log-log specification of the cointegrating long-run relationship for an I(1) dependent variable as a function of a vector of I(d) regressors of order $0 < d < 1$. We specify the housing affordability equation as:

$$\Delta \ln Y_t = \alpha_0 + \alpha_1 \ln Y_{t-1} + \sum_{i=2}^{m+1} \alpha_i \ln X_{it-1} + \alpha_{m+2} \Delta \ln Y_{t-1} + \sum_{i=1}^m \sum_{j=1}^p \alpha_{ij} \Delta \ln X_{it-j} + \sum_{k=1}^n \alpha_k D_{kt} + \varepsilon_t \quad (1)$$

where Y is *HAI* or *HPE*, α_0 is drift, α_1 is an autoregressive parameter, α_i are long-run multipliers for the explanatory variables (*SVM*, *DTA*, *RTD*, *LIN*, *PPH*, *DHP*, *DHG*, *GDP*, *MIN*, *POP*, *PAR*, *ASX*, *BND*, *INB*) where $i = 2, 3, \dots, m+1$ where m is the number of explanatory variables, Δ are first-differenced terms to ensure the residuals, ε_t , are white noise identically and independently distributed (i.i.d), α_{m+1} and α_{ij} are first-differenced parameters where p is the number of lags, α_k are dummy variable parameters where n is the number of dummy variables, D are dummy variables (*TAX*, *GST*, *NEG*, *CGT*) and all other variables are as previously defined.

We estimate Equation (1) with OLS in order to test for the existence of a long-run relationship between the lagged levels of the explanatory variables by conducting a joint F -

test to determine the significance of the coefficients of these slope variables. The null hypothesis of no cointegration among the variables in Equation (1) is tested using $H_0: \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 \dots = \alpha_{m+1} = 0$ against the alternative $H_1: \alpha_1 \neq \alpha_2 \neq \alpha_3 \neq \alpha_4 \dots \neq \alpha_{m+1} \neq 0$. Two sets of critical values reported in Pesaran *et al.* (2001) provide critical values bounds of the test for cointegration, when the explanatory variables are assumed $I(d)$ where $0 < d < 1$. The lower critical value of the bounds test assumes the regressors are $I(0)$ and the upper value assumes the regressors are $I(1)$. If the F -statistic is above the critical upper limit, then the null hypothesis of no cointegrating long-run relationship can be rejected, irrespective of the orders of integration of the individual time series. Conversely, if the F -statistic is below the lower critical value, then the null hypothesis of no cointegrating long-run relationship cannot be rejected. If the F -statistic falls between these critical values, the test is inconclusive.

In the second step, once cointegration has been established the conditional ARDL ($1, p$ lags for each explanatory variable) long-run model for the log of Y is estimated in Equation (2) as:

$$\ln Y_t = \beta_0 + \beta_1 \ln Y_{t-1} + \sum_{i=1}^m \sum_{j=0}^p \beta_{ij} \ln X_{it-j} + \sum_{k=1}^n \beta_k D_{kt} + \varepsilon_t \quad (2)$$

This involves selecting the orders of the ARDL ($1, p$ lags for each explanatory variable) model using the Akaike information criteria (AIC). The third and final step involves the estimation of the short-run dynamic parameters using the error correction model (ECM) associated with the long-run estimates. The ECM is defined in Equation (3) as follows:

$$\Delta \ln Y_t = \gamma_0 + \gamma_1 \Delta \ln Y_{t-1} + \sum_{i=1}^m \sum_{j=1}^q \gamma_{ij} \Delta \ln X_{it-j} + \gamma_2 ECR_{t-1} + \varepsilon_t \quad (3)$$

where γ_{ij} $i = 1, 2, 3, \dots, m, j = 1, 2, \dots, q$ are the short-run dynamic coefficients of the convergence of the model to equilibrium and ECR is the speed of adjustment. Note that as all the dummy variables are by nature very long run (fixed for long periods), they are omitted from the ECM.

5. Empirical results

The ARDL bounds test for cointegration does not depend on pre-testing the order of integration. Nonetheless, a unit root test is conducted on all variables as the ARDL procedure requires that all variables are $I(0)$ or $I(1)$. We employ a relatively more efficient autoregressive univariate Dickey–Fuller generalised least squares (DF-GLS) unit root test (Elliot *et al.*, 1996). This is a modification of the augmented Dickey–Fuller (ADF) unit root t -

test with the application of generalised least squares (GLS) which de-trends the series before applying the ADF test. In general, the DF-GLS test outperforms the ADF test in relation to sample size and power. The DF-GLS test includes a constant and trend for the log level series and a constant with no trend for the difference of the log level series. The DF-GLS unit root test results are presented in Table II and they suggest that all variables are either $I(0)$ or $I(1)$. It is interesting to note the relatively long optimal lags (in brackets) in the level series for *HPE* (2), *DHP* (5), *POP* (5) and *INB* (2).

<TABLE II HERE>

In order to conduct the bounds test for cointegration, the first step taken in the ARDL procedure is to test for the long-run relationship in Equation (1). A maximum lag order of one is employed given the large number of explanatory variables and the short sample period. This is potentially a limitation of the study in that one of the alternative dependent variables (*HPE*) and three of the explanatory variables (*DHP*, *POP* and *INB*) exhibit lags of longer than a quarter year in their levels, as discussed above. The joint F -test is conducted on the lagged log-level variables while the differenced variables have no direct influence on the bounds cointegration test (Pesaran and Pesaran, 1997). The F -statistic tests the joint null hypothesis that the coefficients of the lagged log-levels are equal to zero which implies that no cointegrating long-run relationship exists. The calculated F -statistics for *HAI* and *HPE* are respectively 2.6872 and 2.7790 which are higher than the simulated upper bound critical value of 1.151 for $k = 15$ and $n = 80$ with unrestricted intercept and trend at the 10% level of significance. This suggests that the null hypothesis of no cointegration is rejected, indicating that a long-run cointegrating relationship exists between the dependent and the explanatory variables in both models. That is, the variables tend to move together, or at least not too far apart, over time.

The second step is to estimate the long-run model (in the context of the ARDL procedure) for the log of *HAI* and *HPE* and in line with Equation (2). This equation is estimated using the ARDL (1, 0, 0, ... 0) specification according to the AIC criterion of optimal lag selection (we also employed the Schwarz, Hannan–Quinn and log-likelihood criteria and found no discernible difference in the optimal lags). The results for *HAI* and *HPE* are presented in Table II with the long-run estimated coefficients, standard errors and p-values for *HAI* in columns 2–4 and those for *HPE* in columns 8–10. Consider the results for *HAI*. Other than lagged *HAI* (which indicates a 29.3% probability of a one-quarter deterioration in housing

affordability being followed by another) six explanatory variables exert a significant (10% or lower) effect on housing affordability in the long run: *DTA*, *RTD*, *DHP*, *DHG*, *ASX* and *INB*. Interestingly, none of the variables reflecting economic growth, demographics or taxation have an influence on housing affordability as measured in the long run. Of the former, the financial factors have the greatest combined impact on housing affordability as measured by *HAI*, with a 1% increase in debt servicing (*RTD*) leading to an 0.83 per cent decrease in *HAI* (a worsening of housing affordability) and a 1% increase in leverage (*DTA*) (as an indicator of financial flexibility) increasing *HAI* (improving housing affordability) by 0.68 percent.

<TABLE III HERE>

The effects of the remaining variables are of lesser magnitude. Oddly, increases in both the numbers of private (*DHP*) and public sector (*DHG*) dwelling units approved by 1% are associated with respective decreases of 0.12 and 0.05 per cent in *HAI*. That is, the new dwelling approval process in the long run is not offsetting the immediate deterioration in housing affordability. One possibility is that the inferred increase in the stock of housing given by approvals is coming onto the market of an insufficient magnitude to offset the overall increase in housing prices at any point of time, suggesting persistent undersupply in the housing market. Another possibility is significant lags in the reaction to the market signals being sent to housing developers and those building their own home. This is already well evidenced by the long optimal lag of five quarters for *DHP* discussed above. In terms of alternative investments, a 1% increase in *ASX* is associated with a worsening in housing affordability of 0.07%. This suggests a wealth effect where higher equity returns are diverted in part to the housing market. The yield on indexed bonds (*INB*) also has a negative effect on housing affordability (as real yields increase toward nominal yields, expected inflation falls), with a 1% increase in yields translating to a 0.17% worsening in housing affordability.

These results are generally consistent with the long-run model where *HPE* is specified as the dependent variable. Recall that this measure of affordability ignores financing costs. One noticeable difference is that a worsening of housing affordability in one quarter is 45.41% more likely if the previous quarter experienced a reduction in affordability. Another difference is that the standard variable mortgage rate (*SVM*) also affects the housing price–earnings multiple, with a 1% increase in the standard variable mortgage rate improving affordability by 0.42%, likely by reducing housing demand and thence housing prices. The final differences are that *ASX* no longer (negatively) affects housing affordability, but *GST*

does and does so positively (i.e. improving housing affordability) with the introduction of GST improving affordability by 9.32%.

Overall, both long-run models in Table III are comparable in overall explanatory power, with the model where *HPE* is the dependent variable explaining some 99.06% of the variation in housing affordability compared with 97.40% for the model where *HAI* is specified as the dependent variable. In both cases, the null hypothesis that the slope coefficients are jointly insignificant is rejected at the .01 level. Lastly, we can use the constant in each model as an indicator of the long-run equilibrium level of Australian housing affordability with (log) values of 8.91 and 12.89 for *HAI* and *HPE*, respectively. This indicates equilibrium values for the *HAI* of about 109 (slightly above the historical minimum of 107 and the cut-off of 100 where housing repayments exceed 30% of disposable income) and a housing price–earnings multiple of 7 (below the recent historical maximum set in June 2010 of 8.2).

The third and final step of the ARDL procedure is to estimate the short-run dynamic coefficients associated with the ECM from the long-run relationship as specified in Equation (3). The results are presented in Table II in columns 5–7 where *HAI* is specified as the dependent variable and columns 11–13 where *HPE* serves as the dependent variable. We first consider the overall fit and dynamics of both models. First, the long-run models are clearly better able to explain the variation in housing affordability than the short-run models, with the *HAI* model explaining 76.04% of the variation in housing affordability in the short run (compared to 97.4% in the long run) while *HPE* explains just 58.3% in the short run (compared to 99.1% in the long run. This is consistent with our earlier assertion that housing affordability is very much a long run phenomenon and that interest rates (as reflected in *HAI*) have a relatively more substantial short run effect. Second, the estimated error correction coefficients (*ECR*) of -0.35 for the *HAI* model and -0.50 for the *HPE* model are significant at the 5% level of significance. These indicate the high speed of adjustment to equilibrium after a shock: that is, approximately 35.38 and 50.18% of the deviation in the explanatory variables from a previous quarter's shock converge back to the long-run equilibrium in the current quarter. Lastly, there is an expected worsening in housing affordability each quarter of 0.0341–0.0375% (about 1.4% per annum), regardless of the impact of the macro drivers of housing affordability, as indicated by the significant values of the constants.

We now turn to the differences in the long and short run by first considering the *HAI* model. To start with, it is interesting to see that *SVM* exerts a significant (and negative) effect on *HAI* in the short run, even though *HAI* notionally includes the impact on housing affordability of mortgage interest rates. It may be useful to recall here that the *HAI* assumes a

loan-to-valuation ratio of 80% and it may be that this does not fully capture the short run worsening in housing affordability associated with an increase in *SVM*. The other interesting finding is that in the short run, neither *DHP*, *ASX* or *INB* affect *HAI* as in the long run, but that population (*POP*) does. Somewhat paradoxically, a 1% increase in population actually improves housing affordability by 8.7% in the short run, even though it has no major impact in the long run. However, it is possible that this short-run model is instead reflecting that improving housing affordability promotes an increasing rate of population growth through natural increase and immigration.

Of course, we should recall that population includes long lags not modelled in this analysis, and that the beneficial effect of population on housing affordability seen here in the next-to-most recent quarter only arises after a progressive worsening of affordability in previous quarters. The other interesting finding is that deficiency and/or lags in dwelling approvals found in the long run have no effect in terms of private sector approvals (*DHP*) in the short run, but still do for public sector dwelling approvals (*DHG*). This suggests the deficiencies and/or lags in public sector dwelling approvals aggravate housing affordability in both the long and short run.

The estimated results for the short run model using *HPE* as the measure of housing affordability are also similar with their long run counterpart and with the findings of the *HAI* short run model. Two other key findings are of note. First, economic growth clearly has a negative effect on *HPE*, with a 1% increase in growth reducing housing affordability by 1.34%. Second, *BND* now has a small effect on housing affordability in the short run, with a 1% increase in government bond yields worsening affordability by 0.09%. However, in both cases, the effects of both variables on worsening housing affordability in the short run are negated in the long run.

As a final point, the specification of our models with many possibly related variables highlights a potential concern with multicollinearity. However, at first impression, we do not believe multicollinearity to be a significant problem as many of the estimated coefficients in Table 2 are significant. We also re-estimated the models after removing individual and groups of variables and found that the remaining estimates were fairly stable. Lastly, we calculated variance inflation factors and found no evidence of multicollinearity for either short-run model and only some evidence for the long-run models. However, this is not too concerning as we principally employ the long-run model to obtain forecasts of housing affordability and to inform the short-run dynamics. Both of these roles are unaffected by the presence of multicollinearity.

6. Conclusion

This paper models housing affordability in Australia over the past 25 years. The main drivers of affordability identified in the policy literature during this period include strong economic growth and changing population dynamics, ready access to cheap housing finance, changes in government policy, and a generally favourable tax environment. However, while much of the policy documentation comments on the drivers of housing affordability, there is astoundingly little hard quantitative evidence on exactly how these drivers impact on affordability over both the short and long run nor how they interact with each other. This has meant the policy literature has invariably directed attention to the most obvious cyclical factors rather than the more difficult to identify structural concerns.

In the paper, we employ the ARDL approach, two alternative measures of housing affordability, and six sets of variables to proxy the economic, demographic, financial, social, and other factors that influence long- and short-run housing affordability using quarterly data over the period September 1985 to June 2010. In one sense, the results are both expected and surprising. Against the backdrop of a progressive generational deterioration in housing affordability, the principal expected long-run drivers appear to be more flexible housing finance market conditions and the returns on alternative financial assets and the level of private and public new dwelling approvals.

Of these, the impact of the low rate of new dwelling approvals (public and private sector in the long run and public sector in the short run) points to a persistent structural gap in the demand and supply of housing. This offers qualified support for the argument that the Australian housing supply needs to be made more responsive by designing and enforcing efficient land-use regulations, providing infrastructure and other services along with housing, and using well-designed taxes to encourage and facilitate the use of land for residential purposes. Potentially, it also suggests the need for a nation-building program of private and public housing to make major inroads into the lack of housing supply. However, dedicated work would be required to address the precise relation between the rate of housing approvals and housing affordability.

Nonetheless, the results are also surprising in that some factors argued to underpin worsening housing affordability are either not significant or have only a temporary impact. For example, economic growth only has a negative effect on housing affordability in the short run while taxation potentially related to housing affordability, including personal income tax rates, negative gearing, capital gains tax and the goods and services tax, has no discernible

impact on housing affordability, even in the long run, at least when using aggregate data. One qualifier in this regard is that the taxation conditions as they relate to housing in this study are either unchanged or little changed throughout our sample period.

References

- Abelson, P. (2009), "Affordable housing: concepts and policies", *Economic Papers*, Vol. 28 No. 1, pp. 27–38.
- Affordable Housing National Research Consortium (2001), "Affordable housing in Australia: pressing need, effective solution", available at: <http://www.communityhousing.org.au/> (accessed 4 December 2012).
- Anonymous (2010) "Global house process: floor to ceiling", *The Economist*, 23 October, p. 82.
- Australian Department of Families, Housing, Community Services and Indigenous Affairs (FAHCSIA) (2008), "Housing affordability fund consultation paper", available at: <http://www.fahcsia.gov.au/> (accessed 4 December 2012).
- Australian Government Treasury (2011), "First home saver accounts", available at: <http://homesaver.treasury.gov.au/> (accessed 4 December 2012).
- Beer, A., Kearins, B. and Pieters, H. (2007), "Housing affordability and planning in Australia: the challenge of policy under neo-liberalism", *Housing Studies*, Vol. 22 No. 1, pp. 11–24.
- Berry, M. (2006a), "Housing affordability and the economy: a review of the labour markets impacts and policy issues", Research Paper No. 5, available at: <http://www.ahuri.edu.au/> (accessed 4 December 2012).
- Berry, M. (2006b), "Housing affordability and the economy: a review of macroeconomic impacts and policy issues", Research Paper No. 4, available at: <http://www.ahuri.edu.au/> (accessed 4 December 2012).
- Bor, A. and Moloney, D. (2003), "Improving accessibility and flexibility of mortgage lending for Australians: a report for the Prime Minister's Home Ownership Task Force", Menzies Research Centre, available at: <http://www.mrcld.org.au/> (accessed 4 December 2012).
- Callaghan, G. (2010), "The big squeeze", *The Weekend Australian Magazine*, 30–31 October, pp. 8.
- Caplin, A., Joye, C., Butt, P., Glaeser, E. and Kuczynski, M. (2003), "Innovative approaches to reducing the costs of home ownership: a report for the Prime Minister's Home Ownership Task Force", Menzies Research Centre, available at: <http://www.mrcld.org.au/> (accessed 4 December 2012).
- Carter, N. (1990), "Housing development in Australia: the implications of production and approval processes for availability and choice", *Journal of Property Research*, Vol. 7 No. 3, pp. 153–72.
- Chapman, P. (2006), *Housing Affordability in Australia, Research and Policy Bulletin*, AHURI, Melbourne.
- Committee of Inquiry into Housing Costs (1978), *The Cost of Housing: Volume 1: Report*, Australian Government Publishing Service, Canberra.
- Cox, W. and Pavletich, H. (2010), "6th annual Demographia international housing affordability survey", with an introduction by T. Recsei, available at: <http://www.demographia.com/> (accessed 4 December 2012).
- De Vita, G. and Abbott, A. (2004), "Real exchange rate volatility and US exports: an ARDL bounds testing approach", *Economic Issues*, Vol. 9 No. 1, pp. 69–78.
- Elliott, G., Rothenberg, T.J. and Stock, J.H. (1996), "Efficient tests for an autoregressive unit root", *Econometrica*, Vol. 64 No. 4, pp. 813–36.
- Ellis, L. (2010), "Recent developments in the housing market and its financing", available at: <http://www.rba.gov.au/> (accessed 4 December 2012).
- Engle, R. F. and Granger C.W.J. (1987), "Co-integration and error correction: representation, estimation, and testing", *Econometrica*, Vol. 55 No. 2, pp. 251–76.
- Fosu, O.E. and Magnus, F.J. (2006), "Bounds testing approach to cointegration: an examination of foreign direct investment trade and growth relationships", *American Journal of Applied Science*, Vol. 3 No. 11, pp. 2079–85.
- Gabriel, M., Jacobs, J., Arthurson, K., Burke, T. and Yates, J. (2006), "Conceptualising and measuring the housing affordability problem, background report", available at: www.ahuri.edu.au/ (accessed 4 December 2012).
- Gans, J. and King, S. (2003), "Policy options for housing for low income households: a report for the Prime Minister's Home Ownership Task Force", Menzies Research Centre, available at: <http://www.mrcld.org.au/> (accessed 4 December 2012).
- Gurran, N. (2008), "Affordable housing: a dilemma for metropolitan planning?", *Urban Policy and Research*, Vol. 26, No. 1, pp. 101–10.

- Gurran, N., Milligan, V., Baker, D. and Bugg, L. (2007), "International practice in planning for affordable housing: lessons for Australia", AHURI Positioning Papers, No. 99, September.
- Housing Industry Association (HIA) (2011), "Economics group", available at: <http://hia.com.au/>. (accessed 4 December 2012).
- Housing, Local Government and Planning Ministers (2005), "Framework for national action on affordable housing", available at <http://www.communityhousing.com.au/> (accessed 4 December 2012).
- Johansen, S. (1988), "Statistical analysis of cointegrating vectors", *Journal of Economic Dynamics and Control*, Vol. 12 No. 2-3, pp. 25–31.
- Johansen, S. (1991), "Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models", *Econometrica*, Vol. 59 No. 6, pp. 1551–80.
- Johansen, S. and Juselius, K. (1990), "Maximum likelihood estimation and inferences on cointegration with applications to the demand for money", *Oxford Bulletin of Economics and Statistics*, Vol. 52 No. 2, pp. 169–210.
- Lawson, J. and Milligan, V. (2007), "International trends in housing and policy responses", AHURI Final Reports, No. 110, December.
- Marks, G.N. and Sedgwick, S.T. (2008), "Is there a housing crisis? the incidence and persistence of housing stress 2001–2006", *Australian Economic Review*, Vol. 41 No. 2, pp. 215–21.
- McLaughlin, R.B. (2011), "Metropolitan growth policies and new housing supply: evidence from Australia's capital cities", *Australasian Journal of Regional Studies*, Vol. 17 No. 1, pp. 60–80.
- Merrett, D. (2000), "Paying for it all", in Troy P. (ed.) *A History of European Housing in Australia*, Cambridge University Press, Cambridge, pp. 237–53.
- Narayan, P.K. and Smyth, R. (2005), "Trade liberalization and economic growth in Fiji: an empirical assessment using the ARDL approach", *Journal of the Asia Pacific Economy*, Vol. 10 No. 1, pp. 96–115.
- Narayan, P.K. (2005), "The saving and investment nexus for China: evidence from cointegration tests", *Applied Economics*, Vol. 37 No. 17, pp. 1979–90.
- National Housing Strategy (1991), *The Affordability of Australian Housing*, National Housing Strategy Issues Papers, No. 2. Australian Government Publishing Service, Canberra.
- NSW Office of State Revenue (2011), "First home benefits", available at: <http://www.osr.nsw.gov.au/> (accessed 4 December 2012).
- OECD (2011), "Economy: Well-functioning housing markets are key for stability and growth", available at: <http://www.oecd.org/> (accessed 4 December 2012).
- Pahlavani, M. and Rahimi, M. (2009), "Sources of inflation in Iran: an application of the ARDL approach", *International Journal of Applied Econometrics and Quantitative Studies*, Vol. 6 No. 1, pp. 61–76.
- Pesaran, M.H. and B. Pesaran, (1997). *Working with Microfit 4.0: Interactive Econometric Analysis*, Oxford University Press, Oxford.
- Pesaran, M.H., Shin, Y. and Smith, R.J. (2001). "Bounds testing approaches to the analysis of level relationships", *Journal of Applied Econometrics*, Vol. 16 No. 3, pp. 289–326.
- Priority Review Staff (1975), *Report on Housing*, Australian Government Publishing Service, Canberra
- Productivity Commission (PC) (2004), "First home ownership", Inquiry Report No. 28, available at: <http://www.pc.gov.au/> (accessed 4 December 2012).
- Reserve Bank of Australia (RBA) (2003), "Submission to Productivity Commission inquiry on first home ownership, RBA Occasional Paper No. 16, available at: <http://www.rba.gov.au/> (accessed 4 December 2012).
- Richards, A. (2009a), "Conditions and prospects in the housing sector", address to the 4th Annual Housing Congress, 14 December, Sydney, Available at <http://www.rba.gov.au/> (accessed 4 December 2012).
- Richards, A. (2008), "Some observations on the cost of housing in Australia", address to 2008 Economic and Social Outlook Conference, The Melbourne Institute, 27–29 March, Melbourne, available at: <http://www.rba.gov.au/> (accessed 4 December 2012).
- Richards, A. (2009b), "Housing market developments", talk to CEDA Housing Forum: A National Round-up, 29 September, Sydney, available at: <http://www.rba.gov.au/> (accessed 4 December 2012).
- Sakyi, D. (2011), "Trade openness, foreign aid and economic growth in post-liberalisation Ghana: An application of ARDL bounds test", *Journal of Economics and International Finance*, Vol. 3 No. 3, pp. 146–56.
- Select Committee on Housing Affordability in Australia (SCHAA) (2008) "A good house is hard to find: housing affordability in Australia", available at: <http://www.aph.gov.au/> (accessed 4 December 2012).

- Stuchbury, M. (2010), "Voters defend the quarter-acre dream", *The Weekend Australian*, 4–5 Dec, p. 12.
- Urban Development Institute of Australia (2007), "An industry report into affordable home Ownership in Australia", available at: <http://www.udia.com.au/> (accessed 4 December 2012).
- Yates, J. (2007a), "Access to home ownership: past and present", Research Paper 10, available at: <http://www.ahuri.edu.au/> (accessed 4 December 2012).
- Yates, J. (2007b), "Housing affordability and financial stress", Research Paper 6, available at: <http://www.ahuri.edu.au/> (accessed 4 December 2012).
- Yates, J. (2007c), "The polarisation of housing affordability", Research Paper 8, available at: <http://www.ahuri.edu.au/> (accessed 4 December 2012).
- Yates, J. (2008), "Australia's housing affordability crisis", *Australian Economic Review*, Vol. 41 No. 2, pp. 200–14.
- Yates, J. and Gabriel, M. (2006), "Housing affordability in Australia", Research Paper No. 3, available at: <http://www.ahuri.edu.au/> (accessed 4 December 2012).
- Yates, J., Berry, M., Burke, T., Jacobs, K., Milligan, V. and Randolph, B. (2004), "Housing affordability for lower income Australians", available at: <http://www.ahuri.edu.au/> (accessed 4 December 2012).
- Yates, J., Kendig, H. and Phillips, B., with Milligan V., and Tanton, R. (2007), "Sustaining fair shares: the Australian housing system and intergenerational sustainability", Research Paper No. 11, available at: <http://www.ahuri.edu.au/> (accessed 4 December 2012).
- Yates, J., Randolph, B. Holloway, D. and Murray, D. (2005), "Housing affordability, occupation and location in Australian cities and regions", AHURI, Final Report, available at: <http://www.ahuri.edu.au/> (accessed 4 December 2012).

Figure I.
HAI and HPE, Sep-1985–Jun-2010

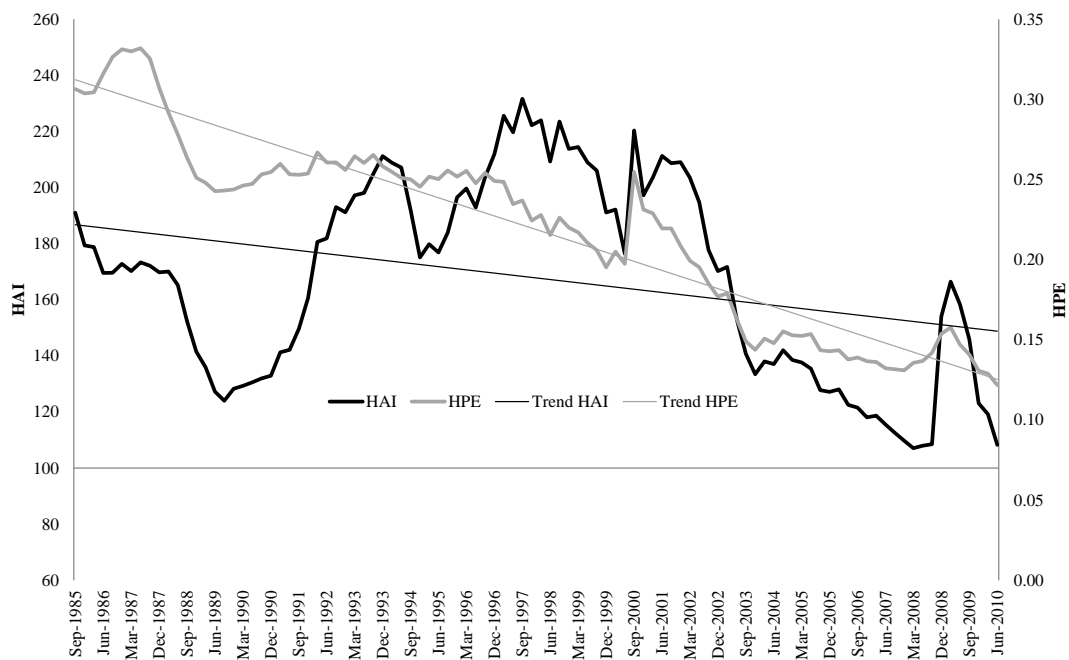
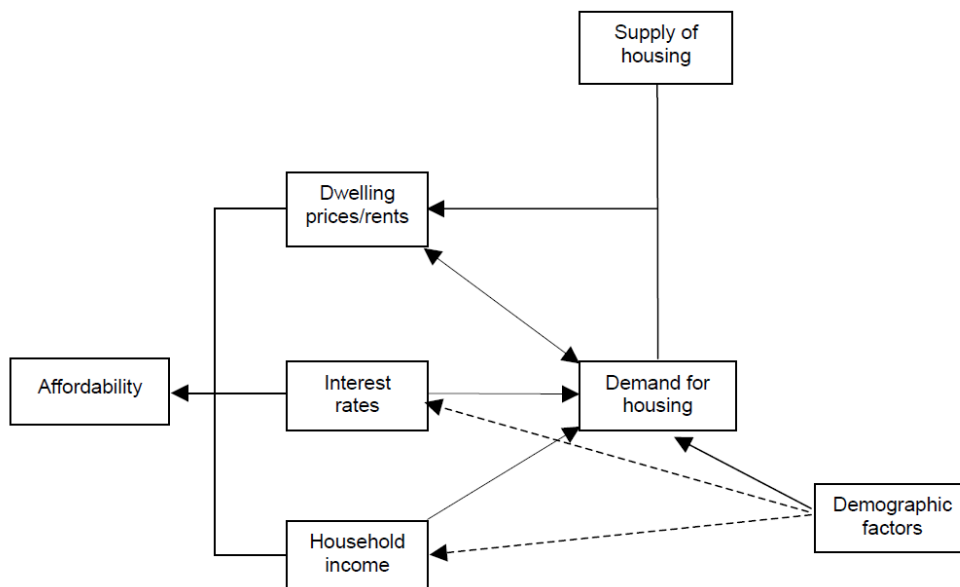


Figure II.
Selected drivers of housing affordability



Source: Yates and Milligan (2007)

Table I.
Variable descriptions and selected descriptive statistics

Variable category	Code	Description	Expected sign HAI	Expected sign HPE	Data source	Min.	Max.	Mean	Std. deviation	Coefficient of variation
Housing affordability	HAI	Housing Affordability Index (n)	n/a	n/a	HIA	107.06	231.62	167.78	35.34	0.21
	HPE	Inverse of housing price–earnings multiple (n)	n/a	n/a	ABS	121.75	331.92	218.75	57.96	0.26
Housing finance	SVM	Standard variable mortgage rate – banks (%)	?	+	RBA	5.80	17.00	9.69	3.42	0.35
	DTA	Housing debt to housing assets (leverage) (%)	–	–	RBA	10.28	31.10	18.90	6.20	0.33
	RTD	Housing interest payments to disposable income (debt servicing) (%)	–	–	RBA	4.02	11.19	6.05	1.86	0.31
	LIN	Lending commitments (share of investor housing) (p)	–	–	ABS	0.05	0.63	0.20	0.15	0.75
Housing construction activity and costs	PPH	Producer price index, housing construction (n)	–	–	ABS	72.10	165.20	119.40	23.62	0.20
	DHP	New private sector dwelling units approved, 000s (n)	+	+	ABS	18.22	36.62	26.56	3.94	0.15
	DHG	New public sector dwelling units approved, 000s (n)	+	+	ABS	0.26	1.97	0.73	0.39	0.53
Economic growth	GDP	Gross domestic product, thousands (A\$)	–	+ / –	ABS	145.15	325.43	224.31	55.50	0.25
	MIN	Index of mining production (n)	–	–	ABS	36.40	109.60	72.79	18.82	0.26
Demographics	POP	Estimated resident population, mil. (n)	–	–	ABS	15.84	22.34	18.77	1.77	0.09
	PAR	Labour participation rate (%)	+	+	ABS	61.12	65.66	63.48	1.06	0.02
Alternative investments	ASX	ASX All Ordinaries Index (n)	+ / –	+ / –	ASX	955.00	6492.40	2832.26	1356.10	0.48
	BND	Yield on 10-year Govt. bonds (%)	+ / –	+ / –	RBA	4.22	14.85	8.12	3.08	0.38
	INB	Yield on indexed bonds (%)	+ / –	+ / –	RBA	2.15	5.94	3.96	1.09	0.28
Taxation	TAX	Marginal personal tax rate at average earnings (%)	–	–	ATO	0.30	0.46	0.35	0.05	0.14
	GST	Introduction of GST (and FHOG) (from Sep-2000 = 1; otherwise 0)	?	?	ATO	0.00	1.00	0.40	0.49	1.23
	NEG	Negative gearing reintroduced (from Sep-1987 = 1; otherwise 0)	–	–	ATO	0.00	1.00	0.92	0.27	0.29
	CGT	Changes to CGT (from Sep-1999 = 1; otherwise 0)	–	–	ATO	0.00	1.00	0.44	0.50	1.14

Notes: GST – Good and Services Tax, FHOG – First-Home Owners Grant, CGT – Capital Gains Tax, HIA – Housing Industry Association, ABS – Australian Bureau of Statistics, RBA – Reserve Bank of Australia, ASX – Australian Securities Exchange, ATO – Australian Taxation Office. All series are quarterly observations from Sep-1985 to Jun-2010.

Table II.
Optimal lag and unit root test results

Variable	Levels series		Differenced series		I(<i>d</i>)
	Optimal lag	Statistic	Optimal lag	Statistic	
HAI	0	-1.3685	1	-3.7837	I(1)
HPE	2	-2.7097	1	-5.2291	I(1)
SVM	1	-2.4804	0	-5.0367	I(1)
DTA	1	-2.2553	0	-4.8150	I(1)
RTD	1	-2.2420	0	-4.3462	I(1)
LIN	0	-5.7655	-	-	I(0)
PPH	1	-1.4015	0	-3.2644	I(1)
DHP	5	-3.6879	-	-	I(0)
DHG	1	-2.8278	0	-14.152	I(1)
GDP	0	-1.5711	0	-7.4145	I(1)
MIN	0	-2.1465	0	-10.637	I(1)
POP	5	-2.5692	4	-1.7693	I(1)
PAR	0	-1.8184	0	-8.0095	I(1)
ASX	1	-3.0237	0	-10.0100	I(1)
BND	0	-2.5859	0	-7.0827	I(1)
INB	2	-3.5547	1	-4.4242	I(1)

Table III.
Estimated long- and short-run models

Variable	Dependent variable: HAI						Dependent variable: HPE					
	Long run			Short run			Long run			Short run		
	Coefficient	Std. error	p-value	Coefficient	Std. error	p-value	Coefficient	Std. error	p-value	Coefficient	Std. error	p-value
CONS.	8.9122	10.6454	0.4050	-0.0375	0.0176	0.0361	12.8887	7.9078	0.1071	-0.0341	0.0158	0.0336
HIA	0.2928	0.0802	0.0005	-0.1183	0.0828	0.1568	0.4541	0.0704	<0.0001	-0.0839	0.1157	0.4704
SVM	0.0531	0.1221	0.6649	-0.3032	0.1063	0.0055	0.4261	0.0964	<0.0001	0.2514	0.0964	0.0108
DTA	0.6754	0.1339	<0.0001	1.2090	0.2177	<0.0001	0.5203	0.1006	<0.0001	1.2040	0.2082	<0.0001
RTD	-0.8284	0.1693	<0.0001	-0.6272	0.1303	<0.0001	-0.6483	0.1131	<0.0001	-0.3864	0.1203	0.0019
LIN	0.0291	0.0243	0.2350	0.0177	0.0166	0.2906	0.0222	0.0187	0.2375	0.0059	0.0147	0.6894
PPH	-0.0636	0.2290	0.7822	-0.3811	0.5137	0.4603	0.1722	0.1849	0.3547	-0.3847	0.4604	0.4058
DHP	-0.1234	0.0436	0.0059	-0.0029	0.0368	0.9378	-0.1066	0.0339	0.0023	-0.0057	0.0328	0.8617
DHG	-0.0467	0.0170	0.0073	-0.0348	0.0113	0.0029	-0.0246	0.0129	0.0602	-0.0291	0.0098	0.0039
GDP	-0.3290	0.3926	0.4046	-0.6776	0.6023	0.2639	-0.2899	0.3031	0.3417	-1.3433	0.5442	0.0157
MIN	-0.0060	0.1282	0.9628	0.0664	0.1375	0.6302	-0.0194	0.0977	0.8435	0.1607	0.1226	0.1937
POP	-0.0493	0.7623	0.9486	8.7086	4.4182	0.0521	-0.2901	0.5776	0.6168	8.0374	3.9498	0.0451
PAR	0.3784	1.1888	0.7511	0.9717	1.1502	0.4007	-0.4648	0.9083	0.6103	0.2632	1.0194	0.7969
ASX	-0.0723	0.0387	0.0653	-0.0390	0.0413	0.3480	-0.0476	0.0292	0.1073	-0.0093	0.0374	0.8041
BND	0.0531	0.0771	0.4929	-0.0700	0.0605	0.2502	0.0546	0.0565	0.3368	-0.0898	0.0538	0.0987
INB	-0.1703	0.0656	0.0112	-0.0283	0.0550	0.6087	-0.1366	0.0475	0.0052	-0.0664	0.0495	0.1840
TAX	-0.0291	0.3568	0.9353	-	-	-	0.1578	0.2670	0.5562	-	-	-
GST	0.0627	0.0541	0.2499	-	-	-	0.0932	0.0418	0.0287	-	-	-
NEG	0.0071	0.0442	0.8732	-	-	-	-0.0204	0.0342	0.5530	-	-	-
CGT	-0.0248	0.0317	0.4358	-	-	-	-0.0174	0.0244	0.4777	-	-	-
ECR	-	-	-	-0.3538	0.1354	0.0107	-	-	-	-0.5018	0.1739	0.0050
R-squared	0.9740	-	-	0.7604	-	-	0.9906	-	-	0.5826	-	-
F-statistic	155.9055	-	<0.0001	16.0700	-	<0.0001	439.7802	-	<0.0001	7.0674	-	<0.0001

Notes: Using White's test, we rejected the null hypothesis of no heteroskedasticity in the least squares residuals for the models specifying HPE as the dependent variable. Hence, the standard errors and p-values in columns 8–13 incorporate corrections for an unknown form of heteroskedasticity.