Within-city dwelling price growth and convergence: trends from Australia's large cities

Christopher Phelps*, Mark N. Harris*, Rachel Ong*, Steven Rowley* & Gavin A. Wood*,**

**School of Economics, Finance and Property, Curtin University, Perth, Australia;*
***School of Global, Urban and Social Studies, RMIT University, Melbourne, Australia*

Correspondence Address: Christopher Phelps, Bankwest Curtin Economics Centre, Curtin University, Kent Street, Bentley, 6102, WA. Tel.: +61 (8) 9266 1744; Email: christopher.phelps@curtin.edu.au

Acknowledgments

The authors would like to acknowledge the contribution of an Australian Government Research Training Program Scholarship in supporting this research. Helpful comments and suggestions were received from two anonymous referees. The authors are responsible for any omissions or errors in the paper.

Within-city dwelling price growth and convergence: trends from Australia's large cities

Within Australia's larger cities, we observe differences in price dynamics across different sub-periods over the period 2001-2016. A combination of housing market cycles, policy reforms and different new supply configurations offer potential explanations. Neighbourhood dwelling prices within all cities and dwelling types converged during a 2001-2006 sub-period that coincided with strong housing price growth. Shifts in monetary policy, as well as tax and housing policy reforms drove this convergence by boosting demand from first homebuyers and investors. Divergence had overtaken convergence in most cities and market segments by the final 2011-2016 sub-period. We argue that falling interest rates were responsible. The findings highlight how price indices based on movements in central measures of the price distribution, can offer a poor guide to housing affordability trends at different points in a city's neighbourhood price distribution. They also suggest that monetary policy has differential effects across market segments. These effects are markedly different in periods when monetary policy is relaxed rather than tightened, and have important implications for first homebuyer accessibility and the ability of existing homeowners to trade up.

Keywords: within-city dwelling price growth, convergence, divergence, Australia, housing affordability.

Introduction

This paper documents recent trends in neighbourhood price dynamics within Australian cities. Real house prices in Australia have trebled in the last three decades while real incomes have grown by 50% over the same period (Pawson et al., 2019). The widening divide separating real dwelling prices from real incomes is one of the key trends driving falling rates of homeownership, most notably for young and low-income households struggling to break into the Australian housing market (Burke et al., 2020).

The growing housing affordability burden is not equally spread across Australia's cities, with some cities experiencing greater increases in housing costs than others

(Duncan et al., 2019). However, a neglected facet of the housing affordability problem is differential dwelling price growth across cheaper and more expensive neighbourhoods *within* a city, that cause subsequent convergence or divergence in neighbourhood prices. *Within-city* dwelling price convergence or divergence has two dimensions. The first dimension can be described by either dwelling prices appreciating faster in lower-priced neighbourhoods than in higher-priced neighbourhoods (beta-convergence), or alternatively dwelling prices appreciating slower in lower-priced neighbourhoods than in higher-priced neighbourhoods (beta-divergence). A second dimension is represented by measures of dispersion across neighbourhood dwelling prices that describe sigma-convergence when dispersion falls, and sigma-divergence when dispersion increases.

There are important implications for housing-related policies across three domains – intra- and inter-generational housing wealth inequality, housing asset-based welfare and access to homeownership. Intra-city price dynamics can affect the distribution of wealth across income groups and between generations (Mayer, 1993). When dwelling prices diverge because of more rapid appreciation in expensive neighbourhoods, intergenerational disparities widen, since older households are more likely to own properties in these neighbourhoods;[i] and within an age cohort there will be a growing wealth divide separating those owning housing in higher-priced compared to lower-priced neighbourhoods. Such differential growth in wealth also affects household mobility, potentially impacting upon labour market efficiency (Wood et al., 2016).

Asset-based welfare strategies are impacted because they encourage households to accumulate private wealth that can be drawn down to replace public assistance (especially government pensions) in retirement. Owner occupied housing is commonly a household’s most important store of wealth. Differential housing price growth across regions (Searle & McCollum, 2014) or city neighbourhoods will then result in asset welfare strategies that have uneven social and spatial effects.

When there is convergence of inter-neighbourhood housing prices there can be negative implications for aspiring first homebuyers. Convergence during the upswing of a market cycle makes saving to meet deposit requirements tougher as entry-level prices increase faster than other housing market segments.[ii] Deposits are the biggest barrier to first home ownership in Australia (Duncan et al., 2019) and deposit constraints are then more likely to bind in these circumstances. This can prompt the introduction of expensive policy interventions designed to ease deposit constraints.

There are also threats to first homeownership from the financialisation of the housing market and the associated rise of private landlordism (Arundel, 2017). Rental investors are prominent in Australian housing markets with private rental housing accounting for around 25% of the nation's housing stock (Rowley & James, 2018). Capital gains tax reform in 1999 introduced a 50% discount on rental investors' realised capital gains (Shi et al. 2016), an especially attractive tax concession for high tax bracket landlords. Investors are therefore encouraged to invest in market segments where capital appreciation is relatively strong (Wood & Tu, 2004). Divergence or convergence in neighbourhood price dynamics will then signal market segments in which tax advantaged capital gains are relatively strong. Convergence will favour acquisitions by high bracket investors in low value segments with the outbidding and displacement of prospective first homebuyers a concern.

The majority of Australia's population is concentrated in five mainland state capital cities – Sydney, Melbourne, Brisbane, Perth and Adelaide. Wood et al. (2016) examined intra-city price dynamics in Australia and reported evidence of house price divergence, but the analysis was limited to a single Australian city (Melbourne) and time period (1990-2009). The empirics reported below document price dynamics within each of the five major cities and the study timeframe bridges both pre- and post-GFC eras. Our convergence measures are computed across the entire timeframe as well as shorter sub-periods that span the pre-GFC housing market boom, the GFC years, and post-GFC recovery, during which there were important shifts in macroeconomic conditions and macroeconomic policy.

As another contribution we differentiate between houses and units. As opposed to houses, Australian units are generally located in inner-city areas and rates of ownership are evenly split between investors and owner-occupiers (CoreLogic, 2016). We explore whether neighbourhood price dynamics differ across these segments. This is especially relevant given the rising importance of units in State Government strategies to meet affordability pressures and infill housing targets (National Housing Supply Council, 2010).

We begin by describing demand-side and supply-side mechanisms that can drive price convergence or divergence across the neighbourhoods of a city. This is followed by discussion of suitable convergence/divergence measures and a detailed explanation of methods and data. The findings from analyses of price dynamics are then presented, with a focus on the potential causes of heterogeneous price patterns that are found across cities and sub-periods of the study timeframe.

Background literature

Mechanisms for convergence or divergence in price dynamics

In the early neoclassical urban economics literature, cities are monocentric with rents (and hence dwelling prices) that are predicted to decline with distance from the central business district as households trade-off accessibility, transport costs and space (Alonso, 1964). More recently, urban housing markets are viewed through a polycentric lens, with price dynamics reflecting various drivers in addition to access-space considerations. Potential drivers of inter-neighbourhood price dynamics can be classified into supply-side and demand-side factors.

Among supply side drivers there is the home-voter hypothesis (Fischel, 2009). It proposes that affluent homeowners can influence local governments and planning authorities by gaming planning and zoning decisions to the betterment of their own property values and amenity. This regulatory capture restricts new dwelling supply but improves amenities in affluent homeowners' (typically higher-priced) neighbourhoods. Dwelling prices in these neighbourhoods diverge from those occupied by less influential lower-income households.

Relevant evidence is presented in McLaughlin et al.'s (2016) local government area supply elasticity estimates for Adelaide, Australia, that find a negative correlation between new supply and areas' average household incomes. Rowley et al. (2020) report relatively high housing supply in local government areas with below average house prices, which is attributed to a lack of site availability and pushback from local owners in higher-priced areas.

He & Cava (2020) link limitations on new dwelling supply to the interaction between Australian monetary policy and dwelling prices. They find that prices in higher-priced neighbourhoods are more sensitive to shifts in the stance of monetary policy, and suggest that limitations on new supply in these areas impede a response to monetary policy induced demand. This notion is supported by Glaeser et al., (2013), who find there to be a larger impact on prices from interest rates movements in supply-constrained American cities. He & Cava (2020) also argue that sensitivity to interest rate movements is due to greater indebtedness among homebuyers in higher-priced neighbourhoods.

On the demand-side, Guerrieri et al.'s (2013) endogenous gentrification hypothesis proposes that a higher quality and variety of consumption amenities shape a neighbourhood's appeal with spill over benefits to adjacent but cheaper neighbourhoods. These neighbourhood consumption externalities can act as a catalyst for gentrification in adjacent neighbourhoods during favourable market conditions. Neighbourhood price differentials will narrow as a result of this process and convergence in neighbourhood price dynamics can be expected.

Studies analysing the dynamics of intra-city dwelling price differentials and housing market cycles typically find that prices diverge during upturns and converge during downturns. Mayer (1993) and Stein (1995) postulate that when housing market conditions weaken, "locked in" homeowners are unable to realize sufficient equity from sale of their existing home to trade up into higher-priced neighbourhoods, and prices therefore stagnate in these neighbourhoods. Meanwhile the weaker market conditions incentivise aspiring owners to enter the market in typically lower-priced neighbourhoods. These differential demand effects combine to promote price convergence. But when housing market conditions are strong, differential demand effects are reversed, and price divergence is anticipated.

Deregulation of the Australian financial sector is potentially relevant. Since the 1970s Australia has, like much of the western world, embraced the neo-liberal paradigm (Pawson et al., 2019). It invigorated competition in both domestic and international financial market, and stimulated new mortgage products, securitization, more relaxed loan eligibility criteria, and reductions in the cost of borrowing, all of which increased homeowners and investors borrowing capacity. Pawson et al., (2019) explains that this benefited higher-income Australian households because of a shift away from conservative lending rules which limited repayments to 30% of a household's gross income. Instead, the 'net income surplus' rule assumes that household income above a minimum subsistence level is available to meet mortgage repayments, allowing higher-income households to borrow much higher percentages of their gross income. This increase in their relative borrowing power has raised the demand for higher-priced property, driving divergence, while concurrent increases in income inequality exacerbate the impact of this change (Wood et al., 2016).

Bradbury (1990) links growing income inequality to property price divergence in the US. In Australia there has been a rise in income inequality since market liberalisation in the 80's, though it has slowed as income growth has stagnated in recent times (Burke et al., 2020). Wealth inequality trends, on the other hand, are more pronounced with the average wealth of the top 20% of Australians growing ten times faster than that of the bottom 20% (Davidson et al., 2020). Higher-priced segments of the housing market benefit due to increasing demand from income rich and wealth rich households. Pawson & Martin (2020) surveyed property investors who had invested in the most disadvantaged suburbs of Sydney, and found investors to be typically high income, better educated, and resident in more advantaged Sydney suburbs. This suggests that some the income and wealth accumulated by high-income households leaks into lower-priced neighbourhoods through their property investments, and is therefore also a potential driver of price convergence.

Measurement of convergence and divergence

Convergence diagnostics came to prominence in the economic growth literature of the 1980's and 1990's. Baumol (1986) estimated a 'growth-initial level' regression model using a country sample of growth rates that was regressed on national income levels at the start of the study timeframe. The sign and significance of the estimated beta-coefficient on the initial national income level variable indicates either beta-convergence (negative sign) or beta-divergence (positive sign) (see Islam (2003) for a literature review).

Housing price dynamics is commonly studied across regions or cities belonging to the same country (see Cook (2012) or Kim & Rous (2012)), rather than across intra-city neighbourhoods. Much of this literature is US or UK focused and many examine 'ripple effects' in housing prices through complex econometric measures of stochastic convergence. This paper's principal motivation is the impacts of different price dynamics on access to homeownership and housing wealth inequality. The convergence measures we employ are simpler and readily interpretable tools for this purpose.

Friedman (1992) and Quah (1993) argue that it is important to test for both sigma- and beta-convergence. Sigma-convergence is evident when the cross-section distribution of a variable narrows over time. Use of both measures is recommended because a negative beta-coefficient from 'growth-initial level' regressions does not ensure sigma-convergence (Sala-i-Martin, 1996).[iii]

Hill et al. (2009) find both sigma-convergence and sigma-divergence across the neighbourhoods of Sydney, Australia, over a six-year period from 2000 to 2006. The authors suggest that dwelling price convergence is related to the dwelling price cycle. Using a longer timeframe of 19 years (1990-2009), Wood et al. (2016) document both beta- and sigma-divergence across 108 submarkets in Melbourne. The findings in these two papers suggest that the spatial dynamics of neighbourhood prices vary across Australian cities, a question that helps motivate this paper.

Methods and data

Beta-convergence or beta-divergence is detected using a 'growth-initial level' regression model adapted to within-city neighbourhood-level dwelling prices, as in Wood et al. (2016). The specification is;

$$r_i = \alpha + \beta y_i + \varepsilon_i, \ \varepsilon \sim \mathrm{N}(0, \sigma^2) \quad (1)$$

where r_i is the annual growth rate of dwelling prices in neighbourhood *i* of a city, and y_i is the natural log of real median price in neighbourhood *i* at the start of the observation period. The size of the beta-coefficient (β) is the key estimate; a larger value indicates faster convergence when negative and faster divergence when positive. The model was estimated by ordinary least squares and separately for Sydney, Melbourne, Brisbane, Perth and Adelaide over the full-period (2001-2016), and three sub-periods (2001-2006, 2006-2011, 2011-2016), as well as by dwelling type (houses and units).[iv]

We also test for sigma-convergence and sigma-divergence. Sigma-convergence is evidenced by a declining standard deviation of real median dwelling prices over time, as described in equation (2):

$$\sigma_{t+1} < \sigma_t, \qquad (2)$$

Where σ_t is the time *t* standard deviation of the natural log of real median dwelling prices. We calculate σ_t over each city's neighbourhoods, in each year from 2001 to 2016 and separately for houses and units. If the standard deviation falls over time, the distribution of dwelling prices across neighbourhoods narrows, and there is sigma-convergence. Conversely, a declining standard deviation over time defines sigma-divergence.

Our chosen spatial unit is the Statistical Area Level 2 (SA2). Each SA2 conforms to the 2011 Australian Statistical Geography Standard (ASGS), and is designed to represent communities within which there are strong social and economic interactions (ABS, 2020). 1067 SA2s are defined within the Greater Capital City Statistical Areas (GCCSA) of our five cities, and 1009 have usable price data. Each SA2 contains a mean 4030 dwellings.

Two house and unit price data sets are employed. The first was obtained from property data provider Australian Property Monitors, and contains yearly median prices for each SA2.[v] This median price data was used to calculate y_i in equation (1) as well as σ_t in equation (2). The second was purchased from property data provider CoreLogic and contains hedonic price growth indices for each SA2. These indices were used to calculate r_i in equation (1). The growth indices are obtained by estimating a hedonic regression; the estimated coefficients are used to 'price' a representative bundle of housing characteristics in each region and year of the sample period (Green & Malpezzi, 2003).[vi] Hedonic estimates of price growth are useful as they control for the time-varying quality and composition of the transacted dwelling stock that is a source of error in measures of price growth (Hansen, 2009). The accuracy of the beta-convergence results are enhanced by the use of this hedonic measure of price growth.

Houses in our price data sets are defined as any dwelling situated on a single title, while units share a title with any number of other dwellings. We inflated the house and unit hedonic indexes and median prices for each SA2 to 2019 prices, using the Consumer Price Index (CPI) of the SA2's relevant city.[vii] The inflation adjusted hedonic index was used to calculate real annual price growth.[viii]

Table 1 provides descriptive data on real price levels and their growth in each city, as well as across the all city sample. In the latter annual real price growth 2001-2016 was 4.8% for houses and 3.5% for units. Property owners therefore enjoyed large real increases in dwelling values and increases in wealth provided they have not leveraged against these gains. Melbourne has the largest SA2 sample with complete dwelling price data - 273 SA2s for houses and 218 SA2s for units. Adelaide has the smallest sample - 101 SA2s for houses and 75 SA2s for units. Sydney SA2s feature the highest initial median price for both houses ($577,491) and units ($404,309). Median prices reach a low in Adelaide at $241,493 for houses and $148,009 for units.

[t]Table 1 near here[/t]

Given housing market cycle theories of neighbourhood price dynamics (Guerrieri et al., 2013; He & Cava, 2020; Mayer, 1993), it is prudent to test for convergence over the entire observation period, as well as sub-periods corresponding to different market cycle segments (Cook, 2012) and shifts in monetary policy. The chosen sub-periods are 2001-2006, 2006-2011, and 2011-2016.

In the first sub-period all cities enjoyed buoyant market conditions leading up to the GFC; all SA2 real price growth reached annual rates of 9.0% for houses and 7.9% for units. Unusually, Australian cities did not suffer a crash in dwelling prices during or immediately post GFC (Murphy, 2011). Indeed, Melbourne and Adelaide still enjoyed annual price growth over the second sub-period. But Brisbane and Sydney prices stagnated, while Perth house and unit prices declined by roughly 2.0% per annum. Price trends in the third recovery sub-period are heterogeneous. Annual price growth was a substantial 7.1% for Sydney houses, 3.9% for Melbourne houses, while house prices were relatively stable in the other cities. But unit prices were either stagnant or declined in all cities bar Sydney (4.3%).

Price dynamics: convergence or divergence?

Table 2 lists beta-convergence estimates using the 'growth-initial level' model (see equation (1)), for houses and units in each individual city, across the entire study-period as well as 3 sub-periods.

[t]Table 2 near here[/t]

Table 3 presents the standard deviation of the log of SA2 median dwelling prices for houses and units in each city at the initial and terminal year of each sub-period.

[t]Table 3 near here[/t]

Convergence and divergence across the full period 2001 to 2016

Over the full period Table 2 confirms beta-convergence for *units* in all cities. But the evidence is mixed across the *house* segments of cities' dwelling stocks. House price beta-convergence was evident in Brisbane and Perth, while Sydney and Adelaide's house price dynamics are uncertain. In contrast Melbourne displays house price beta-divergence over the full period, confirming the findings in Wood et al. (2016) using a different data source and an earlier time period. Melbourne's price dynamics were therefore distinctive; house prices in relatively high-priced neighbourhoods grew faster than those in relatively low-priced neighbourhoods.

For units, Adelaide exhibited the strongest beta-convergence. Rates of price appreciation fell by 0.039 percentage points for every one per cent increase in an Adelaide SA2's initial median unit price. This compares to 0.005 percentage points in Sydney, the city with the slowest unit price beta-convergence.

Table 3 confirms that all cities with *beta*-convergence of house or unit prices also display *sigma*-convergence. We can therefore conclude that price rises in cheaper neighbourhoods were sufficient to narrow the price divide between neighbourhoods at extremes of the price distribution. In some cities and dwelling type segments the price gap has been substantially cut. For example, in the units segment of Brisbane, standard deviations fell from 0.398 (2001) to 0.256 (2016) – a decrease in dispersion of 36%.

In the house segments of the Melbourne and (to a lesser extent) Sydney markets, the sigma measure suggests divergence in price dynamics, and confirms a positive and significant Melbourne beta coefficient. It is noticeable that the Melbourne house market experienced the highest annual real price growth of 6.1% (see Table 1). The large real capital gains offered in Melbourne's market is especially attractive to high tax bracket homebuyers and investors, and so price divergence could reflect the income bias in capital gains tax concessions. While annual real price growth is lower in the house segments of other cities' housing stocks, they nevertheless reach very attractive rates. It seems likely that the conspicuous difference between Melbourne and other cities' house price dynamics is driven by other factors.

In the *Background Literature* section of this paper, it was established that limitations on new supply can drive intra-city convergence or divergence. Table 4 offers a supply-side explanation for the differing price dynamics between dwelling types, as well as Melbourne's distinctive house price divergence. All SA2 house or unit approvals have been assigned to the house or unit price quartile a SA2 belongs to at the beginning of the measurement period. The pattern of supply across these price quartiles is then described by the percentage of city-wide house or unit approvals in each house or unit price quartile. The measurement periods are the three sub-periods, as well as the full period.

[t]Table 4 near here[/t]

Building approvals over the full period reveal a clear differentiation in patterns of supply between dwelling types; house approvals favoured lower-priced quartiles (Q1 and Q2) at the expense of higher-priced quartiles (Q3 and Q4), while unit approvals were the inverse. This reflects the role of each dwelling type in the Australian market and the generally declining price gradient with distance from the city centre. A near majority (48%) of units are investor-owned, and predominately located in inner city areas to meet the demand for housing services in already developed areas (CoreLogic, 2016). Metropolitan planning efforts in the 2000's saw all five cities introduce infill targets of at least 50% of new supply, for which new unit supply plays a key role (National Housing Supply Council, 2010). Houses, on the hand, are mostly owner occupied, and new supply is predominately constructed on the urban fringe where developable land is more abundant.

In the five cities combined, 63% of house approvals were contained in the lower-priced quartiles, as compared to only 38% of unit approvals. The weaker evidence on price convergence in the house segment might reflect the stronger bias in house supply towards lower-priced quartiles, which puts downward pressure on prices in lower-priced neighbourhoods. Computing correlation coefficients between convergence estimates and patterns of supply supports this notion; over the full period, there is a strong positive relationship (0.78) between house beta-coefficients estimated in Table 2 and the percentage of house approvals in the bottom two quartiles of each city, signalling that beta-divergence is more likely as lower-priced supply increases.

In Melbourne new house supply favoured lower-priced quartiles more than in the other cities. Consider, for example, the lowest price quartile where a little over one third of Melbourne's new house supply was approved back in 2001, somewhat higher than in all cities (30%); by 2016 that share of Melbourne's house approvals had approached one half, 13 percentage points higher than the all cities share (35%). Meanwhile the share of all house approvals in the top two price quartiles contracted. This supply side shift reflects the abundance of greenfield sites to the north and west of Melbourne that are relatively close to the city centre (Daley et al., 2018). Development of these sites have helped Melbourne respond to growing population pressures over the study timeframe, suppressing house price growth on the lower-priced fringe and contributing to Melbourne's distinctive divergent house price dynamics. In contrast, Sydney faced the same population pressures, but was burdened by greater geographical constraints, due to national parks to the north and south, ocean to the east, and the Blue Mountains to the west (Daley et al., 2018) leading to a greater reliance on unit development. We now examine price dynamics in each sub-period.

2001 to 2006 sub-period

Convergence is a strong feature of price dynamics in both house and unit segments across all cities in this first sub-period. The beta-coefficients suggest that convergence in unit prices occurred at a faster rate than for house prices (see Table 2). Table 3 reveals falls in the sigma measure in every city and across both dwelling types. There is then strong relative real price gains in initially inexpensive neighbourhoods in mainland state capital cities that narrows price gaps between relatively expensive and inexpensive neighbourhoods. In the house segment of Brisbane's dwelling stock and the unit segment of Sydney's dwelling stock there is a 24% reduction in dispersion in only 5 years.

The period 2001-2006 represents the run up to the GFC when market-wide house and unit price growth was very strong. Brisbane and Perth reach double digit annual inflation rates for real house prices (12.4% and 19.8% respectively), but rates are also robust in the other cities and dwelling types (see Table 1). Brisbane and Perth also had the strongest beta-convergence estimates in both house and unit segments. Past studies typically find that prices diverge during upturns and converge during downturns (Mayer, 1993; Stein, 1995). Pre-GFC price convergence contradicts this hypothesis, and we instead turn to supply and policy explanations.

The exceptionally strong convergence results in Brisbane and Perth in this first sub-period could be related to the commodities boom of the 2000's. Perth and Brisbane are the state capitals of Western Australia and Queensland, states that contribute by far the largest proportion of Australia's mining output, and therefore benefited most from the commodities boom (Garnett, 2012). Western Australia was the most impacted, with big increases in housing demand as investment and employment in the mining sector soared, attracting migrants to the state, and driving incomes higher for workers inside and outside of the mining sector (Garnett, 2012). Strong population growth and income gains lifted demand for dwellings, especially in Perth's lower-priced and land abundant middle and outer ring neighbourhoods. Despite several commodity price downturns, mining continues to be an important sector in the Western Australian economy. Perth is conspicuous as the only city that did not experience house price beta-divergence in any subsequent sub-period.

Table 4 confirms the correlation between the five cities' beta- and sigma-convergence estimates and supply patterns across housing price distributions. For units, approvals in the top two price quartiles are 63% of all cities' approvals, and are especially strong in Melbourne (71%) and Brisbane (69%). The surge in unit approvals in these two price quartiles is likely to have depressed price growth at the upper end of the price distribution. These patterns are also evident in the house segment of cities' dwelling stocks where a strong negative correlation coefficient (-0.85) between beta coefficients and the top two price quartiles share of approvals suggests that convergence is more likely when house supply increases in higher price quartiles.

Trends in interest rates could also play a role in driving these patterns. He & Cava (2020) have shown that in the expensive segments of Australia's housing market, prices are more sensitive to changes in interest rates. Convergence in price dynamics is then more likely following interest rate rises, while divergence is more probable following interest rate cuts. The 2001-2006 sub-period confirms this prediction because it is the only one of our three sub-periods in which interest rates predominately increased; the Reserve Bank of Australia's cash rate was 4.25% at the end of 2001, and then steadily increased to 5.75% by the end of 2006 (RBA, 2020b).

A second potential influence is the $7000 First Home Owners Grant (FHOG) introduced in July 2000 to assist first homebuyers meet deposit constraints. Randolph et al. (2013) found that the $2.5 billion FHOGs approved in Sydney from 2000-2010 was largely spent on existing dwellings in lower-value suburbs. This pattern is also likely in the other Australian cities given that first homebuyers usually purchase towards the lower-end of the price distribution. The resulting pressure on prices in cheaper entry-level segments of housing markets will have encouraged beta and sigma price convergence in that first sub-period, as young homebuyers advanced their planned first transitions into homeownership using FHOGs.

Another relevant policy intervention was the 1999 changes to capital gains tax law that introduced a 50% discount on capital gains realised on asset transactions. Shi et al. (2016) discusses its role in kick starting a housing boom that persisted up until the GFC. This policy change increased the concessions that landlord capital gains benefit from, and encouraged acquisition of properties in neighbourhoods with strong price growth. In this sub-period that price growth was strongest in those neighbourhoods with initially lower prices.

2006 to 2011 and 2011 to 2016 sub-period

The subsequent two sub-periods are grouped together because they offer a marked contrast to the first sub-period. The strong convergence evident over the 2001-2006 sub-period progressively weakens as the rest of the study timeframe unfolds. In the house segments of Melbourne, Brisbane and Adelaide's housing stocks, price dynamics become beta divergent (see Table 2a)[ix]. Sigma-divergence is also apparent in these cities, with increases in the sigma measure evident in Brisbane as well as Adelaide, and across both sub-periods (see Table 3). In the house segment of Sydney's dwelling stock, price dynamics are strongly beta divergent in the 2006-2011 sub-period; while the beta coefficient remains positive in the final sub-period it loses statistical significance. A similar pattern is evident from Sydney's sigma measure. By the final sub-period Perth's house price dynamics are unique in remaining both beta and sigma convergent. Perth is also the only city with falling house and unit prices in both sub-periods.

In the unit segment of cities' housing stocks, the strong convergence detected in the first sub-period's price dynamics also fades over the subsequent two periods. In Brisbane and Melbourne unit price dynamics are significantly beta divergent by the final 2011-2016 sub-period, while Sydney and Adelaide's initial unit beta-convergence weakens such that no discernible pattern is evident by the final sub-period (see Table 2b). In three of these four cities (Sydney is the exception) the sigma measure also increases in the final sub-period. Perth presents a mixed pattern that again contrasts with the other cities.

The change in price dynamics that is generally witnessed in these later two sub-periods correlates with a relaxation of monetary policy following the GFC. Economic growth resumed at relatively low rates, real wages stagnated and fiscal policy sought to restore a budget balance.[x] Monetary policy was therefore relied on to maintain momentum in the economy. The Reserve Bank of Australia cut its cash rate from 5.75% to 4.75% in the 2006-2011 sub-period, and then more steeply from 4.75% to 1.75% over the 2011-2016 sub-period (RBA, 2020b)[xi]. These lower cash rates fed through into the variable rate on mortgage loans and thereby provided considerable financial relief to mortgagors, especially those burdened by large loans.[xii]

The interest rate cycle offers a convincing explanation of the changing price dynamics. When interest rates fall, supply-constrained higher-priced areas experience greater price increases as supply is less able to respond to monetary policy induced demand (Glaeser et al., 2013; He & Cava, 2020). Also, when interest rates fall the largest reductions in mortgage payments are experienced by those with the biggest outstanding loans. It is homebuyers positioned toward the upper end of the housing price distribution that secure the biggest mortgages loans, a factor that has been exacerbated by financial deregulation and widening wealth inequality. According to the 2016 release of the Household, Income and Labour Dynamics in Australia Survey, the average and median mortgage loan serviced by homebuyers in the lowest dwelling price decile is A$141,292 and A$139,500 respectively (See Table 5). In the highest housing price decile, where home values exceed A$1.3m, the average (median) mortgage loan is A$602,706 (A$400,000). Furthermore, only 8% of owners in the lowest price decile are paying off loans, while over one-half (55%) are doing so in the highest decile.

[t]Table 5 near here[/t]

The relationships outlined above between monetary policy, new supply and debt in higher-priced neighbourhoods prompt price divergence following interest rate reductions, and price convergence when interest rates increase. Monetary policy can then be the source of differential impacts across local housing markets. The housing policy implications of this conclusion are developed in the following concluding comments.

Conclusion

Our empirical investigation of price dynamics in five Australian cities finds that the prices of units converged in these cities over the observation period 2001-2016. The price distribution became more compressed because prices of units in initially cheaper neighbourhoods increased more rapidly than unit prices in initially more expensive neighbourhoods. The evidence is somewhat mixed across the house segments of each city’s dwelling stocks, but there is only one city (Melbourne) with price dynamics that could be described as divergent over the observation window 2001-2016. Heterogeneous patterns of new supply across the price distribution of a city offer an explanation for the different outcomes between dwelling types and cities.

The more intriguing findings emerge when we breakdown the observation window into three sub-periods; 2001-2006 in which there is strong market-wide house and unit price growth in the lead up to the GFC; 2006-2011 that straddles the severe economic shock associated with the GFC; and 2011-2016, a period of post-GFC recovery. It turns out that convergence over the entire observation period is primarily driven by very strong price convergence in the pre-GFC 2001-2006 sub-period. An array of macroeconomic, fiscal and housing policy factors combined in these years to stoke price pressures in the cheaper segments. The strong economic growth in these years prompted the monetary authorities to tighten policy by raising interest rates. Heavily indebted households, who typically reside in more expensive neighbourhoods, are hit hardest. At the start of the pre-GFC period the Australian Federal Government introduced a First Home Owner's Grant that eased borrowing constraints for those buying their home for the first time. Those entering homeownership tend to buy in neighbourhoods with relatively low prices. Finally, changes to capital gains tax laws (introduced in 1999) increased the concessions that landlord capital gains benefit from, and encouraged acquisition of properties in neighbourhoods with strong price growth. In this sub-period that price growth was strongest in those neighbourhoods with lower prices.

That unusual combination of government interventions were then (unintentionally) working together to shift patterns of supply and demand in ways that encouraged price convergence. But in our post-2006 sub-periods this synchronicity broke down in one very important respect. The shock delivered to economic systems by the GFC prompted monetary authorities to relax their stance. A period of rising interest rates 2001-2006 was therefore followed by generally lower interest rates and quantitative easing that sought to maintain flows of credit, and maintain confidence in asset markets, with the housing market being to the forefront of policy makers attention given the importance of house prices as a source of wealth effects. Cuts to cash rates fed through into much lower mortgage interest rates and so the monetary factors that had tended to restrain price growth in expensive neighbourhoods were reversed. When interest rates decline there will be stronger demand for housing throughout the housing market, but because supply is less responsive and mortgage debt levels are higher in more expensive neighbourhoods, demand will receive a bigger boost in these more expensive segments of the housing market.

The strongly convergent price dynamics faded as a result of these shifts in the pattern of demand. In the final sub-period 2011-2016, falls in interest rates were especially steep as Australian fiscal policy sought to balance the national budget, and monetary policy was increasingly relied upon to support economic growth. In this final sub-period price dynamics were divergent in the majority of Australian cities' unit and house submarkets. Prices were growing more rapidly in higher priced neighbourhoods, and the price divide separating expensive from cheaper neighbourhoods widened. Monetary policy has well understood aggregate effects on the housing market, but it also has heterogeneous impacts across local housing markets, and thus on subgroups of households as well.

This narrative poses challenges for housing policy makers. The identification of housing market segments where affordability and accessibility problems are worsening is made more difficult. Policymakers need to be wary of using price indices that track movements in average prices. Price dynamics in the lower-priced or 'starter home' market are not necessarily accurately represented by such indices. First homebuyers typically purchase in these market segments and governments commonly intervene by easing their borrowing constraints, and assisting with recurrent mortgage payments. The design of such measures would benefit from the use of price indices that more precisely reflect price dynamics in 'starter home' markets.

Shifting price dynamics also have implications for existing homeowners at different stages of the life course and policies that impact on them at these different stages. Growing families in the earlier stages of their housing careers are typically trading up to larger homes that can better meet their space needs. Their aspirations are easier to meet in periods of price convergence because the price divide is easier to bridge with a smaller loan than would otherwise be the case. Divergence in price dynamics has very different implications. While the young family seeking to trade up confronts a widening price gap, that growing divide is to the gain of ageing couples and singles that have already climbed the owner occupation housing ladder, as their accumulation of housing wealth is boosted. The security this provides is welcome in old age as it is a store of wealth that can be drawn on in emergencies (Smith & Searle, 2008). It is also more important because of the push towards housing asset-based welfare to fund retirement and age care, as governments grapple with the fiscal costs of supporting an ageing population.

In the years following the GFC economic growth has been weak in Australia and many other high income countries. Central banks have generally maintained a relaxed monetary stance, and as we have documented this has encouraged the emergence of divergence in dwelling price dynamics. This is unlikely to change. COVID-19 poses both a public health and economic crisis that is likely to cause a severe and prolonged economic downturn. Lower interest rates and quantitative easing will be a crucial part of the stimulus measures that governments rely on to promote economic recovery. There will be many challenges ahead for housing policy makers in such an environment. It would be judicious to bear in mind that further relaxation in monetary policy will have uneven impacts across local housing markets and neighbourhoods, and these uneven impacts demand a nuanced approach to the crafting of housing policy interventions.

Disclosure Statement

No potential conflict of interest was reported by the authors.

References

ABS. (2020). *Australian Statistical Geography Standard (ASGS)*. Australian Bureau of Statistics. http://www.abs.gov.au/websitedbs/D3310114.nsf/home/Australian+Statistical+Geography+Standard+(ASGS)

Alonso, W. (1964). *Location and land use: toward a general theory of land rent*. Harvard University Press.

Arundel, R. (2017). Equity inequity: housing wealth inequality, inter and intra-generational divergences, and the rise of private landlordism. *Housing, Theory and Society*, *34*(2), 176–200. https://doi.org/10.1080/14036096.2017.1284154

Australian Property Monitors. (2018, August 14). *APM - Timeseries Property Data (SA2 - ASGS 2011) 01/01/1986 - 31/12/2017*. AURIN.

Baumol, W. J. (1986). Productivity growth, convergence, and welfare: what the long-run data show. *The American Economic Review*, *76*(5), 1072–1085.

Bradbury, K. L. (1990). The changing fortunes of American families in the 1980s. *New England Economic Review*, *Jul*, 25–40.

Burke, T., Nygaard, C., & Ralston, L. (2020). *Australian home ownership: past reflections, future directions* (AHURI Final Report No. 328). Australian Housing and Urban Research Institute Limited. https://www.ahuri.edu.au/research/final-reports/328

Cook. (2012). B-convergence and the cyclical dynamics of UK regional house prices. *Urban Studies*, *49*(1), 203–218. https://doi.org/10.1177/0042098011399595

CoreLogic. (2016). *Profile of the Australian Residential Property Investor*. CoreLogic Asia Pacific. https://www.corelogic.com.au/resources/pdf/reports/CoreLogic%20Investor%20Report_June%202016.pdf

CoreLogic. (2018). *Residential Property Index Series*. https://www.corelogic.com.au/sites/default/files/2018-01/Residential-Property-Index-Series.pdf

Daley, J., Coates, B., & Wiltshire, T. (2018). *Housing affordability: re-imagining the Australian dream* (No. 2018–04). Grattan Institute. https://grattan.edu.au/report/housing-affordability-re-imagining-the-australian-dream/

Davidson, P., Bradbury, B., Wong, M., & Hill, T. (2020). *Inequality in Australia, Part 1: Overview*. Australian Council of Social Service and UNSW. http://povertyandinequality.acoss.org.au/inequality/inequality-in-australia-2020-part-1-overview/

Duncan, A., James, A., & Rowley, S. (2019). *Getting our house in order? BCEC housing affordability report 2019* (No. 12; Focus on Western Australia Report Series). Bankwest Curtin Economics Centre. https://bcec.edu.au/publications/getting-our-house-in-order-bcec-housing-affordability-report-2019/

Fischel, W. A. (2009). *The homevoter hypothesis*. Harvard University Press.

Friedman, M. (1992). Do old fallacies ever die? *Journal of Economic Literature, 30*(4), 2129–2132.

Garnett, A. M. (2012). The Effect of the Resources Boom on the Population and Labour Market of Western Australia. *Economic Papers: A Journal of Applied Economics and Policy*, *31*(1), 63–75. https://doi.org/10.1111/j.1759-3441.2011.00154.x

Glaeser, E. L., Gottlieb, J. D., & Gyourko, J. (2013). Can Cheap Credit Explain the Housing Boom? In E. L. Glaeser & T. M. Sinai (Eds.), *Housing and the Financial Crisis* (pp. 301–359). The University of Chicago Press.

Green, R. K., & Malpezzi, S. (2003). *A Primer on U.S. Housing Markets and Housing Policy*. The Urban Insitute.

Guerrieri, V., Hartley, D., & Hurst, E. (2013). Endogenous gentrification and housing price dynamics. *Journal of Public Economics*, *100*, 45–60. https://doi.org/10.1016/j.jpubeco.2013.02.001

Hansen, J. (2009). Australian House Prices: A Comparison of Hedonic and Repeat-Sales Measures. *Economic Record*, *85*(269), 132–145. https://doi.org/10.1111/j.1475-4932.2009.00544.x

He, C., & Cava, G. L. (2020). *The Distributional Effects of Monetary Policy: Evidence from Local Housing Markets* (Research Discussion Paper RDP 2020-2; p. 42). Reserve Bank of Australia. https://www.rba.gov.au/publications/rdp/2020/2020-02.html

Hill, R. J., Melser, D., & Syed, I. (2009). Measuring a boom and bust: The Sydney housing market 2001–2006. *Journal of Housing Economics*, *18*(3), 193–205. https://doi.org/10.1016/j.jhe.2009.07.010

Islam, N. (2003). What have we learnt from the convergence debate? *Journal of Economic Surveys*, *17*(3), 309–362. https://doi.org/10.1111/1467-6419.00197

Kim, Y. S., & Rous, J. J. (2012). House price convergence: evidence from US state and metropolitan area panels. *Journal of Housing Economics*, *21*(2), 169–186. https://doi.org/10.1016/j.jhe.2012.01.002

Mayer, C. J. (1993). Taxes, income distribution, and the real estate cycle: why all houses do not appreciate at the same rate. *New England Economic Review*, *May*, 39–50.

McLaughlin, R., Sorensen, T., & Glavac, S. (2016). Intra-Metropolitan Housing Supply Elasticity in Australia: A Spatial Analysis of Adelaide. *Australasian Journal of Regional Studies*, *22*(3), 435–458.

Murphy, L. (2011). The global financial crisis and the Australian and New Zealand housing markets. *Journal of Housing and the Built Environment*, *26*(3), 335–351. JSTOR.

National Housing Supply Council. (2010). *National Housing Supply Council 2nd State of Supply Report*. Commonwealth of Australia.

Nguyen, Q. H. (2013). Housing investment: What makes it so volatile? Theory and evidence from OECD countries. *Journal of Housing Economics*, *22*(3), 163–178. https://doi.org/10.1016/j.jhe.2013.07.002

Pawson, H., & Martin, C. (2020). Rental property investment in disadvantaged areas: the means and motivations of Western Sydney's new landlords. *Housing Studies*, *0*(0), 1–23. https://doi.org/10.1080/02673037.2019.1709806

Pawson, H., Milligan, V., & Yates, J. (2019). *Housing policy in Australia: a case for system reform*. Palgrave Macmillan US.

Quah, D. (1993). Galton's fallacy and tests of the convergence hypothesis. *The Scandinavian Journal of Economics*, *95*(4), 427–443. https://doi.org/10.2307/3440905

Randolph, B., Pinnegar, S., & Tice, A. (2013). The first home owner boost in Australia: a case study of outcomes in the Sydney housing market. *Urban Policy and Research*, *31*(1), 55–73. https://doi.org/10.1080/08111146.2012.711554

RBA. (2020a). *RBA Statistical Tables*. Reserve Bank of Australia. https://www.rba.gov.au/statistics/tables/index.html

RBA. (2020b, May 15). *Cash Rate Target*. Reserve Bank of Australia. https://www.rba.gov.au/statistics/cash-rate/index.html

Rowley, S., Gilbert, C., Gurran, N., Leishman, C., & Phelps, C. (2020). *The uneven distribution of housing supply 2006–2016* (AHURI Final Report No. 334). Australian Housing and Urban Research Institute Limited. https://www.ahuri.edu.au/research/final-reports/334

Rowley, S., & James, A. (2018). *The private rental sector in Australia* (No. 18; Feature, p. 52). Bankwest Curtin Economics Centre. https://bcec.edu.au/publications/the-private-rental-sector-in-australia/

Sala-i-Martin, X. X. (1996). The Classical Approach to Convergence Analysis. *The Economic Journal*, *106*(437), 1019–1036. https://doi.org/10.2307/2235375

Searle, B. A., & McCollum, D. (2014). Property-based welfare and the search for generational equality. *International Journal of Housing Policy*, *14*(4), 325–343. https://doi.org/10.1080/14616718.2014.955334

Shi, S., Valadkhani, A., Smyth, R., & Vahid, F. (2016). Dating the timeline of house price bubbles in australian capital cities. *Economic Record*, *92*(299), 590–605. https://doi.org/10.1111/1475-4932.12284

Smith, S. J., & Searle, B. A. (2008). Dematerialising money? Observations on the flow of wealth from housing to other things. *Housing Studies*, *23*(1), 21–43. https://doi.org/10.1080/02673030701731225

Stein, J. C. (1995). Prices and trading volume in the housing market: A model with down-payment effects. *Quarterly Journal of Economics*, *110*(2), 379. https://doi.org/10.2307/2118444

Wood, G., Sommervoll, D. E., & de Silva, A. (2016). Do urban house prices converge? *Urban Policy and Research*, *34*(2), 102–115. https://doi.org/10.1080/08111146.2015.1047492

Wood, G., & Tu, Y. (2004). Are there investor clienteles in rental housing? *Real Estate Economics*, *32*(3), 413–436. https://doi.org/10.1111/j.1080-8620.2004.00097.x

Disclaimer Notices

The following Disclaimer Notice applies to content that uses data from CoreLogic:

The following Disclaimer Notice applies to content that uses data from Australian Property Monitors (APM):

For data pertaining to NSW:

For data pertaining to Victoria:

basis that the State of Victoria accepts no responsibility or liability whatsoever for any errors, faults, defects or omissions in the information supplied.

For data pertaining to Queensland:

COPYRIGHT NOTICES

© State of Queensland (Department of Natural Resources and Mines) 2018. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

For data pertaining to South Australia:

Warning

The information contained in this dataset is extracted from records of land status and cadastral boundary definition held by the Government of South Australia (the 'State'). The information is not represented to be accurate, current, complete, or suitable for any purpose, at the time of its supply by the State, and may have changed since the date of supply by the State. The software by which the information is provided is not represented to be error free. No responsibility is accepted by the State for any reliance placed by any person upon the information, or the software by which it is provided. Persons acquiring or using the information and its associated software must exercise their independent judgement in doing so.

Copyright

Copyright in this information belongs to the South Australian Government and the South Australian Government does not accept any responsibility for the accuracy or completeness of the information or its suitability for any purpose.

Privacy

The information contained in this dataset must not be used for the purposes of compiling contact lists, whether personalised or not.

For data pertaining to Western Australia:

Western Australian Land Information Authority (Landgate)

All reproductions and adaptations of the Location Information Products, however altered, reformatted or redisplayed, display the following proprietary notice:

"© Western Australian Land Information Authority (Landgate) (2018)"

Tables

Table 1. Summary of house and unit price and price growth, for the SA2s of Australia's five major cities, 2001 to 2016, in Australian Dollars.

City	*SA2: Sample Size 2001*	*Real Median Price of the Average SA2 2001*	*Annual Price Growth of the Average SA2*			
			2001-2006	*2006-2011*	*2011-2016*	*2001-2016*
			Houses			
Sydney	259	$577,491	4.1%	0.3%	7.1%	4.3%
Melbourne	273	$373,229	5.4%	5.1%	3.9%	6.1%
Brisbane	226	$270,875	12.4%	0.6%	0.7%	4.8%
Perth	150	$300,503	19.8%	-2.1%	-0.8%	4.6%
Adelaide	101	$241,493	7.5%	2.2%	-0.6%	3.2%
All Cities	1009	$378,737	9.0%	1.5%	2.8%	4.8%
			Units			
Sydney	198	$404,309	3.2%	0.9%	4.3%	3.1%
Melbourne	218	$289,439	5.4%	4.7%	0.7%	4.2%
Brisbane	90	$227,491	9.9%	0.5%	-2.3%	2.4%
Perth	93	$180,863	17.1%	-1.9%	-2.0%	3.2%
Adelaide	75	$148,009	11.4%	4.4%	0.0%	6.1%
All Cities	674	$284,193	7.9%	1.9%	0.6%	3.5%

Source: Authors own calculations.

Notes: Prices were inflated to real 2019 values using the relevant cities' CPI from ABS catalogue 6401.0 – Consumer Price Index, Australia. SA2s are defined by their ABS ASGS, and only SA2s within the borders of their cities' GCCSA were included. SA2 Median prices were obtained from data provider Australian Property Monitors. Annual price growth was and calculated using SA2 level hedonic indices obtained from data provider CoreLogic and annualised using the simple annual growth method.

Table 2. Beta-convergence results. Growth-initial level regressions, house and unit initial real median prices against annual price growth, for the SA2s of 5 major Australian cities.

a) *Houses*

	2001-2006	***2006-2011***	***2011-2016***	***2001-2016***
		Sydney		
Convergence?	Convergence	Divergence	-	-
β-coefficient	- 0.016***	+ 0.012***	- 0.004	- 0.0012
Std. Err.	0.0021	0.0025	0.0021	0.0016
R-Squared	0.17	0.09	0.01	0.00
		Melbourne		
Convergence?	Convergence	Divergence	Divergence	Divergence
β-coefficient	- 0.013***	+ 0.006*	+ 0.041***	+ 0.018***
Std. Err.	0.0031	0.0035	0.0029	0.0028
R-Squared	0.07	0.02	0.41	0.13
		Brisbane		
Convergence?	Convergence	-	Divergence	Convergence
β-coefficient	- 0.058***	+ 0.002	+ 0.018***	- 0.011***
Std. Err.	0.0034	0.0027	0.0033	0.0023
R-Squared	0.57	0.00	0.12	0.10
		Perth		
Convergence?	Convergence	-	Convergence	Convergence
β-coefficient	- 0.065***	+ 0.006	- 0.009***	- 0.014***
Std. Err.	0.0072	0.0034	0.0017	0.0021
R-Squared	0.35	0.02	0.15	0.23
		Adelaide		
Convergence?	Convergence	Convergence	Divergence	-
β-coefficient	- 0.017***	- 0.012***	+ 0.018***	- 0.0035
Std. Err.	0.0043	0.0028	0.0036	0.0026
R-Squared	0.14	0.17	0.19	0.02

b) Units

	2001-2006	*2006-2011*	*2011-2016*	*2001-2016*
		Sydney		
Convergence?	Convergence	-	-	Convergence
β-coefficient	- 0.033***	- 0.0001	+ 0.004	- 0.005*
Std. Err.	0.0029	0.0047	0.0029	0.0023
R-Squared	0.38	0.00	0.01	0.03
		Melbourne		
Convergence?	Convergence	-	Divergence	Convergence
β-coefficient	- 0.051***	- 0.003	+ 0.019***	- 0.018***
Std. Err.	0.005	0.0046	0.0044	0.0029
R-Squared	0.32	0.00	0.08	0.14
		Brisbane		
Convergence?	Convergence	Convergence	Divergence	Convergence
β-coefficient	- 0.062***	- 0.01***	+ 0.033***	- 0.018***
Std. Err.	0.0074	0.0039	0.0068	0.003
R-Squared	0.45	0.10	0.17	0.30
		Perth		
Convergence?	Convergence	Divergence	-	Convergence
β-coefficient	- 0.109***	+ 0.02**	+ 0.006	- 0.013*
Std. Err.	0.016	0.0068	0.0069	0.0062
R-Squared	0.34	0.10	0.01	0.05
		Adelaide		
Convergence?	Convergence	Convergence	-	Convergence
β-coefficient	- 0.072***	- 0.021*	+ 0.031	- 0.039***
Std. Err.	0.0154	0.0097	0.0171	0.0108
R-Squared	0.23	0.06	0.00	0.15

* P < 0.05, ** p < 0.01, *** p < 0.001.

Source: Authors' own calculations from various SA2 level price data sets.

Notes: Refer to Table 1's notes.

Table 3. Sigma-convergence results. Standard deviation of the natural log of real median prices, for the SA2s of five Australian cities.

	Standard Deviation of SA2 Log Median Prices			
City	***2001***	***2006***	***2011***	***2016***
		Houses		
Sydney	0.463	0.435	0.497	0.486
Melbourne	0.405	0.387	0.383	0.463
Brisbane	0.385	0.291	0.296	0.340
Perth	0.431	0.361	0.375	0.352
Adelaide	0.354	0.295	0.297	0.329
		Units		
Sydney	0.402	0.307	0.340	0.290
Melbourne	0.341	0.253	0.251	0.298
Brisbane	0.398	0.311	0.200	0.256
Perth	0.331	0.246	0.252	0.259
Adelaide	0.259	0.179	0.195	0.220

Source: Authors own calculations.

Notes: See Table 1’s notes for further details.

Table 4. Percentage of total building approvals, by dwelling price quartile, Australian city, and dwelling type.

SA2 House (Unit) Price Quartile	*Percentage of Total House (Unit) Approvals*			
	2001*-2006	***2006-2011***	***2011-2016***	***2001*-2016***
Sydney				
Q1	28% (19%)	21% (22%)	32% (12%)	31% (18%)
Q2	32% (22%)	41% (22%)	41% (25%)	35% (22%)
Q3	27% (26%)	19% (27%)	15% (35%)	20% (28%)
Q4	13% (32%)	19% (30%)	11% (27%)	14% (32%)
Melbourne				
Q1	34% (13%)	37% (15%)	48% (11%)	37% (14%)
Q2	33% (16%)	36% (18%)	29% (18%)	28% (18%)
Q3	24% (21%)	18% (35%)	11% (38%)	26% (19%)
Q4	9% (50%)	9% (32%)	10% (30%)	9% (49%)
Brisbane				
Q1	26% (12%)	37% (19%)	30% (12%)	33% (17%)
Q2	28% (19%)	23% (27%)	36% (21%)	26% (19%)
Q3	31% (19%)	28% (23%)	22% (21%)	30% (17%)
Q4	14% (50%)	11% (32%)	11% (44%)	11% (46%)
Perth				
Q1	27% (17%)	22% (20%)	22% (35%)	30% (21%)
Q2	29% (24%)	29% (28%)	44% (22%)	27% (29%)
Q3	26% (25%)	36% (43%)	21% (30%)	24% (20%)
Q4	17% (32%)	12% (9%)	12% (11%)	18% (29%)
Adelaide				
Q1	32% (16%)	36% (24%)	34% (10%)	33% (16%)
Q2	36% (28%)	32% (23%)	32% (22%)	35% (32%)
Q3	21% (21%)	20% (21%)	21% (26%)	22% (21%)
Q4	11% (34%)	12% (30%)	12% (42%)	10% (31%)
All Cities				
Q1	30% (16%)	32% (19%)	35% (13%)	34% (17%)
Q2	32% (21%)	32% (22%)	36% (22%)	29% (21%)
Q3	26% (23%)	24% (31%)	17% (34%)	25% (22%)
Q4	13% (40%)	12% (29%)	11% (31%)	12% (39%)

Source: Authors' own calculations from ABS catalogue 8731.0 - Building Approvals, Australia.

* Building approval data is not available for the first year of this period, so the data is reflective of the patterns of supply from 2002 onwards.

Notes: All house or unit approvals in an SA2 have been assigned to price segments as defined by the house or unit price quartile a SA2 belongs to. To create the price quartiles, SA2s within a city were ranked in ascending order by their median house or unit price at the beginning of the relevant period, and spit into four quartiles. A higher quartile number represents SA2s with higher prices than their peers. The 'All Cities' section combines quartile 1 SA2s from within each city, quartile 2 SA2s within each city, … and so on. Percentages in each city may not add to 100% due to rounding.

Table 5. Mean and median mortgage debt of Australian mortgagor households, by primary home value percentile, 2016.

Primary Home Value Percentile	***Primary Home Value Thresholds***	***Mortgagors (% of all owners)***	***Mean Mortgage Debt (mortgagors only)***	***Median Mortgage Debt (mortgagors only)***
1	<$300000	8.4%	$141,292	$139,500
2	$300000 - $390000	51.3%	$210,320	$209,343
3	$390000 - $450000	53.6%	$254,949	$277,000
4	$450000 - $500000	60.3%	$281,447	$300,000
5	$500000 - $560000	61.7%	$306,262	$291,000
6	$560000 - $650000	57.1%	$331,705	$318,000
7	$650000 - $750000	59.7%	$328,381	$340,000
8	$750000 - $900000	49.5%	$360,638	$330,000
9	$900000 - $1300000	50.2%	$523,279	$400,000
10	>$1300000	54.5%	$602,706	$400,000
All	N/A	34.3%	$329,931	$271,000

Source: Authors own calculations using the 2016 release of the Household, Income and Labour Dynamics in Australia (HILDA) Survey.

Endnotes

---

[i] In 2015-16, 40.3% of Australian household heads aged 25-34 possessed owner occupied dwellings with a mean total value of $211200, as compared 79.4% of households aged 55-64 and a mean value of $573000. Authors' own calculations from summary data made available in the 2015–16 Survey of Income and Housing (ABS catalogue 6523.0 - Household Income and Wealth, Australia, 2015-16).

[ii] If inter-neighbourhood dwelling prices were to instead diverge, entry level prices would decrease relative to the market, benefiting first homebuyers.

[iii] For example, the negative beta-coefficient from 'growth-initial level' regressions could be so large that initially expensive (cheap) neighbourhoods end-up being the low-priced (high priced) neighbourhoods, and the resulting neighbourhood price distribution has a higher standard deviation than the initial distribution.

[iv] All years referred to in this analysis are financial years.

[v] This research used the NCRIS-enabled Australian Urban Research Infrastructure Network (AURIN) Portal e-Infrastructure to access the dataset 'APM - Timeseries Property Data (SA2 - ASGS 2011) 01/01/1986 - 31/12/2017' on 14/08/2018 (Australian Property Monitors, 2018).

[vi] The exact methodology used to create the SA2 hedonic indices used in our analysis are explained in CoreLogic (2018).

[vii] CPI obtained from ABS catalogue 6401.0 – Consumer Price Index, Australia.

[viii] Price growth for each SA2 was annualised by calculating the SA2's percentage change in the inflation adjusted hedonic index over the sample period, and then dividing by the number of years comprising the sample period.

[ix] In Melbourne's case the beta coefficient is positive and statistically significant in both sub-periods and increases in size. In Brisbane and Adelaide statistically significant and positive beta coefficients are eventually achieved in the later sub-period.

[x] Annual growth in real GDP slumped from 5.4% pre-GFC (2001-2008) to only 2.1% post-GFC (2008-2016) (Authors own calculations from ABS Cat 5206.0 and ABS Cat 6401). Real wage growth was very low throughout; pre- GFC growth of 0.8% per annum was followed by annual growth of 0.9% post-GFC (total hourly rates of pay excluding bonuses, private and public, seasonally adjusted, ABS Cat 6345.0).

[xi] Before the GFC struck rates rose to 7.25% in March 2008 before falling sharply to 3% in April 2009. By June 2009 they had been increased back to 4.75%. But continued weakness in the national economy meant that cash rates decline throughout the later 2011-2016 sub-period.

[xii] The indicator standard variable rate on owner-occupied residential mortgages initially increased from 7.6% in June 2006 to peak at 9.6% in August 2008; sharp declines followed with rates bottoming out when they reached 5.8% in September 2009. They then rose but remained below June 2006 levels until November 2010. In the last sub-period rates plummeted from 7.8% in July 2011 to 5.4% in June 2016. Sourced from RBA Statistical Table 'Indicator Lending Rates – F5' (RBA, 2020a)