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Housing supply responsiveness in Australia: distribution, drivers and institutional settings

Inquiry into housing policies, labour force participation and economic growth

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AUTHORED BY

Rachel Ong
Curtin University

Tony Dalton
RMIT University

Nicole Gurran
The University of Sydney

Christopher Phelps
Curtin University

Steven Rowley
Curtin University

Gavin Wood
RMIT University

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Authors	Rachel Ong	Curtin University			
	Tony Dalton	RMIT University			
	Nicole Gurran	The University of Sydney			
	Christopher Phelps	Curtin University			
	Steven Rowley	Curtin University			
	Gavin Wood	RMIT University			
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Marilyn Chilvers	Department of Family and Community Services, NSW Government
Michael Fusarelli	Department of Family and Community Services, NSW Government
Shane Garrett	Housing Industry Association Ltd
Michael Lennon	Housing Choices Australia
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Acronyms and abbreviations used in this report

ABS	Australian Bureau of Statistics
AULUPP	Australian Urban Land Use Planning Policy
FIFO	Fly-in-fly-out
GCCSA	Greater Capital City Statistical Area
GFC	Global Financial Crisis
LGA	Local Government Areas
NRAS	National Rental Affordability Scheme
OLS	Ordinary least squares
PSP	Precinct Structure Planning
SES	Socio-economic status

Glossary

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

Executive summary

Key points

- A 1 per cent increase in the level of real housing prices is estimated to produce a 4.7 per cent (3.9%) increase in new house (unit) supply. These house price gains translate into a very small increase in the housing stock which will do little to keep up with demand pressures. Hence, there is a need for policy reforms that promote the price responsiveness of housing supply in Australia.
- Most of the growth in housing supply has been taking place in mid-to-high price segments, rather than low price segments. There seems to be structural impediments to the trickle-down of new housing supply. Targeted government intervention might be needed in order to ensure an adequate supply of affordable housing.
- Job opportunities and population growth pressures are greater in urban areas than regional areas. However, meeting population growth pressures through new *house* supply in urban areas will be challenging. On the other hand, the supply of *units* appears to be stronger (all else equal) in already developed areas.
- The impact of planning regulations on housing supply responsiveness is modest, though there is some evidence of a positive link between growth accommodating controls and housing supply growth.
- Often the most important aspect of the planning system from a developer's point of view is the certainty and consistency of advice provided by planning officers. Planning controls may be generally restrictive but if they are applied consistently the developer can work with them and deliver housing.
- The development industry is extremely diverse, so policy settings will not have a uniform impact across the development industry.

Key findings

Is Australian housing supply sufficiently responsive to price that it will keep pace with growing demand?

Our model results show that the estimated price elasticity of new housing supply is 4.7 per cent for houses and 3.9 per cent for units. While elasticity estimates from international studies vary widely depending on the time periods and models employed, a comparison with US and UK studies suggest that the price elasticity of new housing supply in Australia is typically lower than in the US where the price elasticity can be as high as 15 per cent. However, the price elasticity

of new housing supply in Australia is more comparable to the UK where they are typically lower at between 0 and 1 per cent[1].

These supply responsiveness estimates actually imply an increase in *housing stocks* of much smaller percentage increments. Thus a 1 per cent increase in the level of real housing prices will, according to these elasticity estimates, produce a 4.7 per cent (3.9%) increase in new house (unit) supply but a very small expansion in *housing stocks* of between 0.05 and 0.09 per cent. As populations are increasing at 1 per cent or more per annum nationally, these elasticity estimates suggest that (*all else constant*) we require large increases in real house prices in order to meet even modest increases in housing demand. The large increases in real house prices in Australia since the 1990s could then reflect these price elasticity estimates.

Is new housing supply concentrated in relatively low value segments of the market?

Most of the growth in housing supply has been taking place in mid-to-high price segments, rather than low price segments. Unfortunately, we are not witnessing a trickle-down effect whereby households buying new housing free up vacancies in the established housing stock that housing stressed households are able to move into at lower prices and rents. Consequently, research studies confirm that low-income households continue to experience growing difficulties accessing low cost housing. Housing in low-priced segments is presumably more affordable, but less than 5 per cent of approvals were in the bottom 20 per cent of the house and unit real price distribution in 2005–06, and this remains the case almost a decade later in 2013–14. Hence, the housing supply issue is more nuanced than commonly thought, as there seems to be structural impediments to the trickle-down of new housing supply.

Do urban areas face particular barriers to meeting population growth pressures?

Job opportunities and population growth pressures are greater in urban areas than regional areas. However, easing price pressures and expanding affordable housing opportunities will be particularly challenging for policy-makers in already developed urban areas. This is because housing supply can only be grown by increasing the density of development, or changing land use. The gradient of land areas is negatively linked to housing supply so urban areas that are hemmed in by hilly or mountainous terrain will be especially disadvantaged by these topographical constraints. Hence, our findings suggest that meeting population growth pressures through new *house* supply in urban areas is more difficult.

On the other hand, the supply of *units* appears to be stronger (all else equal) in already developed areas. Many of these urban areas with strong growth in the supply of units are job rich. Hence, the urban network linking jobs and residences in major cities will be strengthened as the market penetration of units increases. A likely by-product is shorter commutes, which can be an important boost to productivity.

How do planning regulations influence housing supply responsiveness in Australian housing markets?

In terms of *direction* of impact, growth accommodating controls are positively correlated with both house and unit approvals while growth restricting controls are negatively correlated with

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1 Mayer and Sommerville (2000a) found that in the US, a 1 per cent rise in house prices would yield a 15 per cent increase in new housing starts over a period of five quarters. Malpezzi and Maclennan (1994) found that in the post-World War II period up to the 1990s, the price elasticity of housing was between 6 and 13 per cent in the US, but much less elastic at between 0 and 1 per cent in the UK when estimated using a flow model. When they adopt a stock adjustment model, the price elasticities are very different for the US—ranging from 1 to 6 per cent—though they remain unchanged at between 0 and 1 per cent for the UK. Whiltehead's (1974) study spans the period 1955–72, and she also found relatively inelastic supply in the UK, with elasticities ranging from 0.5 to 2 per cent.

both house and unit approvals. However, only the relationship between growth accommodating controls and approvals is *statistically significant*; in the case of growth restricting controls the association is insignificant. Moreover, the *size* of the impact is marginal for both types of controls as indicated by the small coefficients on both planning variables in the model.

How do institutional settings affect the responsiveness of housing supply to demand pressures?

The development industry is extremely diverse, so policy settings will not have a uniform impact across this industry. The supply of detached housing is much quicker to respond to changes in market demand than multi-unit supply. The complexity of the multi-unit development process means it is very difficult for developers to respond quickly to changes in market demand. Development timeframes in the middle ring and inner city core suburban multi-unit housing market are long as there are many stages in the development process where there are potential barriers that can extend the development timeframe or prevent development altogether. The availability of finance can be a major barrier to development, particularly for smaller developers. Developers seek certainty in the development process. The more certainty state and local government can deliver in this process the greater the supply responsiveness is likely to be, all other things being equal.

Policy development options

Our findings show that real house price gains translate into a very small increase in the housing stock. Large increases in real house prices are needed to enable housing supply to match demand pressures (assuming other drivers of supply are unchanged). There is a case for policy reforms that promote the price responsiveness of housing supply in Australia.

Housing tax preferences and asset test concessions increase the demand for housing by encouraging the accumulation of savings in housing wealth. They are therefore helping to fuel price pressures by adding to demographically driven increases in demand; at the price elasticities we estimate, it is likely that these tax and asset test concessions are largely capitalised into house prices. If governments are unwilling to curb these concessions, their continued presence makes supply-side policy reform even more important. Those reforms should seek to promote the price responsiveness of new housing supply as well as more efficient use of the existing housing stock. It is the former suite of reform options that we focus on in the following subsections. But we should note that most of the demand for housing at any point in time is met from the established stock of housing. Reforms that help this established stock meet higher levels of demand should not be neglected.

Policy thinking around the supply of affordable housing has tended to focus on the number of new approvals and completions of houses and units, with the assumption that ‘more must be good’ because it eases housing market pressures and expands affordable housing opportunities. The results presented in this report suggest that a broader perspective is warranted to address the structural impediments that weaken the 'trickle down' impact of new housing supply. Furthermore, it is likely that targeted government intervention will continue to be needed to ensure adequate supply of affordable housing. This can be done either through direct subsidies that are targeted in areas in need of affordable housing, including regional and rural Australia, or via indirect measures that improve financial incentives for profit-maximising developers to supply at the lower end of the housing market.

Thinking on Australian planning reform as a supply measure should extend beyond the simplistic interpretation which assumes that the mere presence of a control is a barrier to supply. Indeed, our econometric modelling results suggest that planning measures may not be a key factor influencing housing supply. It may be that restrictive planning policies will prevent development only if they have a negative impact on revenue, making development unprofitable. On the other hand, developers will likely be more willing to work through restrictive controls if it

means they can generate a profit from the site. For instance, a number of restrictive controls may be outweighed by a single control that permits a developer to make a profit, for example a high density zoning within a strong housing market.

This is not to say that planning regulations necessarily have little impact on housing supply responsiveness in a local area. Often a key aspect of the planning system from a developer's point of view is the certainty and consistency of advice provided by planning officers. Planning controls may be generally restrictive, but if they are applied consistently the developer can work more easily with them to deliver housing. Hence, policy reform in the planning system may benefit from a tighter focus on improving certainty and consistency throughout the planning process, so as to minimise potentially adverse impacts on developers' revenues.

Due to topographical constraints and the presence of capital improvements on developed land, a policy development option in urban areas is to permit new supply at higher densities in order to accommodate population growth while easing price pressures. The supply of units appears to be higher (all else equal) than houses in already developed areas and so measures to further promote their construction could prove an effective pathway to easing price pressures and expanding affordable housing opportunities.

The supply of units is less responsive to changes in price than houses. This could be attributable to distinct differences in the development processes governing the supply of houses and units that affects the quantity of new supply in response to a price change and the timeliness of that new supply. The supply of detached housing is much quicker to respond to changes in market demand than multi-unit supply providing there is an available supply of lots for sale. Hence, from a policy development perspective, it is important to ensure such a supply of land will at least deliver a steady supply of such housing. However, multi-unit development has a long development timeline. By the time a developer has secured the land and the necessary development approvals the market may have changed, and the development may no longer be profitable. This affects both the quantity and timeliness of new unit supply when price changes. A more efficient land assembly and approval process would help make this type of development more responsive to changes in price.

There are several other policy development options that will likely improve supply responsiveness on the part of developers. First, even though monetary policy does not have a distinct housing objective, policy-makers need to be aware of the impacts of interest rate changes on housing supply because the availability of finance can be a major barrier to development, especially for smaller developers. Second, the more certainty government can deliver in the development process the greater the supply responsiveness is likely to be, all other things being equal. Third, it is important to note that developers are profit-maximising agents. Hence, ongoing government intervention will likely be needed to cross-subsidise affordable housing through additional development rights.

The development industry can respond much more quickly to negative market changes than positive market changes. The supply of dwellings is inevitably cyclical as a result. From a policy development perspective, government can take advantage of the cyclical nature of development by timing their own development activities counter cyclically and securing development deals when builders are at their least active. Overall, the development industry is extremely diverse and policy-makers need to recognise that policy settings will not have a uniform impact across the development industry. There remains a need to better understand how particular obstacles in the development process affect different sectors of the industry and to pay more attention to how and where new infrastructure is being provided so as to maximise opportunities for development in areas of high demand.

The study

This report forms part of an AHURI Inquiry into housing policies, labour force participation and economic growth. This study addresses the following research question:

What are the key drivers of housing supply responsiveness, and what do the identified effects imply for policies seeking to increase housing supply responsiveness in Australia?

In order to address this research question, the study will shed light on the links between the price responsiveness of housing supply and productivity in Australian metropolitan and regional economies. We examine whether the supply of housing is responsive in various segments of the housing markets, including geographic segments (e.g. metropolitan versus regional), price segments, and areas of low versus high population growth and job opportunities. The key drivers of housing supply responsiveness—including price, cost shifters, topographical constraints, climate, existing land uses and planning regulations—are modelled to determine their relative influence on housing supply responsiveness. The study also investigates the extent to which the organisation and structure of the Australian developer and housing industries favour or impede the responsiveness of housing supply to demand pressures. The findings from this study provide an evidence base to guide policy development that seeks to improve the scale and speed of housing supply responses to market pressures in Australia.

There is a clear and important link between the responsiveness of housing supply and economic development, which has been addressed in the international literature, but much less so in Australia. When housing supply in a regional area fails to respond speedily to positive productivity shocks (e.g. discovery of new minerals), the productivity gains can be squandered in the form of rising house prices. In metropolitan areas, housing cost pressures are becoming acute in already large cities such as Sydney, where new housing supply must overcome challenges posed by topographical, infrastructure and policy constraints. Because global transnational service businesses (banks, financial institutions etc.) are concentrated in cities, the issues in metropolitan economies are aggravated by their greater exposure to international competitive pressures.

A plethora of policy instruments at federal, state and local levels influence housing supply responsiveness. Some have direct housing objectives such as subsidised affordable rental housing schemes and planning regulations. On the other hand, fiscal and monetary policies do not have direct housing objectives but nonetheless influence outcomes in the housing market. Evidence on the drivers that affect the supply of housing will therefore offer insights into the kind of policy interventions that might aid the housing sector to adjust to demand pressures and alleviate undesirable economic and social consequences.

The research draws on a mixed methods framework of enquiry at the local government level. It combines a series of methodological approaches including estimation of the distribution and price elasticity of new housing supply, econometric modelling to uncover the key drivers of housing supply responsiveness in Australia, and industry panels to shed light on the influence of housing industry institutional settings on the responsiveness of supply to demand pressures which cannot be captured using secondary data. The analysis is conducted at the local government area level over the period 2005–06 to 2013–14.

1 Overview

- This report sheds light on the key drivers of housing supply responsiveness in Australia, and identifies policy development options that will improve the scale and speed of new housing supply adjustment to market pressures in Australia.
- There is a clear and important link between the responsiveness of housing supply and economic development, which has been addressed in the international literature but much less so in Australia.
  - When housing supply in a regional area fails to respond speedily to positive productivity shocks, the productivity gains can be squandered in the form of rising house prices.
  - In metropolitan areas, new housing supply must overcome challenges posed by topographical and infrastructure constraints. These challenges have implications for international competitiveness as global transnational service businesses are concentrated in cities.
- A plethora of policy instruments at federal, state and local levels influence housing supply responsiveness. Some have clearly stated housing objectives such as subsidised affordable rental housing schemes and planning regulations with respect to building standards. On the other hand, fiscal and monetary policies are invariably driven by macroeconomic objectives (e.g. employment, economic growth), but nonetheless influence outcomes in the housing market.
- The research draws on a mixed methods framework of enquiry. It combines a series of methodological approaches:
  - estimation of the distribution and price elasticity of new housing supply
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  - economic modelling to uncover the key drivers of housing supply responsiveness
  - industry panels to shed light on the influence of institutional settings in the housing industry on the responsiveness of supply to demand pressures.
- The report focuses on new housing supply. It does not capture changes to the established supply that come about due to demolitions and conversions. However, new housing construction is a much more important source of changes in the housing stock, and government policy interventions tend to focus on new supply.

1.1 Why this research was conducted

This report addresses the following research question:

What are the key drivers of housing supply responsiveness, and what do the identified effects imply for policies seeking to increase housing supply responsiveness in Australia?

In order to address this research question, this report will:

- Shed light on the links between the price responsiveness of housing supply and productivity in Australian metropolitan and regional economies.
- Investigate whether the supply of housing is responsive in various segments of the housing markets, including geographic segments (e.g. metropolitan versus regional), price segments, and areas of low versus high population growth and job opportunities.
- Examine the drivers of housing supply responsiveness, including the price elasticity of housing supply in Australian housing markets in regional and metropolitan areas.
- Analyse whether the organisation and structure of the Australian developer and housing industries favour or impede the responsiveness of housing supply to demand pressures.
- Propose policy development options that will improve the scale and speed of housing supply responses to market pressures in Australia.

Economists have often found it difficult to explain why the local economies of some cities and regions grow in response to a productivity gain, while those of other cities and regions in the same nation fail to respond. One important idea places emphasis on the price elasticity of housing supply, which has been well-covered in the international literature (Glaeser and Gottlieb 2009; Boeri Ichino et al. 2014) but much less so in Australia. A hypothetical two-region illustration helps understanding. If there are two adjacent regions X and Y and the former benefits from a productivity gain (e.g. a discovery of mineral deposits), wages will begin to rise in X as employers seek to fill vacancies. Mobile labour will begin to move from Y to X. This will help curb the rise in wages while also ensuring the productivity gain is converted into increases in employment in region X.

However, this process will be stifled if new housing supply in region X is price inelastic, resulting in soaring house prices and rents as supply fails to keep up with demand pressures. The high housing costs that are a consequence when housing supply is price inelastic are a drag on local, metropolitan and regional economic growth. They depress the real incomes of households in communities affected as local firms in the community find that their business/sales are adversely impacted, exacerbating downside impacts on the local economy (see McKenzie, Phillips et al. 2009).

There is mounting anecdotal evidence of such outcomes. Maclennan, Wood et al. (2015) reviewed 27 local government economic development and housing strategies in WA and Victoria and uncovered numerous references to exactly the kind of problems described above. Many of the cases reviewed concern regional areas, where the mining boom or tourist development are the source of major economic stimulus, but shortages of affordable housing are adversely impacting businesses (e.g. Pilbarra, Surf Coast). They are also prompting the growth sectors to resort to ‘fly-in-fly-out’ (FIFO) and ‘drive-in drive-out’ adjustments that add to business costs and adversely impact communities. The Productivity Commission’s recent Geographic Labour Mobility report also identified these concerns (2014: 30).

But it is not just regional Australia that is affected. Cities expand as population growth prompts radial expansion on greenfield sites. These pressures are becoming acute in already large cities such as Sydney, where new housing supply must overcome challenges posed by topographical, infrastructure and policy constraints identified as being critical constraints on housing supply in the literature (Bramley, 2002; Glaeser and Gyourko 2005). The issues in metropolitan economies are aggravated by their greater exposure to international competitive pressures, since global transnational service businesses (banks, financial institutions etc.) are concentrated in cities, and are increasingly ‘footloose’—for example, outsourcing routine back office functions overseas in response to business cost pressures.

1.2 Policy context

Housing supply responsiveness in Australia is affected by a range of policies at federal, state and local levels. The evidence base presented in this report will therefore have implications for a range of policy instruments across all tiers of government. Indeed the implications of this research will extend beyond policies that are directly targeted at housing outcomes to policies that do not have housing objectives but which nonetheless affect the responsiveness of housing supply in Australia.

In the housing and planning spheres, schemes that aim to deliver subsidised affordable rental housing will clearly affect housing supply responsiveness. A recent example is the now-discontinued National Rental Affordable Scheme (NRAS), a partnership between the federal and state and territory governments to address the shortage of affordable rental housing by providing financial incentives to individuals or organisations to build dwellings for low to moderate income renters at 20 per cent below the market rent. By mid-2015, the scheme had supplied 27,603 dwellings with another 9,980 still to be delivered. Over three quarters of the dwellings were supplied in major cities, and a diverse range of dwelling types were supplied including separate houses, studios, town houses and apartments (Rowley, Gurren et al. 2016b).

Public housing also provides subsidised affordable housing to low-income tenants, as rents are typically set at around 25 per cent of assessable income, though some jurisdictional variations exist. The supply of public housing is limited by the availability of public housing stock; hence it is rationed. To cope with excess demand, state and Territory housing authorities operate wait lists (Dockery, Ong et al. 2008). In 2014–15, there were over 320,000 public housing dwellings in Australia but nearly 154,000 eligible applicants on the wait list awaiting a public housing dwelling (SCRGSP 2016).

Planning regulations have often been mooted as a source of constraint on housing supply growth in the international academic and policy literature. Some quantitative research in the UK points strongly to planning constraints, in conjunction with strong housing demand in some areas such as the South East, as the key cause of housing affordability problems in the UK (see Hilber and Vermeulen 2010; Overman 2012). Over the past decade or so, following the Barker review of housing supply, a series of planning system reforms have been introduced to address regulatory barriers to residential development, and some suggest that explanations for current supply blockages might relate more to industry practices and financing than to the planning system (Barker 2008). In Australia, ongoing concerns about the role that planning regulatory processes play as barriers to new housing supply have repeatedly been raised in the policy documents (see Productivity Commission 2011; COAG Reform Council 2012).

In Australia, planning regulations are implemented at both state and local levels. Hence, a myriad of planning instruments exist at the local level, with wide variations across Local Government Areas (LGAs). It is important to note that not all planning instruments are designed to control development. A range of growth restricting instruments exists, such as residential zoning; minimum lot size requirements, height limits, floor space ratios and protective measures for wildlife habitat and wetlands. However, some planning instruments are designed to accommodate growth, for example plans that permit diverse dwelling types such as granny flats and incentives for mixed residential and commercial development. Subsidised affordable rental housing and planning regulations have clear housing objectives. However, fiscal and monetary policies have long been in place and these have an impact on housing supply responsiveness even though their objectives are not housing in nature.

In regard to fiscal policy, at the federal level income tax arrangements can have significant impacts on housing market decisions by property owners including both owner occupiers and rental investors. For instance, because of negative gearing provisions, investors can deduct ongoing expenses pertaining to their rental property. If these expenses exceed gross rental

income, the loss made on the rental property can be deducted from other sources of tax assessable income. These provisions potentially offer strong incentives for investors to supply rental housing, leading to much contentious debate over the extent to which reform to negative gearing provisions may affect the supply of housing in the private rental market (Wood, Ong et al. 2011). Stamp duties are a state fiscal measure that imposes a tax on property conveyance. This transaction tax could be a cost barrier to the supply of housing because a common property development arrangement entails the developer buying land from a landowner to develop it and therefore incurring a stamp duty liability in the process.

Financing costs are also a critical driver of housing supply responsiveness (see Hwang and Quigley 2006; Rowley and Phibbs 2012). These are of course strongly influencedy by prevailing interest rate settings, a key monetary policy instrument. In principle, the cost of financing development increases as interest rates rise (all else being equal) so during periods of high interest rates the response of housing supply to an expansion in demand can be slow. Even though fiscal and monetary policies do not have direct housing objectives, it is imperative that policy-makers be aware of the 'unintended' consequences of these policies on housing supply.

1.3 The demand and supply-side impacts of housing supply responsiveness: an overview of the literature

The price elasticity of housing supply is a measure of the responsiveness of the quantity of housing supplied to change in the price of housing. In numerical terms, it is the ratio of the percentage change in the quantity of housing supplied to the percentage change in the price of housing. At one extreme, we have perfectly inelastic supply when the price elasticity of housing supply is zero, such that changes in the price of housing will have no impact on the quantity supplied. Here, the price elasticity of housing supply would be zero. At the other extreme, we have perfectly elastic housing supply where even miniscule changes in house prices will lead to large changes in the quantity of housing supply. In this case, the price elasticity of housing supply would be infinite. Typically, an elasticity measure of greater than one would indicate elastic supply, while an elasticity measure of less than one implies inelastic supply (Krugman and Wells 2009).

The importance of housing supply responsiveness to the health of the economy is summed up concisely in the first key point that the Barker Review interim report makes to the UK's Chancellor and Deputy Prime Minister (2003: 2): 'A weak supply of housing contributes to macroeconomic instability and hinders labour market flexibility, constraining economic growth. To date, the issue of housing supply continues to dominate the current UK economic agenda, with a recent Treasury report highlighting concerns over the detrimental effects a lack of affordable housing in the UK is having on productivity and labour market flexibility (HM Treasury 2015).

A lack of responsiveness of housing supply, or price inelastic housing supply, can affect the economy through two major channels as illustrated in Figure 1 below. First, it can have negative impacts on macroeconomic stability (a demand-side impact). Second, it can impede labour market flexibility (a supply-side impact). The overall consequence is subdued economic growth, with the economy operating below its full capacity as housing markets fail to adjust swiftly to demand shocks.

In regard to demand-side impacts, the price elasticity of supply determines the extent to which the housing market responds to demand shocks by increasing the quantity of housing (if supply is price elastic) or rising prices (if supply is price inelastic) (Gyourko 2009). Where housing supply is price inelastic, there are adverse consequences for housing affordability as the increase in demand is translated into rapidly rising house prices. Indeed, Australia is ranked number 9 in the OECD's league table of percentage changes in house prices across 59

countries during 2012–13, indicating it experienced some of the largest percentage increases in house prices within the OECD in recent times (OECD 2014).[2]

However, there are also ramifications for house price volatility and macroeconomic stability. When housing supply is price inelastic, house prices become very sensitive to demand changes caused by financial, labour market or demographic shocks (Andrews 2010). Furthermore, the literature commonly argues that house price bubbles are more likely to occur when housing supply is price inelastic (Ball, Meen et al. 2010). Cheshire (2014) notes that a tightly controlled supply of housing motivates property owners to treat housing as an investment asset to be held in expectation of future price increases, thus further fuelling housing shortages and house price increases in the economy. Hence, in an environment where housing supply is unresponsive to demand shocks, it is likely that house prices will end up gyrating around a rising trend in house prices, creating an undesirable situation of long-run housing market volatility (Girouard 2010; Maclennan 2010).

However, it is important to understand that the impacts of an unresponsive housing supply environment do not just stop with rising and volatile house prices. Rising house prices and house price induced debt increases will in turn affect consumption spending in Australia, and there will be implications for economic and financial stability.

1.3.1 Supply-side impacts

Supply-side impacts of price inelastic housing supply are typically explained within a migration model. This framework dates back several decades to Sjaastad (1962) but has more recently been popularised in the international literature by Glaeser (see Glaeser and Gottlieb 2009), though less so in Australia. Glaeser proposes that labour market decisions are obviously influenced by wage levels and career prospects, but they also factor in the associated cost of living in a new place of employment.

A hypothetical two-region illustration helps understanding. If there are two adjacent regions X and Y and the former benefits from a productivity gain (e.g. a discovery of mineral deposits), wages will begin to rise in X as employers seek to fill vacancies. Mobile labour will begin to move from Y to X. This will help curb the rise in wages while also ensuring the productivity gain is converted into increases in employment in region X. However, soaring house prices and rents will result if housing supply fails to keep up with demand pressures. Workers in more affordable housing markets may be unable to access housing in booming higher priced regions at current wage rates. Those who do move to higher priced areas to take up employment will require higher wages to compensate for higher housing costs (Saiz 2010). A complementary argument is that home owners in areas with high house prices may be reluctant to move to areas with lower house prices to take up suitable employment opportunities for fear of being priced out of the home ownership market if they wish to return to their original place of residence later (Cameron and Muelbauer 1998; Barker 2003).[3]

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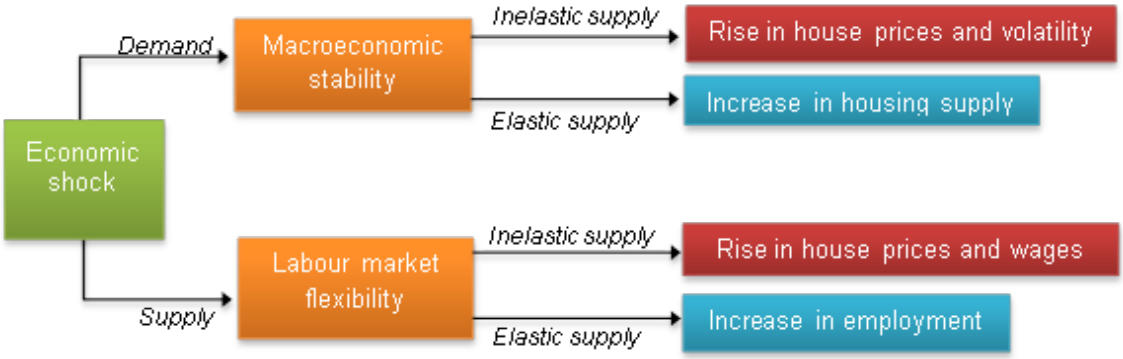
[2] Of course this figure masks variations in house price changes within Australia, which we seek to address by using LGA level data.

[3] There is a caveat here. Some may choose to move out of the high priced area without selling up to rent in a low cost area, so as to continue benefiting from capital growth in the high priced area.

Figure 1: The links between the price elasticity of housing supply and the economy



1.4 Research methods

This study generates research findings through a mixed methods framework of enquiry. The project provides estimates of the price elasticity of new housing supply on a local government area (LGA) basis over the period 2006–15, and is the first research exercise of this kind in Australia.[4] We employ econometric modelling to shed light on important drivers of housing supply responsiveness at a LGA level. This establishes where housing supply is typically unresponsive to price signals and identifies variables that impede or promote housing supply, thereby offering insights into the kind of policy interventions that might aid the capacity of housing to adjust to demand pressures.

We draw on two key sources of data for the period July 2005 to June 2014:

- The use of building approvals at the Local Government Area (LGA) level sourced from the Australian Bureau of Statistics (ABS) as our measure of (new) housing supply.
- Median prices as calculated from transactions in all houses and units at an LGA level from CoreLogic RP Data, a property information, analytics and services provider.

It is important to acknowledge that both data sources suffer from limitations. However, after reviewing the international literature and taking into consideration the importance of measuring supply and price variables at the local level,[5] the above two data sources were selected as the two most suitable options given the project's timeframe and budget constraints.

In relation to building approvals data, a well-known limitation is that not all building approvals are converted into actual housing completions, and it is completions not approvals that matter when measuring additions to the stock of housing. Building commencements or completions are likely to be a more accurate measure of housing supply. There is also a delay between the timing of building permit approvals and housing completions. However, the ABS has indicated that commencements and completions data are only available at the Greater Capital City Statistical Area (GCCSA) level.

A review of the international literature indicates that most local area studies fall back on building approvals data because commencements or completions data is unavailable.[6] Concerns are allayed by claims of a strong correlation between building permits and commencements in both Australia and overseas. In the US, Hwang and Quigley (2006) find that at the national level, the

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[4] McLaughlin (2012) estimated the price elasticity of housing supply in Australia for capital cities only.

[5] Most modelling exercises exploit regional as well as time series variation in prices and housing supply. While better price and supply measures are available at a national level, they are not available at a regional level.

[6] See Poterba (1984); Drieman and Follain (2003); Hwang and Quigley (2006); McLaughlin (2011, 2012).

correlation coefficient between housing approvals and commencements is 0.95 over the period 1959 to 2000, and 0.99 from 1987 to 1999. Using Canadian data, Somerville (2002) finds that around 90 per cent of housing approvals commence the construction phase within two quarters. Our own calculations using ABS data show that over the period 2005–06 to 2013–14, the correlation coefficient between approvals and commencements for houses is 0.96; for units it is 0.93. Furthermore, the delay issue is addressed in modelling exercises by lagging the price variables in building approvals models.[7]

Importantly, while building approvals capture new housing supply, it does not take into account changes in the supply that come about due to demolitions and conversions. Hence, the analysis presented in this report focuses on new housing supply and does not capture changes to the established housing supply. This is a data limitation. However, conversions and demolitions are a relatively small source of changes in the housing stock; additions that come about due to new constructions are a much more important source of changes in the housing stock. Moreover, new supply tends to be the focus of government policy intervention.

Price data also has its limitations because the finest LGA dwelling category breakdown is for houses and units. Ideally the categorisation of dwelling types should take into account various factors including differential access to land, the type of labour used for construction, and access to financing across dwelling types. However, it is not possible to obtain price data at a more disaggregated level than houses and units. Hence, existing empirical studies have tended to focus on all dwelling types or distinguish broadly between separate houses and other dwelling types.[8]

Other data sources were drawn on to measure a wide range of variables for input into the econometric model, and these are detailed further in Chapter 3 and Appendix 1.

However, behind the secondary data on market supply adjustments, there are developers and housing construction companies, and their efficiency will reflect industry organisation and structure, as well as the regulatory environment and development approval processes governing their behaviour. As highlighted by Ball, Meen et al. (2010), the empirical estimations are unlikely to offer insights into these angles. Hence, industry panels were held twice in Melbourne to elicit industry-specific views on institutional arrangements affecting housing supply responsiveness. The panel comprised eight members, including housing and residential land development representatives drawn from industry organisations and federal and state governments.

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7 It should also be noted that our housing supply variable captures additions to the housing stock, through new construction, but omits additions and alterations eventuating as a consequence of renovations.

8 A second concern is a mismatch between the price variable, which is based on all transactions (in both established and newly constructed housing), and housing supply, which is based on approvals for the construction of new housing.

2 Housing supply in Australia: some stylised facts

- Much of the growth in Australia's housing stock between 2005–06 and 2013–14 has not been in areas where it is most needed.
- New housing supply has been concentrated in mid-to-high price segments. Housing in low-priced segments is presumably more affordable, but less than 5 per cent of building approvals were in the bottom 20 per cent of the house and unit real price distribution in 2013–14.
- New housing supply in high price segments should in theory push down the prices of existing housing as purchasers of new housing vacate their established properties, making it more accessible to low-income households. However, this process does not seem to be working very well. It could be due to structural impediments that weaken the trickle down impact of new housing supply, but further research is needed to establish what, if any, structural impediments are relevant.
- On a positive note, because the supply of units is overwhelmingly concentrated in job rich areas, the urban network linking jobs and residences in major cities will be strengthened as the market penetration of units increases. A likely by-product is shorter commutes, which can be an important boost to productivity.

In this first analytical chapter we present descriptive statistics that depict the pattern of new housing supply with respect to price segments, geography and other important dimensions of the housing market. The empirics cover a nearly 10-year period from July 2005 to June 2014. This empirical material offers some important insights into the scale of Australia's new housing supply response to population growth, as well as its relationship to affordable segments of the housing market.

2.1 Existing research on the nature of the housing supply 'problem'

The existing policy literature highlights strong concerns regarding a perceived failure of housing supply to keep up with demand. The issue of a housing supply shortage was highlighted in the recent senate inquiry report into housing affordability (Senate Economics References Committee 2015) as well as a major UK review of housing supply back in 2004 (Barker 2004). The unresponsiveness of housing supply to demand pressures remains a current concern of government, industry and other parties engaged in policy debates (see for instance, Baker and Johnson 2014; Department of Social Services 2014; Housing Industry Association 2014).

However, some studies make a more nuanced observation that the housing supply 'problem' is a complex one that cannot be captured by a simple aggregate measure of the gap between overall demand and supply. Indeed, various studies in the policy and academic literature have highlighted the issue of *mismatch* between demand and supply, that is new housing is not being supplied in areas where it is most needed to support population and employment growth. For instance, the National Housing Supply Council (2014) noted that even when the aggregate supply of dwellings exceeds the demand for housing, a shortage of affordable housing might still exist because dwellings are being added that are either unaffordable, or inaccessible to

households that need housing (p. 22). Furthermore, the Barker review (2004: 121) states that '(s)imply comparing the number of households and the number of dwellings fails to capture mismatches between the location of supply and demand or between the type of housing desired and that which is available'.

During the 1990s, there was significant interest in the hypothesis of a spatial mismatch between the supply of housing and employment opportunities in the American literature. In particular, an extensive literature exists that focuses on the extent to which limits on housing choice for Afro-American workers are responsible for low rates of employment and earnings among this population subgroup (see e.g., Kain 1992; Ihlanfeldt and Sjoquist 1998; Raphael 1998). The urban economics literature has also investigated the links between patterns of residential choices and job locations extensively and shown that there is a relationship between commuting patterns, land use values and density. In 2004, Dodson conducted a study testing whether there is a spatial mismatch between housing affordability and employment opportunity in Melbourne, and found that low cost housing areas appear to be correlated with concentrations of unemployment. While outer suburban areas had the most affordable housing, these also featured high unemployment, particularly in declining industrial areas. On the other hand, if workers living in suburban areas are forced into longer commutes to access jobs in the CBD, it can result in reduced productivity through time 'lost' in commuting and reduced income after accounting for travel costs (Spiller 2013; Maclennan, Wood et al. 2015). This may deter low-paid workers from seeking jobs in CBDs (van den Nouwelant, Crommelin et al. 2016). The resulting labour market mismatch means that certain skills become unavailable in production, and firms may be forced to adjust to this mismatch through reduced productivity (Spiller 2013).

In short, the *geography* of housing supply matters, and if there is a *spatial mismatch* between new housing supply and existing demand, the supply of new housing will be less effective in easing housing shortages that tend to emerge in areas of strong population or employment growth. The findings in this chapter fill a gap in the literature by focusing on the geography of housing supply and investigating the extent to which housing is being supplied in low-priced segments that are likely more affordable, as well as areas experiencing high rates of population growth. We also examine whether the geography of housing supply is fostering productivity by providing housing opportunities closer to where jobs are located.

2.2 National housing supply trends

Figure 2 below displays building approvals per 1,000 persons in the population over the period 2005–06 to 2013–14. In 2013–14 an average six house building permits were approved per 1,000 persons in the population. This supply outcome was achieved in both metropolitan and regional areas. The Australia-wide supply of houses has not changed much over the period 2005–06 to 2013–14. There was a dip in supply during the global financial crisis (GFC) year 2008–09 before rising to 2009–10, but this has been followed by another decline through to 2012–13.

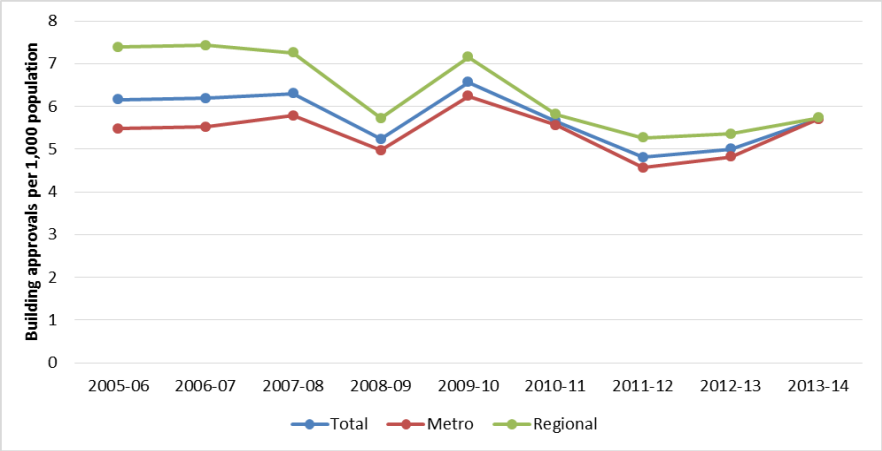
On the other hand, there has been considerable change in the supply of apartments (units), both geographically and in terms of trends over time. In metropolitan areas they have been rising since 2008–09, confirming a notable development that has attracted some media attention in recent times.[9] Between 2008–09 and 2013–14, the annual number of units per capita tripled from around 1.2 to 3.5 units. However, there is a conspicuous geographical variation because the supply of units in regional areas has trailed well behind metropolitan

[9] See Jericho (2016).

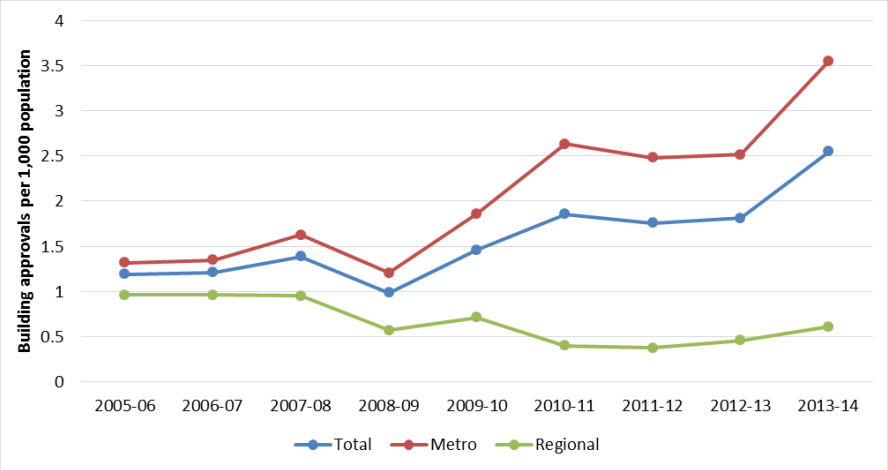
areas. Indeed 2013–14 figures reveal unit approvals in the regions at 0.5 per 1,000 persons, levels that remain below those sustained in years immediately preceding the GFC.

Figure 2: Building approvals per 1,000 population, 2005–06 to 2013–14

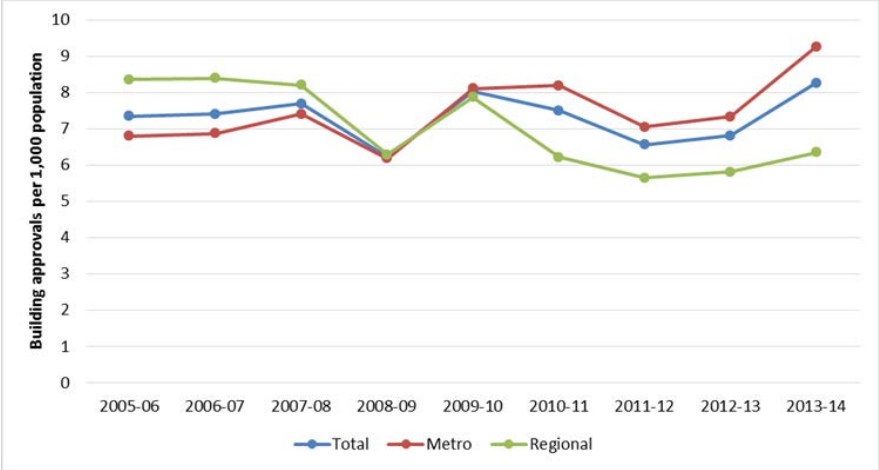
(a) Houses



(b) Units



(c) All



Source: Authors' own calculations from ABS Cat. No. 8731.0

2.3 Distribution of new housing supply

This section presents an analysis of the distribution of new housing supply across market segments. We address the following key research questions:

- Is new housing supply concentrated in more or less affordable higher or lower priced market segments?
- Are new houses and units being built where population and labour markets are dense?
- What is the geography of new housing supply across Australia, and are there significant variations in relation to dwelling types?

The descriptive statistics offer some preliminary insights on whether new housing supply is *directly* adding to housing opportunities for lower income households that also offer ready access to employment, and with a spatial configuration promoting compact cities. These are important links because all three have been prominent issues in housing and urban policy debates in recent years.

We begin by assessing the distribution of approvals for houses and units across real price deciles. In the case of houses, nominal median house price values are converted to 2013–14 price levels using the Consumer Price Index; the transformed prices can be interpreted as real median house price values. LGAs are then ranked from lowest to highest according to their real median house price values, and divided into 10 equal-sized groups (deciles). All building approvals for an LGA are assigned to the decile that it sits in.[10] The same exercise is repeated for units. The deciles are also defined contemporaneously so an LGA may not be in the same decile in both 2005–06 and 2013–14.

2.3.1 Is new housing supply concentrated in low priced segments?

We begin by assessing the distribution of approvals for houses and units across real price deciles. Table 1 below reveals a distribution of house approvals that is concentrated in the mid-to-high price deciles, but largely absent from the lowest priced segments. Almost 80 per cent of house approvals are to be found in the 6th to 9th deciles, a range covering transactions between $306,000 and $795,000 in 2013–14. There has been little change in this supply pattern between 2005–06 and 2013–14. While new house supply does little to *directly* increase the supply of housing in low priced segments, there is an indirect effect as the prices of existing housing could be pushed down by new supply, making it more accessible to low-income households.[11]

The distribution of units by price segment is also biased in the same direction as houses. On average over the timeframe 2006–14, 80 per cent of unit approvals were in the high 8th to 10th deciles, and this concentration increased from 79 per cent to 84 per cent between 2005–06 and 2013–14. New supply of units peaked in the 9th decile in 2013–14, where the midpoint of the price range is $500,000; almost one in three unit approvals were granted in this second highest price decile. On the other hand, the bottom two price deciles, which represent the lowest priced market segments (price midpoints of $198,000 and $140,000 in 2013–14), accounted for less

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10 There is an important caveat here. It is conceivable (though implausible) that most approvals in high value segments have been issued for the construction of low cost housing with prices well below the median in that LGA, yet they will all be assigned in the high value segment. The opposite might be happening in LGAs in low value segments.

11 This process is commonly referred to as filtering (see Somerville and Holmes 2001). The price segment is irrelevant if the filtering process is efficacious; what matters is the quantity of new house supply. If there are barriers to residential moves, purchase of new housing as second homes or by overseas investors, filtering may be ineffective as a process promoting the supply of affordable housing.

than 1 per cent of new unit approvals over the period 2005–06 to 2013–14.This paucity of new supply at the bottom end of the housing market is also characteristic of the house approval data.

We find that unit and house approvals in low price ranges are not just low in terms of their share of all approvals; they are also lower than the share of housing stock in these price ranges back in 2006. New supply of units and houses is disproportionately high relative to the 2006 housing stock in relatively expensive house price ranges. Consider units in Table 1, for example; 84 per cent of 2013–14 approvals were in the 8th–10th price deciles (a price range of $376,000 and above). Yet in 2006 the share of the stock of units in these deciles was a much lower 69 per cent.

Table 1: Building approvals for houses and units by real price decile, per cent by column, 2005–06 and 2013–14

(a) Houses

	2005–06			2013–14			Average
Price decile	Price band ($'000)	% of house stock	% of approvals	Price band ($'000)	% of house stock	% of approvals	% of approvals
1	$19.1–$96.3	0.8	0.2	$29.2–$144.2	1.1	0.2	0.2
2	$97.8–$148.2	1.2	0.4	$146.0–$184.0	1.6	0.6	0.5
3	$149.9–$190.3	2.6	1.6	$184.0–$226.3	3.4	1.7	1.8
4	$190.4–$227.3	4.0	3.2	$228.6–$263.9	5.7	3.3	4.2
5	$227.7–$262.2	8.9	8.6	$264.0–$306.1	6.5	5.9	7
6	$262.8–$303.2	9.2	13.2	$306.5–$357.1	9.2	10	15.6
7	$303.4–$343.6	14.6	24.8	$357.9–$418.0	18.8	27.1	22.3
8	$347.5–$425.2	17.9	17.2	$419.3–$515.6	20.7	26.2	21.7
9	$426.7–$589.2	28.9	25.5	$524.0–$794.7	22.0	19.5	21.3
10	$596.1–$2,776.0	11.9	5.4	$806.3–$3,581.7	11.0	5.5	5.3
Total		100	100		100	100	100
N			12,4931			13,3264	

(b) Units

Price decile	2005–06 Price band ($'000)	2005–06 % of unit stock	2005–06 % of approvals	2013–14 Price band ($'000)	2013–14 % of unit stock	2013–14 % of approvals	Average % of approvals
1	$78.4–$176.4	1.2	0.2	$95.4–$184.5	1.7	0.1	0.3
2	$176.9–$203.3	2.5	0.7	$185.7–$209.6	2.2	0.1	0.6
3	$203.8–$217.2	3.3	1	$210.2–$236.2	3.6	0.4	1
4	$219.2–$241.4	3.6	1.7	$236.8–$270.7	2.6	0.6	1.5
5	$242.2–$270.5	5.1	4.1	$270.7–$302.1	6.2	2.1	3.5
6	$271.3–$294.9	5.8	6.7	$303.1–$330.8	5.6	2.9	4.3
7	$295.4–$333.8	9.2	6.2	$332.2–$369.0	13.8	9.4	8.5
8	$335.0–$391.1	18.0	31.1	$376.5–$445.6	18.1	26.7	22.8
9	$391.3–$449.8	26.4	30.9	$446.4–$555.3	21.0	32.1	33
10	$456.6–$783.6	25.0	17.3	$555.9–$863.0	25.1	25.6	24.4
Total		100	100		100	100	100
N			2,3997			5,9294	

Notes: The average estimates refer to the nine-year period 2005–06 to 2013–14. House and unit prices are expressed in real terms by inflating pre-2013 prices to 2013–14 price levels following Consumer Price Index movements. The price deciles are calculated based on house (unit) prices for houses (units), and are measured contemporaneously. The 2005–06 (2013–14) stock percentages are derived from the 2006 (2011) Census.

Source: Authors' own calculations from ABS Cat. No. 8731.0 and 2006 and 2011 Census.

2.3.2 New houses and units and population patterns

In Table 2 below LGAs are grouped into 10 equal sized groups according to the size of their population. The table is gauging whether more populous LGAs have higher levels of new supply, and this is confirmed. However, it is hardly surprising to find that LGAs with populations ranging from 111 to 945 (as in the lowest decile) have a much lower share of all approvals (whether units or houses) than the share accounted for by LGAs with populations ranging from 106 thousand to 988 thousand (as in the top decile). But more meaningful is the observation that by 2013–14 approvals in the most populous LGAs were accounting for a disproportionately high share of unit and house approvals relative to population shares.

Table 2: Building approvals for houses and units by population decile, per cent by column, 2005–06 to 2013–14

Pop'n decile	Population band	% of total population	% of total housing stock	% of house approvals	% of unit approvals
			2005–06		
1	111–945	0.2	0.2	0.1	0.1
2	946–2,000	0.4	0.5	0.3	0
3	2,003–4,174	0.8	0.9	0.8	0.1
4	4,186–7,129	1.5	1.6	1.5	0.2
5	7,179–11,649	2.5	2.9	2.9	0.5
6	11,729–19,052	4.0	4.4	4.2	5.4
7	19,241–31,404	6.8	7.8	8.9	2.2
8	31,450–56,252	11.5	12.4	11	6.1
9	57,950–10,5579	21.7	22.1	23.4	27
10	105,717–987,831	50.6	47.1	46.9	58.4
Total		100	100	100	100
N				125,030	24,244
			2013–14		
1	75–1,002	0.1	0.2	0.1	0
2	1,010–2,065	0.3	0.5	0.2	0
3	2,076–4,292	0.7	1	0.5	0.1
4	4,308–7,401	1.4	1.6	1	0
5	7,409–12,028	2.3	2.8	1.6	0.4
6	12,517–20,580	3.9	4.4	4	0.7
7	20,740–36,053	6.7	7.9	7.3	5.3
8	36,145–63,338	11.1	12.2	9.8	7.7
9	65,527–125,503	22.2	22.4	21.8	36.5
10	125,889–1,146,787	51.3	47.0	53.9	49.4
Total		100	100	100	100
N				133,032	59,481

Notes: The population deciles are measured contemporaneously. The 2013–14 stock percentages are derived from the 2011 Census.

Source: Authors' own calculations from ABS Cat. No. 8731.0 and 2006 and 2011 Census.

2.3.3 Is the geography of housing supply fostering productivity by providing housing opportunities closer to where jobs are located?

Table 3 below reports findings that have important implications for productivity. LGAs are ranked from lowest to highest according to the number of jobs that are located within their

geographical boundaries.[12] As in earlier tables, LGAs are then grouped into deciles in ascending order—thus decile 1 is occupied by the 'job poorest' 10 per cent of LGAs, and decile 10 by the 'job richest' 10 per cent of LGAs.

Both house and unit approvals are more likely in job rich LGAs. In 2005–06, for example, roughly three-quarters of all jobs were located in the 20 per cent most job rich LGAs (top two deciles); those same LGAs attracted 64 per cent of all house approvals and 82 per cent of all unit approvals. But we have witnessed a strengthening of that co-location of jobs and the supply of units. By 2010–11 more than 9 in every 10 units (92%) were approved in the 20 per cent of LGAs that are relatively job rich. The spatial correlation between jobs and house approvals is weaker; job poor LGAs can even attract a disproportionately high share of house approvals (as in LGAs grouped in deciles 3, 4 and 5). However, as the market penetration of units has grown the urban network linking jobs and residences strengthened, with shorter commutes a likely by-product. Those shorter commutes are a potentially important boost to productivity, especially in metropolitan economies.

Table 3: Building approvals for houses and units by number of jobs decile, per cent by column, 2005–06 and 2010–11

Decile of number of jobs	2005–06			2010–2011		
	% of jobs	% of house approvals	% of unit approvals	% of jobs	% of house approvals	% of unit approvals
1	0.1	0.1	0.0	0.1	0.1	0.0
2	0.4	0.4	0.2	0.4	0.2	0.0
3	0.7	0.8	0.1	0.7	0.9	0.0
4	1.2	2.5	0.2	1.2	1.3	0.1
5	2.0	2.5	0.4	2.0	3.2	0.1
6	3.3	5.0	3.5	3.3	4.0	0.6
7	5.9	7.7	4.4	6.2	8.2	3.6
8	10.4	17.0	9.1	10.2	13.9	4.2
9	19.4	26.3	23.7	19.3	26.1	43.6
10	56.6	37.8	58.5	56.5	42.1	47.9
Total	100.0	100.0	100.0	100.0	100.0	100.0
N		113,869	23,128		124,984	41,212

Notes: The deciles of number of jobs are measured contemporaneously.

Source: Authors' own calculations from ABS Cat. No. 8731.0 and 2006 and 2011 Census.

2.4 Growth of the housing stock

We now turn our attention to estimates of growth in Australia's housing stock. We analyse growth in the stock of housing (all dwellings), as well as breakdowns into house and unit (flats and apartments) measures. If we can assume that most approvals result in completions, our measure is an estimate of growth in the housing stock since 2005–06 that is *due to new*

[12] This measure specifically refers to the number of jobs within each LGA boundary, as opposed to the number of people employed within an LGA.

construction. If we visualise the 2005–06 housing stock as a cake, the growth measure indicates how much bigger that cake has become *as a result of new construction*.

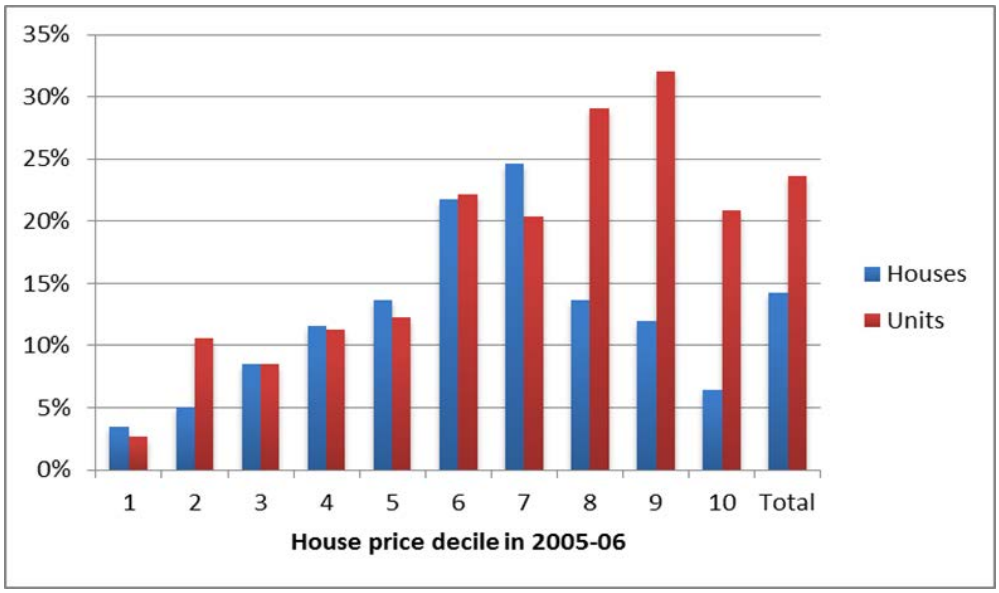
Across the entire nation, housing approvals in the nine years between 2005–06 and 2013–14 have added 15 per cent to the Australian housing stock (17% in GCCSAs). But we can measure the stock of houses and units along different dimensions. It is possible, for example, to divide LGAs into 10 equal sized deciles that are ranked in ascending order according to real median house values (price).[13] A LGA's stock growth estimate can then be assigned to the decile that it has been classified into according to real median house prices in 2005–06. The resulting growth estimates for houses (blue bars) and units (red bars) in Figure 3 indicate the degree to which the stock of houses and units in different value segments have grown *due to new construction* since 2005–06.[14]

Figure 3 shows that approvals are responsible for the strongest growth in the stock of houses in the middle price segments (6th and 7th deciles). Approvals are responsible for the strongest growth in the stock of units in the more expensive market segments; in each of the 8th and 9th deciles the stock of units expanded by around 30 per cent over the study timeframe, perhaps reflecting their concentration in the inner rings of our metropolitan cities where housing is typically most expensive. On the other hand, it is the most affordable areas that have seen the slowest proportionate growth in the stock of both houses and units. In the bottom price decile, approvals have 'grown' the stock of both houses and units by a mere 3–4 per cent.

[13] Thus, if there were 100 LGAs there will be 10 LGAs in each decile; decile 1 will include the 10 LGAs with the lowest median house prices. Decile 10 will include the 10 LGAs with the highest median house prices.

[14] There are some important caveats here. First, because all of an LGA's housing stock is placed in a decile according to its median price, it means that inexpensive housing in LGAs with a relatively high median price is assigned to high value segments, and vice versa for LGAs with a relatively low median price. Hence, while expansion in the stock of housing has been low in those LGAs with the most affordable housing, this need not be a concern if the relatively large expansion of the housing stock in LGAs with expensive housing is due to the construction of affordable housing units. Second, the growth estimates do not measure the *net growth* in the stock of housing in each value segment. This is because changes in each value segment can come about through demolitions, and conversions, as well as additions through new construction. Moreover, established housing back in 2005–06 can subsequently filter (down or up) as a result of depreciation, obsolescence and renovation.

Figure 3: Growth in the stock of houses and units between 2005–06 and 2013–14, by real price decile, per cent



Note: House and unit prices are expressed in real terms by inflating pre-2013 prices to 2013–14 price levels following Consumer Price Index movements. The house (unit) price deciles are calculated based on prices for houses (units) in 2005–06.

Source: Authors' own calculations from ABS Cat. No. 8731.0 and 2006 Census.

2.4.1 Is supply keeping pace with population increases?

This is a critically important question as there is a widespread perception that housing supply has failed to keep pace with population growth and investment demand, especially in larger Australian cities. Two dimensions of the housing supply—population nexus are analysed. In Figure 4 below we calculate growth in the housing (houses and units) stock (since 2006) by summing all (units and houses) approvals over the period 2005–06 to 2013–14, and expressing this aggregate as a percentage of the 2006 housing stock.[15] We also calculate the growth in the population of individuals over the same period using population estimates from the ABS.[16] These calculations are completed both nationally, and for all state and territory capitals. It is intriguing to note that growth in the national housing stock has kept pace with population growth over a nearly decade long timeframe that includes the significant disruption caused by the GFC (both increasing by 17%). However, the picture differs across the state and territory capitals. In Perth, Brisbane and Sydney, increases in the housing stock are insufficient to match the increase in these state capitals' populations. But there are different patterns underlying this common outcome. In Perth population growth was exceptionally strong—indeed faster than any other city with its population soaring (by 2014) to more than one-quarter above 2006 levels. Such rapid growth would stretch the capacity of most housing construction sectors even in the absence of any supply-side impediments. But Sydney's population growth (at 14 %) is below the average across all cities (at 17%). Despite this relatively low increase in its population, housing supply failed to produce a matching increase in the housing stock. House price

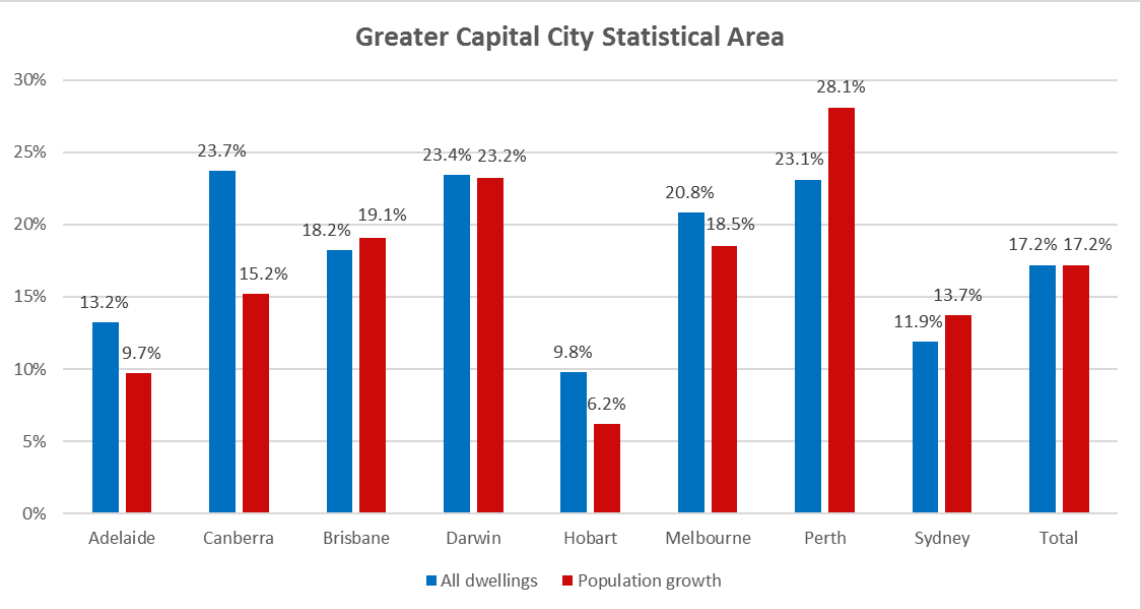
[15] There is a caveat worth repeating. The growth measure is an approximation. Not all approvals will result in completions, and there will have been losses due to demolition and abandonment. Another issue is dwelling renovations that add to living space and are therefore additions to the housing stock, but will not be captured by housing approvals data.

[16] Population estimates are derived from ABS Cat. No. 3235.0—*Population by Age and Sex, Regions of Australia, 2014*.

pressures were intense at times over the study timeframe in both these cities, but it would seem that supply-side barriers are more acute in Sydney. Brisbane's supply and population growth trajectories lie in between those of Perth and Sydney, and housing supply only just fails to match expansion in the city's population.

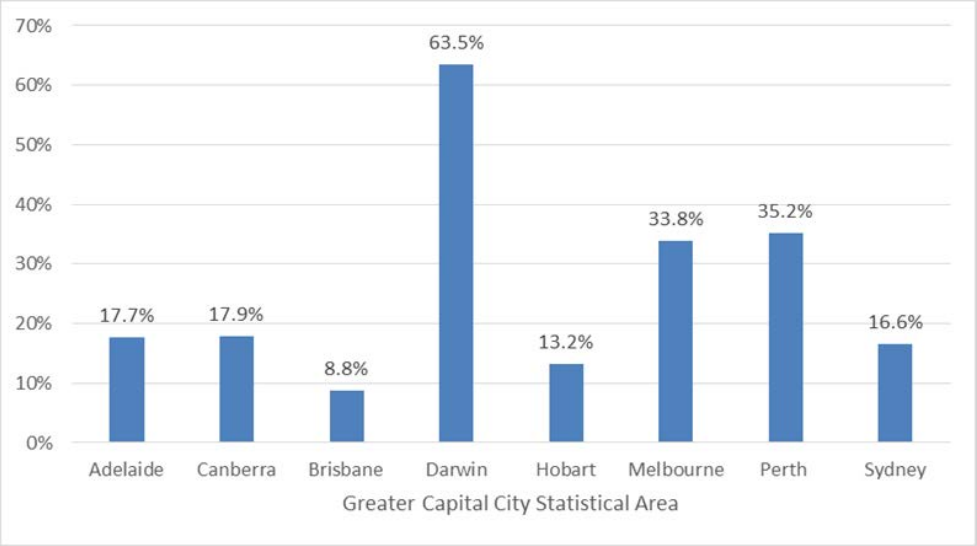
In the remaining cities, housing stocks expanded at a rate surpassing the increase in their populations. In Canberra this outcome is particularly striking as it increased its housing stock by almost one-quarter on the back of very strong growth in units, yet its population increased by a much smaller 15 per cent. It is curious to note that Melbourne increased housing opportunities on a scale that more than matched population growth, yet house prices have surged to be 34 per cent higher than at the onset of the study timeframe (see Figure 5 below). In a puzzling twist, Perth, where housing supply failed to match population growth, price inflation was only slightly higher at 35 per cent. This unexpected finding for 'supply rich' cities is not an isolated one; in Darwin the median house price in 2014 soared by 64 per cent above 2006 levels, even though additions to the housing stock (as a result of new supply) equalled the roughly 23 per cent increase in Darwin's population. The balance between growth in population numbers and expansion in the housing stock due to new housing supply is typically relevant to an understanding of house price pressures. But these comparisons appear to show that there is much more that needs to be understood if we are to account for divergent housing price inflation trajectories across the state and territory capital cities.

Figure 4: Growth in the stock of housing (all dwellings) and population between 2005–06 and 2013–14, by Greater Capital City Statistical Area, per cent



Source: Authors' own calculations from ABS Cat. No. 8731.0, ABS Cat. No. 3235.0 and 2006 Census.

Figure 5: Growth in median house prices between 2005–06 and 2013–14, by Greater Capital City Statistical Area, per cent

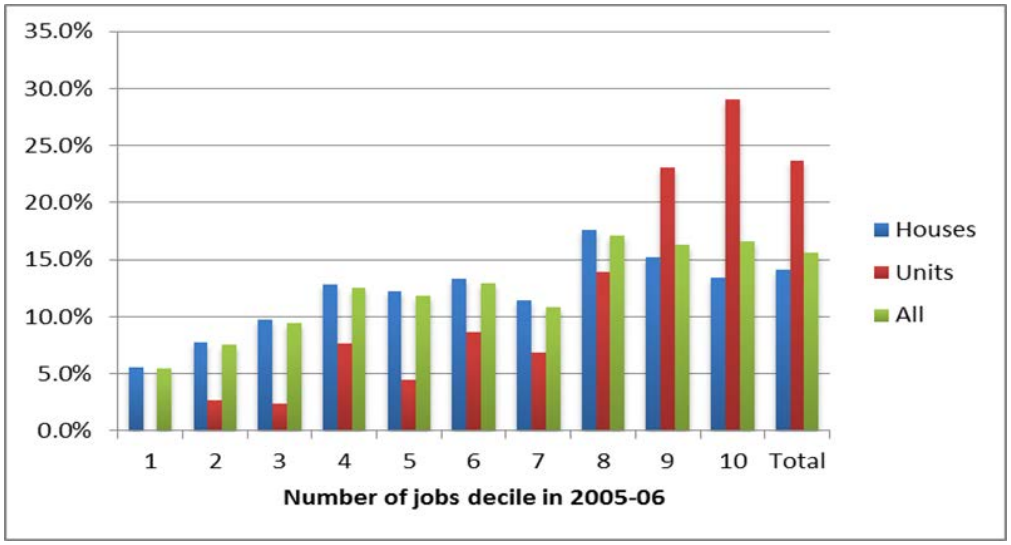


Source: Authors' own calculations from RPData.

2.4.2 Is housing supply growth providing housing opportunities where more jobs are located?

Next, we investigate other dimensions of the housing stock. In Figure 6 below, the deciles are measured based on *number of jobs* in 2005–06. Expansion of the stock of houses has been greatest in the middle to upper population size and job number deciles (7th and 8th deciles). But overall the distribution of house approvals is *relatively* evenly distributed across the deciles. In the case of units, the additions to the stock have been greatest in job rich areas and those with larger populations. The stock of units has expanded by over 25 per cent in each of the two most populous deciles and by roughly 25 per cent in each of the two most job abundant deciles (between 2005–06 and 2013–14). This is strong confirmation that unit approvals are promoting the strongest growth in the housing stocks of areas with plentiful job opportunities. These findings are important because we can expect productivity gains as congestion is eased, and commute times lowered.

Figure 6: Expansion in the stock of houses and units between 2005–06 and 2013–14, by job decile, per cent

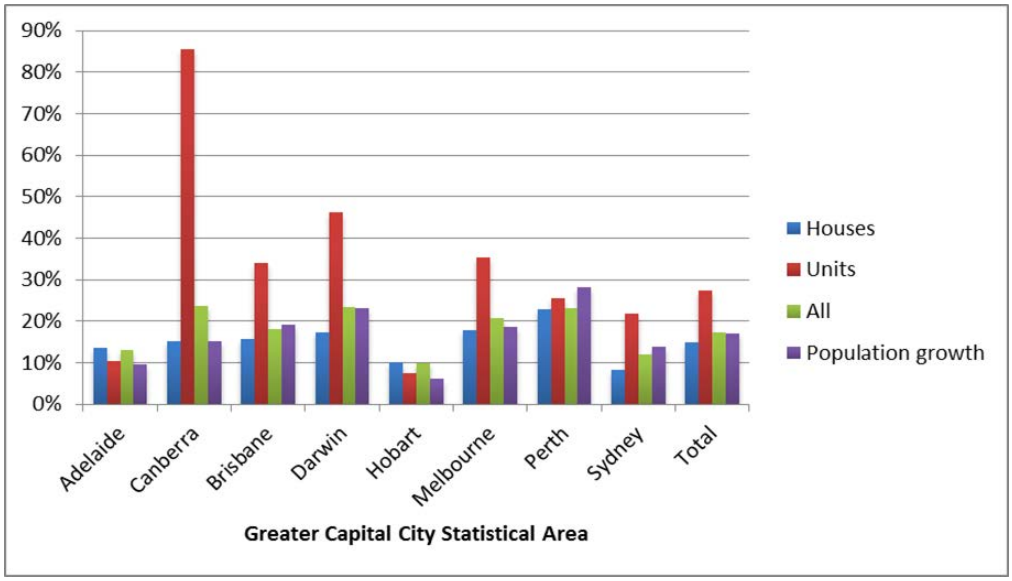


Source: Authors' own calculations from ABS Cat. No. 8731.0 and 2006 Census.

Geographically, there is wide variation in growth of the stock of houses and units by capital city (see Figure 7 below). First, the proportionate increase in housing (houses and units combined) stock has been greatest in the territories. On the other hand, Sydney and Hobart have experienced relatively low growth in their housing stocks. Second, with the exception of Adelaide and Hobart—both housing markets with relatively slow price growth—the stock of units experiences more rapid growth than the stock of houses.

As indicated in Figure 7, the strongest growth in the supply of units has been in the territories (though this is from a low base), followed by Melbourne and Brisbane. However, the strongest growth in the stock of houses has been in Perth, at around 22 per cent, while Sydney has experienced comparatively low growth in its stock of houses, at under 10 per cent.

Figure 7: Growth in the stock of houses and units between 2005–06 and 2013–14, by Greater Capital City Statistical Area, per cent

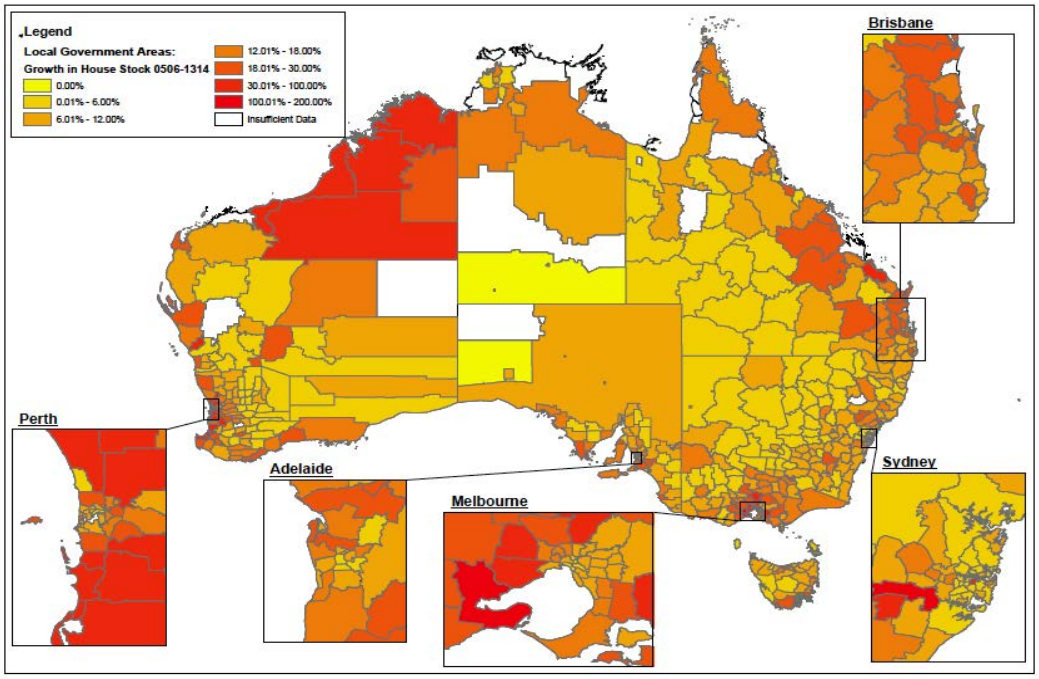


Source: Authors' own calculations from ABS Cat. No. 8731.0 and ABS Cat. No. 3235.0.

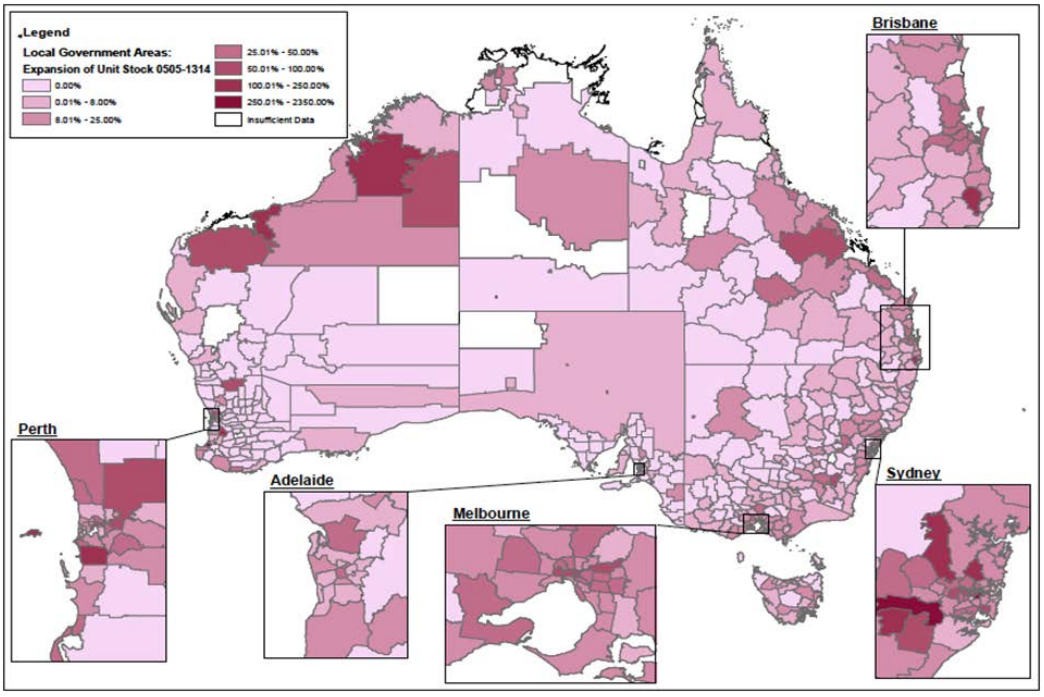
The spatial map in Figure 8 below provides more fine-grained detail. Figure 8(a) illustrates the percentage growth in the stock of houses across LGAs between 2005–06 and 2013–14, with dark red indicating strongest growth and light yellow indicating weakest growth. Similarly, Figure 8(b) illustrates the percentage growth in the stock of units across LGAs between 2005–06 and 2013–14, with light to dark pink representing weakest to strongest growth. The figure indicates that there are intra-city variations in the growth of housing stock. Hence, strong growth in the housing stock in one LGA does not necessarily spill over into all other LGAs within the city. For instance, while Sydney as a whole has experienced a slow growth in the stock of houses, it is clear that there are pockets within the city that have experienced high rates of growth in the stock of houses (as depicted by isolated pockets of red within the Sydney box).

Figure 8: Growth in the stock of houses and units between 2005–06 and 2013–14—a spatial map

(a) Houses



(b) Units

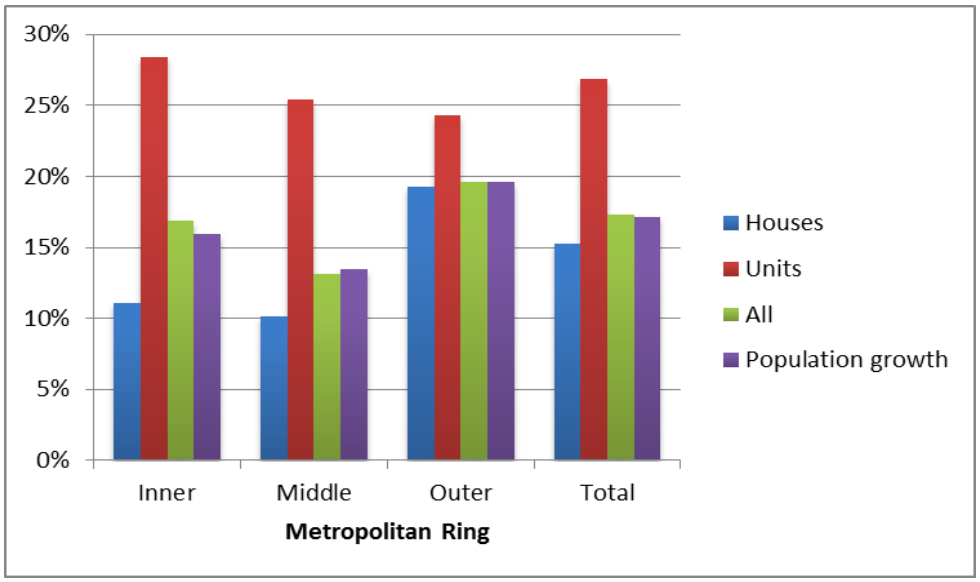


Source: Authors' own calculations from ABS Cat. No. 8731.0.

Contrasting trends are also observed for houses and units across metropolitan rings (see Figure 9 below). Growth in the stock of houses has been greatest at nearly 20 per cent in outer metropolitan rings, compared to just 11 per cent in inner metropolitan rings. On the other hand, growth in the stock of units has been higher in the inner ring (28%) declining gradually at

greater distances from the CBD, falling to 24 per cent in the outer ring. Although the number of unit approvals in the outer rings is low, they translate into a high percentage increase because of a low base figure in 2005–06. On examining growth in the stock of housing (units and houses combined) we find that growth in the housing stock has been relatively weak in the middle ring suburbs of our metropolitan cities. Despite the surge in unit approvals in the inner ring over the study timeframe, growth in the stock of *housing* remains strongest on the 'fringe' (the outer ring of suburbs).

Figure 9: Growth in the stock of houses and units between 2005–06 and 2013–14, by metropolitan ring, per cent



Source: Authors' own calculations from ABS Cat. No. 8731.0 and 3235.0.

2.5 Policy development implications

The housing supply 'problem' has traditionally been pitched in terms of supply failing to keep pace with growing demand (Barker 2004; Senate Economics References Committee 2015). However, this chapter's findings reveal that the housing supply issue is more nuanced, and cannot therefore be captured by a simple comparison between the levels of demand (as proxied by population numbers) and supply. Our descriptive statistics show that the growth in the *national* housing stock has kept pace with *national* population growth over a nearly decade-long timeframe. However, we also discover that most of this growth in housing supply may not be constructed in areas where it is most needed. The findings have important policy implications for the targeting of housing programs that seek to boost the supply of affordable housing, such as NRAS.

A key finding is that new housing supply has been concentrated in mid-to-high price segments, rather than low price segments. New housing supply in high price segments is generally beyond the reach of low-income households as well as first home buyers, and therefore does little to directly increase their access to low cost housing. Housing in low-priced segments is presumably more affordable, but less than 5 per cent of approvals were in the bottom 20 per cent of the house and unit real price distribution in 2005–06, and this remains the case almost a decade later in 2013–14. Indeed, poor targeting was a major concern highlighted in Rowley, James et al.'s (2016a) assessment of the NRAS program, which was in operation during the

timeframe of this report's analysis.[17] Rowley, James et al. (2016a) find that while NRAS delivered a significant boost to the supply of affordable units within a relatively short time, poor targeting afflicted the program, and the report recommended the scheme to geographically target areas in need of affordable housing, including in regional and rural Australia.

While new housing supply in high price segments does little to directly increase the supply of housing that low-income groups can afford, there should in theory be an indirect effect because the prices of existing housing become cheaper as a result of new supply, making it more accessible to low-income households. However, the evidence from studies such as those conducted by Wulff, Reynolds et al. (2011) suggests that affordable rental housing opportunities are contracting. It would seem that the trickle-down effect that new housing supply is supposed to initiate has not eventuated. Policy thinking around housing supply has tended to focus on the number of new approvals and completions of houses and units, with the assumption that 'more must be good' because it eases housing market pressures and expands affordable housing opportunities. The results presented in this chapter suggest that a broader perspective might prove fruitful, especially if future research identifies the structural impediments that weaken the trickle down impact of new housing supply. Evidence-based propositions about the importance or otherwise of structural impediments will help guide the design of policies that seek to remove the relevant impediments.

The geography of new housing supply over the study timeframe reveals some intriguing patterns that deserve attention, because they hint at the importance of location-specific factors that state-based policy frameworks might need to identify and tackle. In some capital cities (e.g. Melbourne, Darwin), new supply appears to have exceeded or at least equalled population growth, but the price of housing has soared. On the other hand, there are some cities (e.g. Perth), where new supply has clearly failed to keep pace with population growth, yet price inflation has not reached the levels attained in cities where supply and population growth are more in balance.

These findings confirm that there is more to learn before we can provide an informed explanation of divergent housing price inflation trajectories across the state and territory capital cities. We examine the importance of some of these factors, including potential structural impediments (e.g. planning regulations, existing land use, cost shifters etc.), in the next two chapters.

There is a positive note to the results reported in this chapter that will please those advocating more compact cities. It seems that the supply of units is concentrated in job rich areas. The spatial correlation between jobs and house approvals is weaker. Houses currently far outweigh units as a share of the housing stock. But this appears to be changing as the market penetration of units grows, especially in our major cities. The urban network linking jobs and residences will be strengthened by these developments. A likely by-product is shorter commutes, which can be an important boost to productivity, especially in large metropolitan economies.

[17] The program commenced in 2008 and was discontinued in 2014.

3 Modelling the drivers of housing supply in Australia

- The estimated price elasticity of new housing supply is 4.7 per cent for houses and 3.9 per cent for units, and lagged effects are apparent. When expressed in terms of the proportionate change in housing stocks, a 1 per cent increase in the level of housing prices will, according to these elasticity estimates, produce a very small expansion in housing stocks of between 0.05 and 0.09 per cent.
- Differences in price elasticity estimates between the supply of new houses and the supply of new units may be attributable to differences in the development processes governing the supply of houses and units.
- Meeting population growth pressures through new *house* supply in already developed areas is more difficult due to topographical constraints and the presence of existing capital improvements.
- The supply of *units* appears to be higher (all else equal) in already developed areas and so measures to further promote their construction could prove an effective pathway to easing price pressures and expanding affordable housing opportunities.

3.1 Existing research on determinants of housing supply responsiveness

The international literature features an extensive pool of studies spanning several decades that model the determinants of housing supply responsiveness. Typically, one of two approaches is adopted. The first relies on econometric models that combine housing supply and demand functions into a single (reduced form) equation. The equation then features variables that represent both supply and demand shifters. The coefficients on these shifters allow the derivation of estimates of the responsiveness of housing supply to demand changes. Examples include Muth (1960), Follain (1979), Stover (1986), Malpezzi and Maclennan (1994), Sinai and Waldfogel (2002) and Malpezzi and Vandell (2002). The second approach focuses on stock adjustments by modelling housing starts as a function of house prices and various cost variables that influence the decision to supply housing (see for instance DiPasquale and Wheaton 1994; Mayer and Sommerville 2000a, 2000b; Zabel and Paterson 2006; Hanak 2008; McLaughlin 2011, 2012). This second approach draws from what is commonly known as the urban growth theory, which postulates that new housing starts constitute additions to the existing stock of housing and are therefore a function of *changes* in house prices (Mayer and Sommerville 2000b).

Most of these studies have been conducted in the UK and US. McLaughlin (2011, 2012) are a couple of rare Australian exceptions that focus on housing supply in state capital cities. It is this gap that the present chapter tries to fill, by offering an econometric analysis of housing supply responsiveness for Australia at a detailed LGA level. Model estimation at an LGA level represents a significant improvement on existing capital city models because it allows identification of more fine-grained differences across housing markets. Furthermore, the impact of local planning controls on housing supply (which we focus on in Chapter 4) can be better captured using LGA rather than city-wide measures.

Typical elasticities generated by existing studies vary widely across time periods, countries and the kinds of models employed. Mayer and Sommerville (2000a) found that in the US, a one percent rise in house prices would yield a 15 per cent increase in new housing starts over a period of five quarters.[18] Malpezzi and Maclennan (1994) found that in the post-World War II period up to the 1990s, the price elasticity of housing was between 6 and 13 in the US but much less elastic at between 0 and 1 in the UK when estimated using a flow model. When they adopt a stock adjustment model, the price elasticities are very different for the US—ranging from 1 to 6—though they remain unchanged at between 0 and 1 for the UK. Whiltehead's (1974) study spans the period 1955–72, and she also found relatively inelastic supply in the UK, with elasticities ranging from 0.5 to 2. Australian studies found that the overall supply response to a 1 per cent increase in house prices in Australian cities is around 4 to 6 per cent over five quarters (McLaughlin 2011), but for multifamily units, it is higher at 17.3 per cent (McLaughlin 2012).

The literature provides a good indication of the plethora of factors that are likely to drive housing supply responsiveness. Price is clearly a key factor, and various studies also include lagged price variables as supply may respond sluggishly to price shocks over several time periods (see for instance Mayer and Sommerville 2000b; Hwang and Quigley 2006; McLaughlin 2012).[19] Cost shifters are clearly important, including both material and labour cost (Sommerville 1999; Hwang and Quigley 2006). Planning regulations are often cited as a constraint on housing supply (Hilber and Vermeulen 2010). Studies have also highlighted the importance of topographical (see Saiz 2010) and climatic constraints (Fergus 1999) on housing supply.

3.2 Model specification

We draw on the urban growth theory, which explains new housing starts as a function of changes in prices. As mentioned in the previous section, this theoretical framework is widely used in the international literature and has informed the econometric approach in a plethora of studies on housing supply.

The modelling is based on an LGA unit of analysis and conducted separately for houses and units over a period of nine years from July 2005 to June 2014. This separation recognises the different house and unit development and constructions phases that imply a different structure to the dynamic relationship between prices and new supply. We exploit monthly variations in building approvals and other relevant data to compile a maximum of 108 records for each LGA (i.e. 9 years x 12 months).[20]

The analysis models the log of building approvals in month *t* as a linear function of the change in the log of price between *t* and *t*-1 within an ordinary least squares (OLS) regression specification. This follows a common approach used in the international literature that derives the price elasticity of housing supply by modelling housing 'starts' as a function of the change in house prices and various cost shifters (see for instance Mayer and Sommerville 2000a and 2000b). These studies also commonly allow for lagged relationships between supply and house prices due to factors such as construction lags. This is captured by including price variables that are lagged up to five quarters.

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[18] While this may seem like a huge increase in supply it is in fact much smaller relative to the size of the housing stock. New construction typically increases the housing stock by between 1 and 2 per cent. According to the Mayer and Sommerville (2000a) estimates a1 per cent increase in house prices will then increase the housing stock by between .15 per cent and .3 per cent over a period of five quarters.

[19] This is especially relevant in the context of units (apartments and flats) because the development and construction phase is much longer than that for houses.

[20] However, there are missing values in the approvals data; not all LGAs have a complete 108 set of records.

An important control variable is each jurisdiction's population size. A larger population means a correspondingly larger number of new households forming in any given month. We therefore enter each of the LGA's 1991 Census population estimates into model specifications. This population figure precedes the onset of the study time frame (2005–14). Our measurement approach helps to address an endogeneity issue that can arise due to reverse causation. While the population size of an area can stimulate new housing supply, it is equally true that abundant housing supply can promote an area's population growth and stimulate new household formation from among a static population. We wish to identify the former and to avoid confounding the two effects; we therefore enter population estimates from a year (1991) that is well before the onset of the study period, and so cannot have been influenced by building approvals between 2005 and 2014.

We also allow for land use, geographic and climatic constraints on housing supply. So, for example, the extent of the land that is covered by water bodies or has already been built up is accounted for in model specifications. Following Saiz (2010), who found that geography is a key determinant of urban development in the United States, we include the percentage of each of the LGA's land area with gradient greater than 15 per cent. Residential development on land characterised by steep slopes is more costly. Climatic constraints are measured by a series of variable(s) representing average precipitation, temperature ranges and climatic zones. This also helps control for the influence of seasonality on housing construction activity. These variables are novel additions that have not previously been experimented with in Australian housing supply studies. Finally, calendar year indicators are included as crude proxies to represent prevailing macroeconomic settings (including interest rates that are uniform across LGAs) and housing market cycles, while state capital indicators capture unobservable capital-specific factors that might shape supply conditions.

We begin with a model that excludes the planning variables, which are reserved for a more focused analysis in Chapter 4. In algebraic terms, the model is therefore expressed as follows:

$$\log BA_{it} = f\,(\Delta\log Price_{it.t-1} + \Delta\log Price_{it-1,t-2} + \Delta\log Price_{it-2,t-3} + \Delta\log Price_{it-3,t-4} + \Delta\log Price_{it-4,t-5} + \Delta\log Price_{it-5,t-6} + \Delta\log Price_{it-6,t-7} + \Delta\log Price_{it-7,t-8} + \Delta\log Price_{it-8,t-9} + \Delta\log Price_{it-9,t-10} + \Delta\log Price_{it-10,t-11} + \Delta\log Price_{it-11,t-12} + \Delta\log Price_{it-12,t-13} + \Delta\log Price_{it-13,t-14} + \Delta\log Price_{it-14,t-15} + \Delta\log Price_{it-15,t-16} + logCost_{it} + logPop_{it} + logLUse_{it} + Clim_{it} + logTop_{it} + Year_{it} + Statecaps_{it})$$

where

i indexes LGAs

t represents time periods (months)

BA = Number of building approvals

Δ*Price* = Change in real median price

Cost = Cost of construction

Pop = Area population in 1991

LUse = Land use

Clim = Climate indicator variables

Top = Topographical constraints

Year = Calendar year

Statecaps = a vector of state capital dummy variables (regional (rest of) Australia omitted).

All continuous variables are converted to natural logarithms; detailed definitions of the variables can be found in Appendix 1. Descriptive statistics for the dependent variable and vector of explanatory variables are presented in Appendix 2, Table A2(a).

There is an estimation sample of 495 LGAs used in the descriptive statistics for house approvals and 331 LGAs in the unit estimation sample. There is a different number of LGAs because price data is missing in only some months of the timeframe and invariably it is missing for units but recorded for houses. We therefore have two unbalanced panel data sets used in the estimation of the unit and house supply models. The total number of observations in the house supply model is 42,880; the total number of observations in the unit supply model is 26,721.

We present descriptive statistics for the house and unit sample separately. Over the time frame 2005–06 to 2013–14 there are 22 average monthly house approvals, double the 11 average monthly unit approvals. There is considerable variation around this average, as is to be expected given the huge LGA population range (minimum less than one thousand, and maximum a little over three quarters of a million). The variation in monthly unit approvals is especially large.[21] This reflects the large number of zero monthly unit approval figures; 89 per cent of unit monthly approvals are zero.[22] This is much less common for house approvals (26% of house monthly approvals are zero). On the other hand the strong surge in unit approvals in the inner city areas of Sydney and Melbourne produce some observations with monthly approvals exceeding 1,000 (the maximum is 1,748). Monthly house approvals never exceed 1,000 (the maximum is 836).

Descriptives for the explanatory variables suggest that each has substantial variation around the average. Only two weather variables have coefficients of variation less than 1. Variation in the explanatory variables is necessary in order to detect causal effects; lack of variability is thus unlikely to impede identification of effects if present. Over 50 per cent of LGAs have less than 1 per cent of their land area covered by water; steep gradients are a somewhat more important supply impediment with an average of between 11 per cent (houses sample) and 14 per cent (unit sample) of LGA land areas featuring gradients in excess of 15 per cent (though the medians are well below the averages). One of the variables with a wide range of values is the percentage of a LGA land area that has been built up. There are a few LGAs in our metropolitan cities that have completely (100%) developed land areas; in these areas new build requires demolition of existing buildings, subdivision or adding stories to existing low rise buildings. But the majority of LGAs in the house sample have less than 1 per cent of their land areas developed (only 4% in the unit sample).

3.3 Key findings

A full set of coefficient estimates from the econometric model discussed in this chapter is provided in Appendix 2, Table A2(b).

A summary of the key findings and their interpretation is provided below. The model for houses performs very well in terms of ‘fit with the data’ (adjusted R-squared of 0.655), indicating that the variables when combined in a log linear model are capable of ‘explaining’ almost two-thirds of the variation in house building approvals. The F-stat is statistically significant at the 1 per cent level (as indicated by the triple asterisks), again suggesting an overall significant model. The model for units is weaker in terms of the adjusted R-squared, which is unsurprising in view of the high proportion of observations with a zero supply value, but the F-stat indicates that it is also an overall statistically significant model.

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21 The coefficient of variation is 4.9; and a much smaller 2.1 for monthly housing approvals.

22 This raises econometric issues that will need to be addressed in future research. OLS estimation will be inefficient and an estimation technique such as the Tobit model is appropriate. The estimates obtained for the unit supply equation must be treated with extreme caution given that 89 per cent of unit observations are zero.

Turning to the 'houses' model first, we interrogate the magnitude, direction and significance of the price coefficients in this model, the key coefficients as far as the price responsiveness of building approvals is concerned. Note that the change in price variables—both current and lagged—is positive and highly significant. So, for example, the sum of the statistically significant coefficient estimates suggest that a 1 per cent increase in real house prices results in a temporary 4.7 per cent increase in new approvals spread over the current and ensuing 15 months. It is worth noting that such a response represents a very small addition to the stock of houses of between 0.05 per cent and 0.09 per cent (given that approvals add between 1% and 2% to the stock of houses). The effects spread over 15 months reflect lags in approval processes; they suggest that developers must anticipate future demand and may need to 'bank' developable residential land in order to meet upswings in demand.

Higher construction material costs are linked to lower housing supply, as indicated by the negative and significant coefficient on the construction materials index variable. However, higher construction labour cost appears to be linked to greater housing supply. This is surprising, but could reflect the fact that more housing is being supplied in areas with higher demand for housing which pushes up the wages of construction workers. As expected the population variable is positive and highly significant; areas with large populations generate correspondingly higher new household formation as compared to areas with low populations. The coefficient on the population variable suggests that a 1 per cent increase in population is matched by an almost 1 per cent increase in house supply, and so there is a unitary population elasticity of house supply.

Most of the geography and climate variables work in the expected direction. LGAs with high proportions of their land already developed, or featuring gradients in excess of 15 per cent tend to have a lower housing supply 'all else equal'. These constraints on supply are strongly statistically significant as are variables measuring climate conditions. We find that higher levels of precipitation, and more extreme temperature ranges, have adverse supply impacts. Looking through the climate zone category variables, the estimated coefficients suggest that relative to a reference category of climate zone 1 (high humidity summer, warm winter), areas with dry summers tend to have lower levels of house supply, while areas with more temperate climates have higher levels of house supply. The one unexpected finding is the suggestion that areas with a higher proportion of surface area covered by water attract a greater supply of houses. While land covered by water cannot ordinarily be built on, it is an attractive topographical feature that may favour new development in the vicinity. The calendar year variables are negative and increasingly so, perhaps picking up a longer run decline in the capacity of the Australian housing sector to increase supply. The state capital variables are also of interest because they show that supply at any given configuration of the other explanatory variables (including price) is higher in regional Australia. The supply side of the Sydney market is considerably weaker than that in regional Australia with monthly approvals running at only 36.9 per cent of those in regional Australia (all else equal).[23] These findings could be especially worrying as they are uncovered after controls for topographical and climate constraints have been accounted for. However, we do detect a significant recovery on the supply side of the Sydney market in the post-GFC era. This is also apparent in Melbourne.

The 'units' model estimates present some interesting similarities and differences from the 'houses' model though we once again note that results should be treated with caution in view of the high proportion of zero observations for the critical dependent variable. The effect of price on unit supply appears to be weaker than for houses, though the price-supply link still exists for

[23] The 36.9 per cent estimate is obtained from (exp(α)-1)*100, where α is the estimated coefficient on the statistically significant non-interacted and interacted Sydney variables (see Halvorsen and Palmquist1980).

units. A 1 per cent increase in real house prices results in a temporary 3.9 per cent increase in new approvals spread over the current and ensuing 15 months.

Large populations matter, but not quite as strongly as for houses. An uneven topography is a hindrance to supply-side responses, and more so for units than houses. But other geographical variables work differently. An LGA that has already been built up tends to have a higher supply of units than LGAs with abundant greenfield sites. This is the opposite of findings with respect to houses, but makes some sense. In densely populated urban areas where undeveloped land is scarce, clearing sites for multiunit development is a more economic and efficient response to housing market pressures than detached housing.

Higher construction costs are positively linked with the supply of units, which is less easily explained. Once again reverse causation may be the source of biased estimates here; a strong supply-side response in housing markets can be the source of bottlenecks in supply chains that cause the prices of materials and capital equipment to soar.

As in the case of houses, extreme temperature ranges can negatively impact on the supply of units. A greater supply of houses is seen in areas with lower rainfall. Areas with high humidity and warm winters appear to be more conducive for the construction of both houses and units.

The calendar year and state capital category variables offer a fascinating account of temporal and spatial patterns on the supply side of the market in units. The series of calendar year dummy variables confirm a declining underlying trend (once account is taken of other factors), but this time the coefficients are insignificant, and their magnitudes are much smaller than the state capital indicator variables. Geography is more important and so the key findings are revealed by the state capital indicator variables, and particularly the interactions with calendar year dummies. They suggest that relative to regional Australia, and *after controlling for topography and other influences on supply*, Adelaide, Hobart and Perth generally issued lower levels of monthly unit approvals over the study timeframe. On the other hand, Canberra achieves a very strong outcome. The largest cities—Melbourne and Sydney—offer a more complicated picture as revealed by the combination of state capital indicators and their interaction with calendar year variables. They show that in the early years of the study timeframe the supply of units in these cities actually fell below that in regional Australia (all else equal). But in Sydney and Melbourne this situation was quickly reversed (by 2012 in Sydney, and 2009–10 in Melbourne) with a surge in unit approvals to levels well above those in regional Australia.

3.4 Policy development implications

As outlined in Section 1.1, the price responsiveness of housing supply has important implications for productivity in both metropolitan and regional economies. The high housing costs that are a consequence when housing supply is price inelastic are a drag on local, metropolitan and regional economic growth. They depress the real incomes of households in communities affected, and local firms' business/sales are adversely impacted, exacerbating downside impacts on the local economy. In regions with productivity gains inelastic housing supply can stifle regional economic growth as higher house prices and rents ignite a spiral of 'catch-up' wage claims; productivity gains result in higher prices and wages rather than translating into employment and economic development gains

Our model results show that the estimated price elasticity of new housing supply is 4.7 per cent for houses and 3.9 per cent for units, and lagged effects are apparent. These elasticity estimates are significantly lower than those for the US. For instance, Mayer and Sommerville (2000a) estimated a price elasticity of 15 per cent using the same econometric approach. Furthermore, these supply responsiveness estimates actually imply an increase in housing stocks of much smaller percentage increments. Thus a 1 per cent increase in the level of

housing prices will, according to these elasticity estimates, produce a very small expansion in housing stocks of between 0.05 and 0.09 per cent. When populations are increasing at 1 per cent or more per annum, as has been the case nationally over the study timeframe (see Chapter 2), a 1 per cent increase in housing price levels will do little to close any gap between supply and the housing needs of growing populations. However, the modelling estimates suggest that a more complicated set of factors shape a region's capacity to meet the housing needs of a growing population (see below).

There are also differences in price elasticity estimates between the supply of new houses and the supply of new units. The latter shows a weaker responsiveness to changes in prices. These differences could in part be due to statistical issues that make it especially difficult to precisely estimate unit price elasticity estimates. However, to the extent that estimates are reliable, the divergence in elasticity estimates could be attributable to distinct differences in the development processes governing the supply of houses and units. The development process for units is less orderly and more contingent, with potential barriers at each stage of the development process including site identification, feasibility appraisal, site assembly, development approval, pre-sales of apartments, obtaining development finance, construction and completion involving settlement of pre-sales and sale of remaining apartments (Rowley, Costello et al. 2014). The implications of this finding for policy development are discussed in detail in Chapter 5.

Finally, the importance of topographical constraints and history is worthy of comment. Our results suggest that both topography and history matters, and especially the gradient of land areas which has a negative impact on supply. Urban areas that are hemmed in by hilly or even mountainous terrain will then be disadvantaged when it comes to meeting population growth pressures. Past development is also a potential constraint. The presence of capital improvements on land implies that new supply on that land can only come about through renovation or demolition and clearance in preparation for new build. The supply of *units* appears to be higher (all else equal) in already developed areas and so measures to further promote their construction could prove an effective pathway to easing price pressures and expanding affordable housing opportunities.

The findings on the importance of topography and existing development, as well as the climate variables, suggest considerable heterogeneity in supply responses to the demand pressures accompanying population growth. It seems that housing prices are but one of a number of drivers of housing supply. The econometric estimates suggest that nationwide the supply of *houses* will increase to match population growth (the population elasticity estimate is close to one), but in regions where a high proportion of land is already built up, the topography is difficult due to an uneven terrain and levels of precipitation are relatively high, supply adjustments will be weaker. There may then be spillover effects as unmet housing needs are displaced and met in regions where these impediments are not present.

The findings and conclusions based on them are tentative given that econometric models of Australian housing supply processes are at such an early stage of development. There are numerous caveats regarding statistical methods where refinements will be a critical future direction for research, which are described in detail in Section 6.2. They are also open to the objection that models exclude planning controls, and results could be sensitive to their inclusion. We address this issue in the next chapter.

4 Land use, planning and housing supply

- Thinking on Australian planning reform as a supply measure needs to extend beyond a simplistic linear approach that assumes that the more restrictive the measure, the greater the barrier to housing supply.
- Our findings reveal that growth accommodating controls are positively correlated with both house and unit approvals while growth restricting controls are negatively correlated with both house and unit approvals. However, the size of the impact is marginal for both types of controls and not statistically significant in the case of restricting controls.
- This is not to say that planning regulations necessarily have little impact on housing supply responsiveness in a local area. Often the most important aspect of the planning system from a developer's point of view is the certainty and consistency of advice provided by planning officers. Planning controls may be generally restrictive but if they are applied clearly and consistently, the developer can work with them and deliver housing.

One of the more contentious debates around housing supply is the role of land use planning and building codes. We are fortunate to have access to a rich data base containing measures describing the range of planning instruments that local governments use. It was assembled from the Australian Urban Land Use Planning Policy (AULUPP) Survey. We report measures of the number of controls used by different local governments, and describe their nature by cross-tabulating planning control measures with variables representing various housing market characteristics such as price segments and housing supply. The chapter is concluded by a discussion of results from a housing supply model that includes planning variable measures that have been sourced from the AULUPP Survey.

4.1 Existing research on planning regulations and housing supply

Internationally, a number of studies have used econometric models to examine differences in local regulatory settings, land and housing supply constraints, and implications for the quantity and price of new homes at local and regional scales (White and Allmendinger 2003; Gyourko, Saiz et al. 2008; Glaeser and Ward 2009). The majority of this work originates from the US and the UK, which are characterised by different planning systems (see Section 1.2). Like Australia, planning responsibility in the US sits with the states and local governments, and a variety of regulatory systems have evolved. Land use zoning and detailed development controls (expressed through legal ordinances) represent the main form of planning regulation across North America, and local authorities typically have significant leeway in defining and implementing these local instruments. The practice of 'exclusionary zoning' where land use zones explicitly prevent diverse housing types and other forms of development, arose in many parts of the US, with clear implications for the supply of affordable housing (Fischel 2004). Similarly the application of strict 'growth management' regimes which constrain residential land supply without providing alternative opportunities, has also been shown to reduce new housing development, with price effects in high demand locations (Landis 2006). The planning system in the UK operates within a national framework, and uses a discretionary, merit-based approach to decision-making rather than land use zoning. Nevertheless local constraints to development,

through strict 'greenbelt' policies for instance, have also been shown to limit housing supply with flow on implications for price (White and Allmendinger 2003; Leishman and Bramley 2005).

Several studies have used econometric models to examine differences in local regulatory settings and supply constraints, but the reliability and transferability of findings is heavily dependent on the quality of the data and assumptions used (Bramley and Watkins 2014; Hincks, Leishman et al. 2013). A comparative approach is typical with researchers exploiting actual variations in local planning control, to explore potential relationships between regulatory settings and differences in housing supply outcomes. Owing to the difficulty of obtaining data on local planning frameworks, particularly under discretionary systems, a number of studies have used process-based indicators of regulatory constraint—such as local differences in decision speeds (Ball 2011), or rates of planning approval / refusal (Hilber and Vermeulen 2014)—to test for housing market impacts. However, the validity of these measures is questionable since more complex and higher value development contexts would usually attract more complex and non-complying proposals (Bramley and Watkins 2014). Over the past decade, research efforts in the US have focused on collecting comprehensive data on local planning regulations. While the majority of work in this area has focused on single jurisdictions, more comprehensive, national data has been collected through surveys (e.g. the postal survey by Pendall, Puentes et al. (2006) of local planning approaches across 50 US metropolitan areas). The collection of papers in Ihlanfeldt (2004) offers a helpful overview of US evidence.

Since the primary regulations governing housing development in Australia are prepared at the local government level (within a policy and legal framework set by the states), there is considerable variation in the content of local plans, including objectives, policies and tools for development control, across local government areas. This scope is somewhat narrowed by state governments' capacity to govern the content and format of local planning instruments. Over the past decade or so, state policy has generally sought to contain the outward expansion of urban areas, encourage more sustainable urban form and design as well as diversify housing development, particularly in accessible locations near transport nodes. While these directions should generally be reflected in local planning instruments, variation in the extent to which these goals are addressed and how they are implemented remains.

It is often thought that this variation influences patterns of new development and impacts local housing market conditions. In particular, more restrictive land use planning settings, often adopted in higher value or established suburban areas are seen to represent barriers to new and more diverse housing development, including higher density and non-traditional dwelling types (McLaughlin 2014). However, empirical examination of the impact of local planning regulations is challenging owing to the difficulty of capturing data on the content and regulatory character of local planning instruments, and the lack of systematic auditing or state level review of planning instruments, which are prepared and amended at different points in time and in response to changing development pressures and circumstances. A previous study has sought to overcome this data gap by the use of proxy measures such as development approval rates, which vary between cities, but with few demonstrable implications for the housing market (Otto 2007).

4.2 Australian Land Use Planning Policy (AULUPP) Survey

The core analysis in this chapter is based on a rich data set describing LGA's use of planning controls that has been informed by US-based surveys on local planning controls. To address the data gaps outlined above, the Australian Urban Land Use Planning Policy (AULUPP) survey was designed to capture information on the content of local planning schemes across Australia (for a fuller description see Gurran, Gilbert et al. 2013, 2014). The AULUPP survey is a valuable source of information on local planning approaches to encourage sustainability (including sustainable urban form and building design, biodiversity conservation, and environmental

protection), housing choice and affordability (including objectives and provisions to encourage diverse dwelling types). It identifies the presence or otherwise of over 350 individual planning interventions. The extensive range of interventions includes the type of planning tools thought to constrain housing supply and inflate house price (e.g. urban growth controls and density restrictions), as well as ones that might facilitate housing supply (e.g. permissive zoning). The measures of land use planning that emerge from this survey are the most sophisticated to have been used in Australian housing supply studies.

The range of specific tools and development controls for inclusion in the survey was refined by analysing a sample of local planning interventions from each of Australia's six states and two territories. This identified the range of regulatory measures that address environmental sustainability goals and manage housing development within different state planning frameworks; helped to identify differences in nomenclature; and, ensured that the full range of potential mechanisms used to regulate housing development were captured. An expert group of planning professionals with experience across the different Australian jurisdictions reviewed the survey instrument. It was then piloted with a group of practicing planners. The survey's practical application was tested by creating a 'dummy' instrument that was then trialled with masters level planning students.

The final survey instrument, which used a matrix design and a tick-box format, captured information on over 350 specific regulatory settings (see Appendix 3 where these regulatory controls are listed). Survey questions addressing zoning for residential and mixed use development elicited information on primary forms of density control (e.g. height limits, minimum lot sizes, and site coverage restrictions); the permissibility (subject to assessment) of diverse dwelling types; requirements for sustainable urban design features (e.g. passive energy use and water sensitive urban design); special environmental protections (e.g. wildlife habitat corridors, special environmental impact assessment requirements or referrals to other government agencies); and the inclusion of objectives or requirements relating to diverse and/or affordable housing. The survey was designed for completion by any qualified professional making reference to publically available local planning instruments.

The first AULUPP survey was conducted online between 2007 and 2009 and therefore represents the nature of planning controls nearly midway through our study period. All local governments in Australia (there were 583 LGAs in 2015) were invited by email to complete a survey (accessible by a secure URL). This approach yielded 59 local government returns. To ensure the consistency and quality of the data collected, a research assistant with planning qualifications was able to verify results with reference to the primary planning controls for each locality.

To supplement the local planner returns, a further 232 surveys were completed by researchers with planning qualifications. They completed the survey through content analysis of applicable local planning instruments. The researcher returns focused primarily on the largest population centres, with the aim of achieving complete survey coverage of the four largest metropolitan regions (i.e. Sydney, Melbourne, Brisbane and Perth). The final dataset (incorporating local planner and researcher returns) included data on 291 local plans, equivalent to around half of local government areas in Australia *at the time the survey commenced*.[24] The limited sample coverage is a potential source of sample selection bias, which needs to be heeded when interpreting the results. However, this is likely to be a more important qualification with respect to regional rather than urban Australia, as coverage of the latter is more complete. We take this point up again in more depth later in the chapter.

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[24] By 2014–15, 39 of these 291 LGAs surveyed ceased to exist, leaving a surviving number of 252 LGAs in 2014–15.

While we recognise that local planning decisions may be influenced by policies and regulations not embedded or referred to within the primary planning intervention, a focus on the legally enforceable local plan assisted consistent reporting across a heterogeneous range of local municipalities in Australia.

To analyse the survey data, responses were coded using ones and zeros, with one indicating a positive response (i.e. the control is present/employed in the plan) and zero indicating a negative response (i.e. the control is not present/employed). This enabled straightforward count measures (frequencies) to be calculated for each survey question and across each planning instrument in the sample.

The initial analysis of planning constraints involved calculating frequencies for each survey question in order to assess variation in policy orientation and statutory plan content. A cumulative score was calculated for each LGA based on the overall number of planning controls employed by the local government. This measure captures differences in the scope of policy adoption, and is documented in Section 4.3 below. However, it should be noted that a higher number of planning controls does not necessarily mean that one local government area seeks to be more 'restrictive' in its approach to regulating housing development. Some of the measures captured in the survey—such as the inclusion of zones for higher density housing, or mixed uses—aim to accommodate or encourage higher levels of residential development. The analysis reported below uses a classification of planning interventions into growth accommodating and restrictive groups (see Appendix 3 where planning controls are classified). According to this broad classification, there are more growth restrictive settings (239) than growth accommodating (111). Nevertheless, a plan could according to the survey contain a high number of planning controls, yet the composition of those interventions might be primarily growth accommodating.

A second stage of the analysis examined variations in the degree of relative regulatory constraint between local planning jurisdictions using weighted measures. Two weighted measures were constructed: a weighted score focusing only on the extent of growth restricting controls; and a weighted measure focusing only on growth accommodating controls.

To construct these measures, planning controls were characterised as either growth accommodating, growth restrictive or neutral, based on their interpretation in the planning literature and the findings from interviews with developers and planners across major metropolitan regions of Australia. Each control is multiplied by a factor of 1, 2 or 3 to reflect the degree to which a control is accommodating or restrictive. In the case of growth accommodating instruments, a score of +3 indicated the highest degree of growth accommodation (e.g. high density residential zoning); in the case of growth restricting instruments, a score of +3 indicated the highest degree of growth restriction (e.g. height limitations; minimum lot size requirements). The two measures are summarised in Table 4 below. The scores assigned to growth accommodating and growth restricting controls are also reported in Appendix 3.

Table 4: Summary of regulatory measures

Measure	Explanation	Interpretation
Weighted score—growth accommodating	Surveyed planning controls were valued on a scale of 0 to 3, with 3 being most accommodating of growth. This measure is the sum of the weighted value of all the planning controls deemed to be accommodating of growth in the LGA.	A high score will reflect: (i) a high number of growth accommodating controls that an authority employs, or (ii) high weightings ascribed to the growth accommodating controls, or (iii) a combination of (i) and (ii).
Weighted score—growth restricting	Surveyed planning controls were valued on a scale of 0 to 3, with 3 being most growth restricting. This measure is the sum of the weighted value of all the planning controls deemed to be growth restricting in the LGA.	A high score will reflect: (i) a high number of growth restricting controls that an authority employs, or (ii) high weightings ascribed to the growth restricting controls, or (iii) a combination of (i) and (ii).

Source: Authors; adapted from Rowley, Gurran et al. (2016b).

One important limitation of the AULUPP survey is that information on planning controls is not able to be connected to the cadastral system as a quantitative measure of land parcels subject to different levels of planning constraint. This is a common limitation across other studies of this nature. Thus, AULUPP data should be interpreted as a measure of the regulatory *stance* of a local area.

4.3 Descriptive statistics on local planning controls

We begin by describing the number of controls that local governments typically employ. A simple count measure of each local government's cumulative number of planning controls indicates that across the 252 local governments sample the average is 27 controls (the median is 28.5). However, there is some variation around these measures of central tendency.[25] Table 5 below offers a more complete picture; local governments are grouped into 10 bands of equal length ranging from 1–9 controls through to between 90 and 99 controls. Very nearly 50 per cent of local governments use between 10 and 29 controls; one-third (81) of all local governments are relatively active regulators that apply between 30 and 49 controls. A small number (23) use 50 or more interventions.

[25] The standard deviation is 16.

Table 5: Frequency distribution of LGAs by number of planning controls

Ranges	No. of LGAs	Per cent
0	3	1.2%
1–9	21	8.3%
10–19	53	21.0%
20–29	71	28.2%
30–39	53	21.0%
40–49	28	11.1%
50–59	9	3.6%
60–69	8	3.2%
70–79	4	1.6%
80–89	1	0.4%
90–99	1	0.4%
Total	252	100%

Source: Authors' own calculations from the AULUPP Survey.

Table 5 is an aggregate count measure. But as explained earlier in our report a distinction can be drawn between growth accommodating and growth restricting controls. The direction and strength of their impacts on housing supply (and other planning outcomes) is likely to differ. Hence, the following descriptive analyses present statistical measures on the two types of controls separately.

4.3.1 Growth accommodating planning controls

In Table 6 below, LGAs are again grouped into 10 bands of equal length. A simple count measure shows that a little over two-thirds of local governments use fewer than 10 growth accommodating interventions. One-quarter use between 10 and 19 controls, and less than 1 in 10 use 20 or more accommodating controls. On average, local governments employ around nine growth accommodating planning controls (the median is 7).

Table 6: Frequency distribution of LGAs by number of growth accommodating planning controls

Ranges	No. of LGAs	Per cent
0	10	4.0%
1–9	158	62.7%
10–19	65	25.8%
20–29	16	6.3%
30–39	2	0.8%
40–49	1	0.4%
50–59	0	0.0%
Total	252	100%

Source: Authors' own calculations from the AULUPP Survey.

In Table 7 below LGAs are first assigned into 10 equal groups (deciles) according to *median house* prices; mean and median number of controls are computed for each decile (as well as the standard deviation). Then LGAs are assigned into deciles according to median *unit* prices, and the same measures computed. There is some evidence of a positive association between *house* prices and the overall number controls. In the low (high) price segments the typical number of controls is below (above) the overall average of 8.7. But when LGAs are grouped according to median *unit* prices there are fewer signs of any systematic relationship.

Table 7: Average number of growth accommodating planning controls, by price deciles

House price decile	Median	Mean	Std	Unit price decile	Median	Mean	Std
1	7.5	6.4	4.3	1	6.0	6.7	3.8
2	7.0	6.6	4.4	2	6.0	8.2	6.3
3	5.0	5.1	3.7	3	6.0	8.1	6.4
4	5.5	7.8	7.9	4	8.5	9.7	8.0
5	6.0	7.3	5.8	5	9.0	9.9	6.0
6	9.0	9.7	5.4	6	11.0	13.0	10.9
7	13.0	14.5	9.2	7	9.0	11.6	7.6
8	8.5	9.7	9.0	8	6.5	7.7	5.5
9	8.0	9.0	5.4	9	9.0	9.1	4.8
10	6.5	8.8	6.7	10	7.0	10.1	7.5

Note: Price deciles are measured in the year 2008–09.

Source: Authors' own calculations from the AULUPP Survey and RPData.

We now group LGAs into deciles according to their median household income. According to Table 8 below local governments with higher socio-economic status (SES), as proxied by median household income, are inclined to employ an above average number of growth accommodating controls. Local governments with median household incomes below the 50th percentile typically have a below average number of growth accommodating controls in their local planning instruments, and vice versa. The income range across these local authorities is wide; in the 10 per cent of local governments with the lowest median weekly household incomes, the midpoint of the range is $392, while the midpoint of the range in the 10 per cent of local governments with the highest median weekly household incomes is $2,248, more than five times that in the lowest socio-economic range.

Table 8: Average number of growth accommodating planning controls, by median household income decile

Median household income decile	Income band ($)	Median	Mean	Std
1	0–784	5.0	5.5	4.1
2	785–837	6.0	5.9	4.8
3	838–886	7.5	7.6	4.8
4	887–939	9.0	8.6	5.8
5	942–999	5.0	6.8	5.8
6	1,003–1,077	8.0	9.6	8.2
7	1,078–1,181	11.5	14.5	11.6
8	1,183–1,360	9.0	9.8	5.9
9	1,361–1,639	6.0	8.3	5.9
10	1,657–2,839	7.0	8.7	6.7

Note: Median weekly household income is measured in 2011.

Source: Authors' own calculations from the AULUPP Survey and 2011 Census.

The percentage increase in housing stock (2006–14) achieved by our sample of LGAs ranges from only 2 per cent in the 10 per cent of LGAs that have achieved the smallest increases in housing stock, to 45 per cent in the 10 per cent of LGAs that have achieved the largest increases in housing stock.[26] Table 9 below presents the mean (and median) count measures of growth accommodating planning controls in each decile, where on this occasion deciles are organised according to the percentage increase in housing stock. We find those LGAs where housing supply has produced the strongest (weakest) increases in housing stock tend to employ an above (below) average number of growth accommodating controls.

[26] See Section 2.4 where the approach to measurement of increases in housing stock is described.

Table 9: Average number of growth accommodating planning controls, by percentage increase in housing stock decile

Decile of percentage increase in housing stock	Bound (%)	Median	Mean	Std
1	0–3.2	5.0	5.9	2.9
2	3.3–4.9	6.5	8.6	7.3
3	5–6.4	4.0	7.1	10.0
4	6.4–8	5.0	8.1	7.1
5	8–9.7	7.0	9.2	6.6
6	9.7–12	8.0	9.5	7.6
7	12–14.1	8.0	8.3	4.8
8	14.1–17.6	9.0	10.4	5.9
9	17.6–25.7	6.5	8.1	5.9
10	25.9–242.2	9.0	10.4	7.9

Source: Authors' own calculations from the AULUPP Survey.

4.3.2 Growth restricting planning controls

We now turn our attention to growth restricting planning controls. Table 10 below shows that under one-fifth of local governments use fewer than 10 growth restricting interventions. On the other hand, almost two-thirds use between 10 and 30 controls. The mean (median) number of growth restricting planning controls is 19.8 (19).

Table 10: Frequency distribution of LGAs by number of growth-restricting planning controls

Ranges	No of LGAs	Per cent
0	4	1.6%
1–9	40	15.9%
10–19	90	35.7%
20–29	74	29.4%
30–39	28	11.1%
40–49	11	4.4%
50–59	4	1.6%
60–69	1	0.4%
Total	252	100%

Source: Authors' own calculations from the AULUPP Survey.

Table 11 below shows that there is a positive link between the number of growth restricting controls and *both* house and unit prices. In the low (high) house price segments the average number of controls is invariably below (above) the overall average of 19.8. This systematic relationship is less evident across unit price deciles.

Table 11: Average number of growth restricting planning controls, by price deciles

House price decile	Median	Mean	Std	Unit price decile	Median	Mean	Std
1	15.0	15.8	7.9	1	18.0	19.3	8.4
2	13.5	15.0	7.4	2	15.0	16.2	8.7
3	15.5	17.2	10.2	3	19.0	20.3	9.4
4	15.0	18.4	9.6	4	25.0	25.0	10.2
5	20.0	19.6	10.5	5	24.0	22.5	11.3
6	23.0	21.9	9.8	6	23.0	24.0	13.2
7	21.0	23.6	13.4	7	21.0	22.5	11.8
8	24.0	23.5	14.8	8	20.0	19.8	12.9
9	21.0	20.1	9.8	9	19.5	20.7	11.1
10	16.5	18.9	11.3	10	17.0	20.6	13.0

Note: Price deciles are measured in the year 2008–09.

Source: Authors' own calculations from the AULUPP Survey and RPData.

For growth restricting controls, the *patterns* by area socio-economic status (SES) are very similar to growth accommodating controls. Local governments with higher SES, as proxied by median weekly household income, are inclined to employ an above average number of growth-restricting controls. It seems that the more interventionist stance in higher SES LGAs is evident across both growth accommodating and restrictive controls; as shown in Table 8 above and Table 12 below, local governments with median household incomes above the 50th percentile typically resort to above average inclusion of both growth accommodating and restricting measures in their local plan.

Table 12: Average number of growth-restricting planning controls, by median household income decile

Median household income decile	Income band ($)	Median	Mean	Std
1	0–784	22.0	21.2	10.7
2	785–837	15.0	16.4	10.4
3	838–886	15.5	17.9	8.9
4	887–939	15.5	17.3	8.6
5	942–999	15.0	17.8	10.2
6	1,003–1,077	20.0	20.1	11.7
7	1,078–1,181	16.5	22.5	16.8
8	1,183–1,360	21.0	21.8	8.8
9	1,361–1,639	21.0	22.0	10.2
10	1,657–2,839	17.0	18.5	12.7

Note: Median weekly household income is measured in 2011.

Source: Authors' own calculations from the AULUPP Survey and 2011 Census.

Table 13 below presents the average count measures of growth restricting planning controls in each decile of percentage increase in housing stock. One might assume that there would be a negative link between the number of growth restricting planning controls and the percentage increase in housing stock over time. However, we find that the association between these two variables is in fact positive, that is, the percentage increase in housing stock between 2006 and 2014 is greater in LGAs with a higher number of growth restricting planning controls. The results in this table suggest that the relationship between planning controls and the growth of housing supply is not a straightforward one. The next section attempts to isolate the relationship between the two by controlling for potentially confounding factors through econometric modelling.

Table 13: Average number of growth restricting planning controls, by percentage increase in housing stock decile

Decile of percentage increase in housing stock	Bound (%)	Median	Mean	Std
1	0–3.2	12.0	13.4	6.6
2	3.3–4.9	17.5	20.8	13.8
3	5–6.4	15.0	18.6	13.4
4	6.4–8	14.0	16.7	12.8
5	8–9.7	19.0	22.2	12.6
6	9.7–12	19.0	20.6	11.3
7	12–14.1	19.0	20.1	8.5
8	14.1–17.6	20.0	20.7	9.6
9	17.6–25.7	19.5	22.3	10.5
10	≥25.9	24.0	21.2	9.9

Source: Authors' own calculations from the AULUPP Survey.

4.4 The links between planning controls and housing supply

In this section we report modelling results that adapt the model in Chapter 3 to include planning control variables. A potentially important aspect of this analysis that distinguishes it from other studies is the use of variables that are measures of growth accommodating and restrictive controls. The econometric analysis therefore permits a more nuanced estimation of the statistical relationship between planning controls and housing supply. It allows for the possibility that measures of different kinds could be statistically related to housing supply in opposite ways, and moreover the strength of their statistical relationships with housing supply could also vary. There is a second novel experimentation. As explained in Section 4.2, the AULUPP offers weighted measures of growth accommodation and restrictive controls that reflect the degree to which they are accommodating or restricting. We have added the weighted growth accommodating and restrictive control variables to the model specification. Descriptive statistics for the dependent variable and vector of explanatory variables are presented in Appendix 4, Table A4(a) and a full set of model coefficients are listed in Appendix 4, Table A4(b).

The planning variables are only available for 252 LGAs. This is a smaller number than was available for estimation of the model reported in Chapter 3. According to the descriptive statistics (see Appendix 4, Table A4(a)) this smaller sample is more metropolitan oriented. As a result the average population across these LGAs is much larger (roughly one-third higher in the houses sample and 14% higher in the units sample). Two other important consequences are a

much higher proportion of land areas that is typically built up and elevated monthly approvals in the smaller sample used in this chapter—monthly house approvals are 27 (22) in the smaller (larger) sample while monthly unit approvals are 14 (11). These comparisons justify some caution when interpreting model results as they will be vulnerable to sample selection bias.

Of particular interest are the coefficient estimates on the planning variables, and the impact of their inclusion on the price elasticity of supply (see Appendix 4 Table A4(b)). The price variable coefficient estimates reveal a sharp drop in the number of statistically significant lagged price variables. They suggest that a 1 per cent increase in real house prices results in a temporary 2.2 per cent increase in new house approvals spread over the current and ensuing 15 months. This is less than half the price elasticity estimate (4.7%) when planning variables are omitted. In the unit approval model, only one lagged price variable is weakly statistically significant at the 10 per cent level, suggesting a weak 1.1 per cent increase approvals when real unit prices rise by 1 per cent. As noted in the previous chapter, these new house and unit supply responses (to a 1% increase in prices) represent very small percentage increases in the housing stock.

As suggested earlier in this section, the role of planning controls is more nuanced than traditionally thought. In both house and unit models the coefficient estimates on the logarithmic transformed weighted growth accommodating and growth restricting variables are small. In addition, the coefficient estimates suggest that growth accommodating controls are positively correlated with both house and unit approvals. On the other hand, growth restricting controls are negatively correlated with approvals. While the statistical links between growth restricting controls and approvals are weak, the growth accommodating interventions are statistically significant. There is ample variation in the weighted control variables,[27] so the small coefficient estimates and their at times statistical insignificance cannot be the product of a statistical artefact due to variable measures tightly centred around their mean values. However, before firm conclusions can be made, there are potentially serious endogeneity issues that must be addressed in future research, and the sharp fall in the estimates of price elasticities of supply when planning controls are present in model specifications deserves further investigation.[28] We consider these issues further in the final chapter.

Turning now to the other variables, there is confirmation of the statistical importance of an area's population size. Despite a restricted sample that is drawn from a more urban oriented group of LGAs with higher populations, the population elasticity estimate in the house model is again close to 1. There are also similar findings with respect to topography—areas featuring steep gradients or that have already been developed are linked with lower house approvals, but with units there is a positive association with LGAs that have a relatively high proportion of land that is built up. High levels of annual rainfall and a climate featuring extreme temperature ranges are negatively linked with house approvals, but statistically insignificant for unit approvals.

Among the other variables, the calendar year and state capital variables once again merit special mention. There is reaffirmation of a longer run decline in house approvals, once allowance has been made for the rich set of supply-side factors included in model specifications. While coefficient estimates on calendar year variables are negative in the unit approvals model, they are again statistically insignificant. There would therefore appear to be divergent long-term trends in house and unit approvals.

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27 Growth accommodating scores range from a minimum of zero to a maximum of 66, with a standard deviation of 9.9. Growth restricting scores range from 0 to 113, with a standard deviation of 19.

28 The sample used to estimate model specifications is smaller and as pointed out earlier in the chapter more urban oriented. This, rather than the introduction of planning control variables, could be responsible for the change in the size and significance of price coefficients.

With regional Australia as the benchmark, all the state capitals again have statistically significantly lower monthly house approvals holding values of all other variables constant. In the early years of the sample timeframe (2005–06) Sydney's (Melbourne's) monthly house approvals are running at an estimated 8 per cent (20%) below regional levels when values of the other variables are held at common values. With planning approval variables present in model specifications, monthly unit approvals in Adelaide, Perth and Melbourne were 55 per cent, 46 per cent and 60 per cent below those of regional Australia in the early years. On the other hand, monthly unit approvals have surged ahead in Brisbane 2006–14. From 2010 onwards, soaring unit approvals is also apparent in Sydney and Melbourne. For example, we estimate that by 2013 and 2014 monthly unit approvals in Sydney are running at double the approvals in regional Australia (all else equal).[29]

4.5 Policy development implications

The findings in this chapter have particular policy development implications for the planning regulatory system in Australia.

As indicated in Section 4.1, the literature generally postulates that restrictive land use planning settings represent barriers to new housing supply (see for instance McLaughlin 2014 for Australia and Hilber and Vermeulen 2010 for the UK). However, the econometric estimates in this chapter suggest that the role of planning controls is more nuanced than traditionally thought.

Our findings reveal that in terms of *direction* of impact, growth accommodating controls are positively correlated with both house and unit approvals while growth restricting controls are negatively correlated with both house and unit approvals. However, in terms of *significance* of the impact, only the relationship between growth accommodating controls and approvals is statistically significant; in the case of growth restricting controls the association is insignificant. Moreover, the *size* of the impact is marginal for both types of controls as indicated by the small coefficients on both planning variables in the model.

The findings imply that thinking on Australian planning reform as a supply measure needs to extend beyond a simplistic linear approach that assumes that the more restrictive the measure, the greater the barrier to housing supply. Indeed, the restrictiveness of planning measures is unlikely to be the key factor in influencing housing supply. This is not to say that planning regulations necessarily have little impact on housing supply responsiveness in a local area. It may be that other aspects of the planning regulatory framework are more important.

Qualitative work with developers points to a number of explanations as to why planning controls are less significant than expected. The biggest driver of development is profitability. The planning system determines what a developer can do with a site, which in turn helps influence the revenue the site can generate, and therefore its profitability.[30] Restrictive planning policies are likely to prevent development only if they have a negative impact on revenue and therefore make a development unprofitable. There are also planning controls that increase costs and therefore have a negative impact on profit. If the cost burden placed on the developer is too high relative to revenues, financial incentives for development will be weak. Developers are more likely to work through restrictive controls if they can nevertheless generate a profit from the site. Therefore, a number of restrictive controls may be outweighed by a single control that permits a developer to make a profit, for example a high density zoning within a strong housing

[29] The quantitative comparisons drawn in this paragraph are all made assuming that all other variables in the model are held constant at common values.

[30] However, some of the effects may be capitalised into land prices rather than developer profits.

market. Unfortunately, zoning and density measures are not captured in detail at the local level by the AULUPP survey.

A key finding arising out of the industry panel discussions was that often the most important aspect of the planning system from a developer's point of view is the certainty and consistency of advice provided by planning officers. Planning controls may be generally restrictive but if they are applied consistently the developer can work more easily with them to deliver housing. A key frustration experienced by developers arises when advice given part way through the development process conflicts with advice given at the onset of that same planning process. This could adversely impact potential revenue, or cause a delay, and reduce profit.

5 Institutional settings and housing supply responsiveness

- The development industry is extremely diverse, so policy settings will not have a uniform impact across the development industry.
- The supply of detached housing is much quicker to respond to changes in market demand than multi-unit supply.
- The complexity of the multi-unit development process means it is very difficult for developers to respond quickly to changes in market demand. Development timeframes in the middle ring and inner city core suburban multi-unit housing market are long, as there are many stages in the development process, each stage raising potential barriers that can extend the development timeframe, or prevent development altogether.
- The availability of finance can be a major impediment to development, particularly for smaller developers.
- Developers seek certainty in the development process. The more certainty state and local government can deliver in the development process the greater the supply responsiveness is likely to be, all other things being equal.

This chapter extends the analysis of housing supply by presenting an overview of the institutional arrangements through which housing is produced. In this context, the concept of an institution refers to the practices of individuals and firms and constitute the social and economic structures that are referred to in general terms as the residential land and housing development industries. Within these industries there are particular arrangements, or subsectors, that produce different types of residential land and housing with distinct variations in shape, size, configuration, amenity, finance, vendor arrangements, building materials and methods of construction. There are considerable spatial variations with some developers operating nationally while others operate very locally, perhaps within only one or two local government areas. Funding arrangements also differ with larger, national firms having access to significant loan facilities that can be secured on their balance sheets, while smaller organisations rely on project specific finance (Rowley, Costello et al. 2014). These factors could be important determinants of the price the elasticity of supply, that is the ability of different producers to respond to price signals as well as the timeliness with which they can respond.

Understanding that property developers cannot respond quickly to market changes is crucial to understanding the nature of new supply. Indeed the elasticity estimates in previous chapters indicate the existence of a lagged supply response to price changes. Different residential property types have different levels of responsiveness depending upon their scale and complexity. By its very nature, property is slow to respond to demand because new sites have to be taken through the development approval process, some may have to be re-zoned, communities consulted, and added to this is the period of physical completion which will take a minimum of months to well over two years for larger apartment developments. The detached housing market is best placed to respond provided lots are available on the market for purchase as it involves only a household or investor contracting a builder. Unless developers have a supply of build ready sites where construction can start immediately, and this is unrealistic due

to the cost of holding such sites (land tax, rates, opportunity cost of capital etc.), supply is always going to be relatively unresponsive to changes in demand.

There are three reasons for presenting an overview of institutional arrangements in this report. First, the description and model will be better understood if the institutional arrangements and differences are clear. For example, behind the big category of 'units', there are not just one, but a number of distinct production arrangements evident in the shape, size and configuration of buildings and with very different development timeframes. For example, a small, three-storey walk-up apartment development is far quicker to deliver than a large residential tower. Further, the firms producing these distinct forms respond to price signals quite differently due to the scale of development and the amount of capital involved, particular initial capital required for securing the level of pre-sales necessary to secure finance. Some producers are able to respond very quickly while others take longer. Second, policy development must rest on a sound understanding of industry arrangements. Governments seeking to shape the conditions that influence the responsiveness of businesses to produce new residential land and housing are likely to realise their objectives more fully if policy-makers understand some of the key features of the industry. Different types of developers will respond differently to policy settings due to their structure and decision-making processes. Finally, institutional arrangements help explain 'gaps' in the modelling outcomes, that is where modelling results do not conform to standard economic theories.

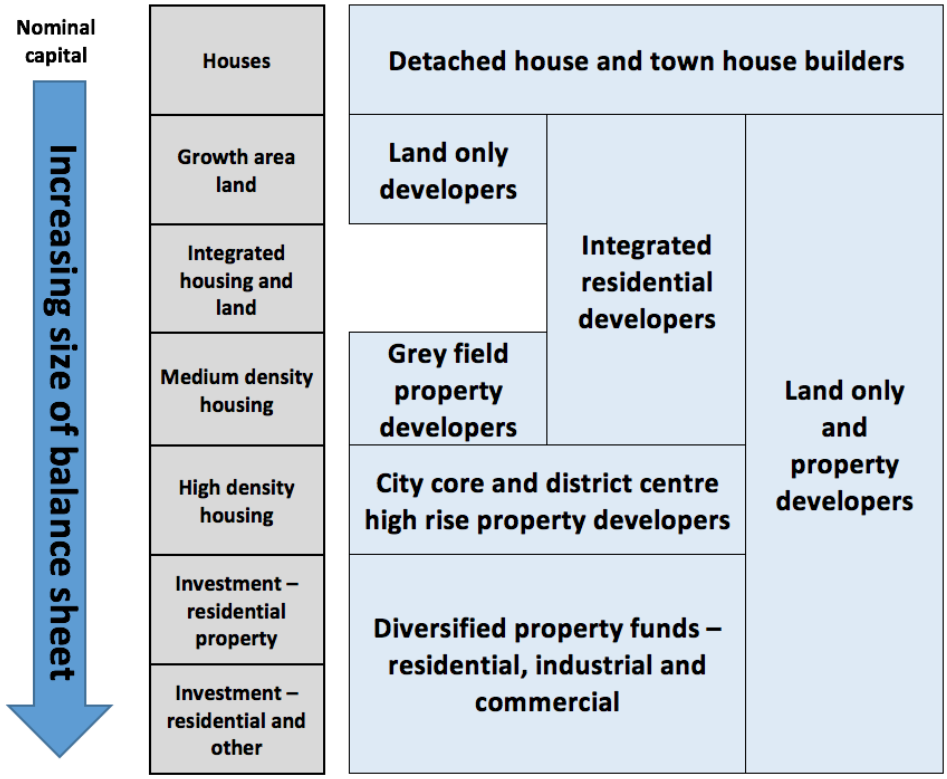
This chapter is based on the findings of two industry panels convened during this project and previous work undertaken by the authors in this space.

5.1 A highly differentiated institution

Much discussion in the media and in economic discourse on the housing industry is highly generalised and focused on *new* housing supply as if it is a single product rather than consisting of many varied outcomes delivered by many different types of organisations. Recent research, largely that funded by AHURI, shows that the development industry is highly differentiated. This research has focused on suburban house building (Dalton, Chhetri et al. 2011); the development of housing on infill development sites in existing urban areas (Rowley and Phibbs 2012); the financing of residential development (Rowley and Phibbs 2012); and the housing sector labour force that builds and renovates housing (Dalton, Horne et al. 2013; Dalton, Hurley et al. 2013).

A starting point for an overview of the institutional arrangements that produce new housing in Australian cities is the typology presented by Rowley, Costello et al. (2014). They identify distinct types of land and residential development companies and relate them to the capital intensity and financing of their operations, which ranges from house builders with little reliance on accumulated or invested capital to diversified companies listed on the stock exchange with access to wholesale capital. Figure 10 below, derived from Rowley, Costello et al. (2014: 15), presents a stylised map of the industry using capital intensity of businesses as the key dimension.

Figure 10: Land and housing development in Australia



Source: Adapted from Rowley, Costello et al. (2014: 15)

There are a number of types of new development. First, land development, where lots are sold for the development of, largely, detached dwellings. Second, small scale built form where project home builders will deliver detached houses or, in some areas, semi-detached, terraced and townhouse style houses. Medium rise multi-unit apartment blocks are developed in the middle and inner suburbs, though they are also becoming increasingly common in outer suburbs with appropriate transport links. This type of housing tends to replace earlier, low density residential housing, or industrial or commercial land uses. Another distinct group of developers build high rise apartment towers in capital city central areas or in district centres that are also replacing earlier land uses. In all cases supply will be delivered only where the revenue generated from selling such dwellings is sufficient to cover total costs (construction, finance, marketing etc.), required profit and an acceptable price to the landowner.

Detached suburban houses and town houses are constructed by builders who have limited reliance on accumulated or invested capital (Dalton, Horne et al. 2013). These businesses are primarily cash-flow businesses where they build houses on order (project homes) from households who have chosen their house design from a catalogue. The purchaser makes agreed ‘progress payments’ when the builder reaches certain defined milestones. These houses are built on land already purchased by the household or investor and that land has been subdivided by another organisation, the land developer. The builder will often ‘speculate’ on future demand by building a small number of additional houses or town houses for sale, often initially used as show homes. The materials used to build these dwellings overwhelmingly continue to be bricks (double brick in WA) and timber on a concrete slab. An extensive system of contracting is used to supply materials and build the dwellings: supply contracting is used to buy in the materials on an as-required basis; sub-contractors are engaged to build using the already purchased materials; and sub-contractors are engaged to both supply and install other

materials and components. Approximately one hundred separate contracts comprised of these three types are used to build a typical house.

These house builders work very closely with land developers that develop raw land, primarily in growth areas (Burke and Hulse 2010; Dalton and Nelson 2015). They take the land through a strategic planning process and manage the civil works programs that produce serviced lots purchased by households prior to engaging a builder. These companies either purchase the raw land from the original rural land owner or establish a development agreement/joint venture with the owner. In the latter case, developers manage the land through the planning and development stages before taking a commission on sales. The larger land developers, who are overwhelmingly responsible for new lot production, acquire large tracts of land using investor capital and development business plans that are designed to withstand fluctuations in demand. There are then a large number of smaller land developers who are less capitalised and have developed shorter term and more opportunistic business models. Land developers do not typically deliver any built form product at all and many specialist 'developers' make their money by taking the land through the planning process before selling it on for others to undertake the subdivision process.

In the middle ring and inner suburbs, multi-unit mid-rise apartment blocks have formed an increasing proportion of new housing supply in capital cities in recent decades. This infill or greyfield development (Newton, Murray et al. 2011) is becoming increasingly important in the densification of Australian cities but is a more complex process than land and detached housing development. As Rowley and Phibbs (2012) and Rowley, Costello et al. (2014) note, there are potential barriers at each stage in the development process. The typical, simplified process and potential barriers to housing supply include:

- Site identification and site assembly: Finding suitable sites that will deliver an acceptable return for the developer can be very difficult. Physical development barriers and zoning that does not support profitable development are two challenges. On infill sites, land ownership is fragmented and it is often difficult to assemble a site together of sufficient size to make a development feasible.
- Feasibility appraisal: Once a potential site is identified, the developer needs to determine if the balance between the potential revenue from the completed development is sufficient to cover total development costs, including the land price, and deliver an acceptable internal rate of return or return on equity. The higher the cost of construction and landowner demands, the greater the revenue required per dwelling. In the majority of cases, revenue will not support development (Rowley and Phibbs 2012).
- Development approval: If the development is potentially feasible, the developer needs to navigate the development approval process including community consultation. This process may result in changes in the initial development which mean it is no longer profitable.
- Development finance: The vast majority of developers will require some form of debt funding. This typically comes from banks and their policy settings will determine the availability of finance. Without a supply of finance, there is no development (Rowley, Costello et al. 2014). Lenders will impose conditions on finance and that often means securing a level of pre-sales, for both land and built form development, necessary to cover a proportion of the debt, often 100 per cent. Securing pre-sales is costly given the marketing required and there is no guarantee the required level of sales, typically between 60 and 80 per cent of units, will be met.
- Construction and completion: Construction comes with its own challenges, particularly around the cost and availability of materials and labour.

High rise residential towers are now a feature of central city and metropolitan district centres. In most cities they have been encouraged by several decades of planning policies that have

sought to encourage residential living in central city areas. The developers who plan and develop these buildings, with a few exceptions, constitute a different group to the developers who develop mid-rise apartment blocks in the middle and inner ring suburbs. They are smaller in number and tend to be engaged in other forms of property development, commercial for example, and ownership. Many such developers are from overseas. A key element of this broader involvement in property is that they have well established links to financial institutions that enables them to fund large projects with long planning and development timeframes (Rowley, Costello et al. 2014). They have access to debt capital and their balance sheets are underpinned by substantial assets and property income providing security for debt funding arrangements. Conversely, smaller developers operate on a project-specific basis meaning their activities are very much dependent on the appetite of banks for residential property lending. This appetite reflects lenders' perceptions of development risk and depends on the state of the housing market, both demand and supply and the availability of this capital contributes to the cyclical nature of housing supply.

5.2 The drivers of, and barriers, to new housing supply

The above overview of the industry structure and the production of different housing types provides the context for an account of what industry participants say about ‘responsiveness’. A key question surrounds the major drivers of responsiveness to demand for housing that leads to increases or reductions in land and housing supply. This section answers this question by reviewing the transcripts of two industry panels/focus groups comprised of participants who have had long-term involvement in different parts of the land development and housing industry. Their participation in the industry is through their work as land developers, project developers, planners and regulators, financiers and industry association leaders. This review begins by identifying overarching features related to responsiveness of the land and residential development industry as recognised by focus group participants. It then identifies differences in the way actors respond to demand for new land and housing across the growth areas, middle ring and city core.

5.2.1 Overarching features

A starting point for understanding the responsiveness of land and housing producers to the market is understanding the basic elements of their decision-making model. Regardless of what type of housing is being produced, developers and builders see themselves as producers of products that are sold to purchasers at a price which will result in an acceptable return. They identify what inputs are required and the constraints and costs that are associated with them. This approach to development is described in very matter-of-fact terms by a developer:

> *You look at a market and you think, 'I can do …' … And so the first question I’d always ask on a project: Who am I going to sell it to? Can they afford it? Can they pay for it? Okay, that’s good. They can pay this much. And I deliver it for that much and make enough money out of it. So that’s my perception of the risks in there. … the next thing I’d go to is always planning. Can I actually produce what they want, sort of allowed … And then there’s a bunch of things that come to the table: build costs: Is there money available? If you’ve got a good deal, someone will fund it. There are times when it’s harder and there’s times when it’s easy, but if it’s a good deal ….*

This describes the process for initiating projects—being responsive to the market with profit being the key. If the returns available are not going to compensate for the risk of the project, development will not occur. In times of low demand, development is more risky as rates of sales and final revenues are less certain. This reflects the other side to responsiveness; the way producers respond to declining demand. This can be a lot quicker than responses to increasing supply but has profound implications:

> *Housing takes quite a long time to go from here up to here, but when the opposite happens, when something changes in an unfavourable way for housing demand, it can really fall back quite quickly because it doesn't really need any permission to reduce output. It's much easier to reduce output activity. Whereas if you're trying to increase output and activity in housing, you know, you have to hire more people. You have to increase your capital, lines of credit and all that sort of stuff. So that's something that we do see with housing. So it tends to respond slowly when an increase is required, but it tends to respond quickly when a reduction in output is required.*

Pulling away from a proposed development is much quicker than getting development approval so supply can contract much faster than it can expand, although there is still a lag in supply contraction as many projects may already have commenced construction. Developers may secure a development approval, but not follow through on that approval if there is a risk that development may prove unprofitable due to falling demand. The developer is better to withdraw from a project early than be left with unsold product and debt to repay with no revenue available.

A second important overarching feature is the concept of a minimum price of housing, based on the cost of the land, construction costs, professional fees and minimum acceptable developer return. This means developers are unable to deliver a product to a large part of the population who cannot afford this minimum price because their income is too low, or they lack the necessary savings to meet the deposit requirements of lenders.

Participants thought the capacity of the industry to supply new housing to households much further down the income scale was questionable. The costs of supplying land and housing in metropolitan housing markets and continuing to make a profit meant that prices had quite a high base, certainly too high for those in the lowest income quartile . As one developer noted: '*Yeah, the market is not going to produce sub-economic housing*'. Further, developers were clear that stripping out costs from the production of new housing was not going to lower the price of established housing. Indeed, the price of new housing is related to the price of established housing, not simply what it costs to produce. This is due to the nature of the residual based land pricing model where the cost paid for the land is a function of the revenue which can be generated from the development. This revenue is estimated based on the prevailing price of existing, comparable product in the local area.

In other words, there was a gap between prices and affordability for many households. This could only be met through some type of government intervention or a shift in the balance between prices and incomes. A developer stated: '*that's one problem for households on the bottom quartile, there's no way they can get into the market without subsidy*'. Another developer stated:

> *So, if you're going to increase affordability you have to actually tap into the multi-unit, multi-level family housing and look at subsidising the uneconomic bit, and getting private capital in there. That's my simplistic view on the affordability bracket because it's only market housing; we won't do it if it's not, if it doesn't stack up.*

This then leads to the issue, if there was to be a subsidy, what form would this subsidy take? A developer posed the issue in the following terms:

> *If you want to go sub-economic, a whole lot of mechanisms, there's been models used in Australia that worked, there's been models used overseas that work; we just don't, we haven't as taxpayers made that decision yet.*

5.2.2 Different responses: growth area, middle ring and inner core

During the panel, developers discussed the responsiveness of new suburban house supply by making a comparison between Melbourne and Sydney. In Melbourne, growth area housing supply was now seen to be more responsive because there had been a significant change in the way the Melbourne Planning Authority led land supply arrangements through the Precinct Structure Planning (PSP) system. The PSP system was a form of strategic planning that clearly sequenced the development of growth area land and added certainty to the timing of development. Developers developed their land within this framework which resulted in a steady supply of serviced lots available for purchase. A developer spoke of the significance of the PSP system in the following terms:

> *Planning systems, you whinge and moan about it, and our PSP system, but in comparison to like New South Wales it's amazing. Oh, it's a key driver in terms of getting supply to the ground, you know, certainty, de-risking, keeping the banks and financiers happy, so it's serious.*

Indeed, one developer suggests that some in the outer suburban land development industry might be wanting to slow the process down. '*I'll guarantee you some developers will come and say, 'Slow down. There's too much on the market,' which is what happened, and prices, what, they dropped below $200,000*'.

This supply of land leads to increased responsiveness in the building of housing. This model of development is relatively responsive to market demand as there is a supply of lots available to meet any increase in demand and a house soon follows (typically 6–12 months) once the lot is purchased. A developer notes: '*at the same time [the] lag it'll be gone, because you do move a lot quicker on houses*'. House builders are able to respond quickly because the housing built form is simple, they are able to operate largely as a cash flow business, funded by the deposit and mortgage capital supplied by the purchaser, and they work with sub-contract labour that is very responsive to demand and highly mobile. The planning process for detached house development is also quick and simple compared to multi-unit development.

Development timeframes in the middle ring and inner city core suburban multi-unit housing market are greater. As noted above, there are many stages in the development process where there are potential barriers that can extend the development timeframe or prevent development altogether. A developer notes how the time taken for a small project is about four years, but for a larger project it can take up to eight years.

> *I think our minimum cycle time might be below four years, but if it is it's not much [less]. That's from buying it [the land] to having … money in the bank. And they're quick little projects. So if you start doing the biggies … I mean, we used to talk about a cycle time of eight years from things appearing on our market list and being finished for a typical 100-dwelling apartment project. It takes time to find something, time to buy it, a year or two on the terms to buy it, a bit of planning, a bit of 'Oh, we better stop for a couple of months because something happened'. It's a sluggish business.*

5.2.3 The timing of supply

Developers release large lot subdivisions in stages, partly due to capacity issues and partly because they do not want to flood a local market with a large quantity of similar product as this will affect price. Developers are profit maximisers and it makes financial sense to control supply in times of weak demand if the costs of holding the land do not outweigh any potential price benefits from delaying land release. Market conditions often result in developers releasing new subdivisions in smaller stages than originally planned therefore fewer units are on the market at any one time. Controlling the timing of development to maximise potential rates of sale is a strategy commonly applied by land developers.

It is more difficult to control supply in the multi-residential market as you cannot complete just part of a large apartment building. A developer is unlikely to market and complete two similar projects at the same time as this will potentially affect revenue, unless demand is very strong. Additionally, a developer cannot control the supply pipeline but may delay a project if a competitor is likely to complete a similar project shortly before the developer's own project, again if the costs of doing so do not outweigh the potential revenue benefits.

Developers are often accused of land banking and holding off development with adverse consequences for supply and affordability. But developers are profit maximisers and without intervention such practice is hardly surprising.

5.3 Multi-unit development time influences

The complexity of the multi-unit development process means it is very difficult for developers to respond quickly to changes in market demand. By the time a developer has assembled the site and secured planning approval, the market may have changed and the development may no longer be profitable. Other factors influence the way developers respond to the market and affect the time taken to plan, build and sell apartments in existing urban areas. Developers identify three stand out factors: the stock of already approved development proposals that developers have not commenced; the fragmentation of land; and the effect of the planning system on the land that is available for development.

The stock of approved proposals comprises projects that developers have taken through the planning approval process but have not yet commenced. These approved projects can be held by the original proponent or held by another developer. This happens when a developer who starts the development process decides part way through the process not to continue and on-sells the land and the development approval to another developer.

> *From a point of supply … what you're [often] actually seeing is not the production of houses or units as the land price has gone up; you're just seeing people trading. So people that typically produce are getting offered prices that they go, 'Why would I develop? Why would I take the risk on?' 'Here you go, take it'. I mean I'll just, I'll bank that.*

Therefore, the link between approvals and completions can be weaker than that indicated by approvals data on its own, and certainly weaker than for the more responsive separate house sector. Developers who purchase land with a development approval may or may not proceed with the development. If they do not proceed then the development can reappear as new supply at a later date, as long as the planning approval remains current (usually five years). In these situations, supply responsiveness involves several owners each making a judgement about costs and prices at the time of completion and whether to commence development.

> *One thing is that industry's capacity to respond to a peak in demand is whether it's coming out of a recessionary period where there is a whole lot of approvals in place sitting around waiting to be used because then you can just [be] reactivate.*

There can also be a situation where previously approved projects can provide a buffer if developers discern an increase in demand. '*If you have been going relatively hard and you get a spike and there's no stock of approvals lying around … it's much harder to respond*'.

Multi-unit development is a business where the timeframes can become more certain if state governments assist in resolving the difficulties associated with fragmented land ownership in an area. Developers talk about how the fragmentation of land mitigates against development because of the costs of negotiating with multiple private owners to create larger more viable development sites. The WA Government is one government that is reviewing land use in

existing urban areas with a view to overcoming the constraints of fragmented land ownership and promoting a more strategic redevelopment process:

> *We're currently doing some work trying to identify those three things: vacant sites, where the building stock is over 40 years, but it's not heritage, and also where you've got capacity in the planning system. So again that land availability in inner areas is quite specific because not every bit of land is equal. So if you've got building stock that's been through a development phase and it's got to 10 to 20 years old you're not going to get that redeveloping, so there's all sorts of subtleties in that area that [you] somehow going to take into account.*

The operation of the planning system also shapes supply responsiveness across metropolitan areas. In their discussion of the effect of the planning system, developers make a distinction between zoning and development controls. In Melbourne, they are clear that some local government authorities have used the new system of residential zones to stop new multi-unit development in large areas of the city. The way the local authorities use the system 'is an indication of the 'willingness of the local government to embark on change, and that reflects the community' and it is 'a major factor in determining where the growth is going and where it's not going'. In this context, some local authorities receive special mentions. A developer notes '*it's an absolutely major factor, and if you look at the way in which the zones are played out here in Melbourne … we've got one local government that's got a reputation for being difficult to deal with, and a lot of developers just wouldn't go out to that local government*'. In this context the use of detailed development controls is less important and are generally not seen as preventing development. Developers indicate that they are able to negotiate and accommodate the use of particular development controls.

Developers strive for certainty in the development process. If the process is smooth with no complications then forecasted profits are likely to eventuate. If there are problems caused by delays, for example, then profits can be affected. Some local governments offer more certainly in the planning process than others who may have a reputation for being difficult to deal with or providing inconsistent advice. Developers may go as far as to avoid certain local government areas based on past experiences. A developer's relationship with the local government area can be another barrier to supply responsiveness. Indeed the Property Council of Australia[31] have gone as far as benchmarking the performance of WA local governments in the area of development control to aid developers in their decision-making.

5.4 Policy development implications

The development industry is extremely diverse and policy-makers need to recognise that policy settings will not have a uniform impact across the development industry. Indeed, institutional factors can help explain why supply responses are not spatially uniform.

The responsiveness of housing supply to changes in demand varies significantly across types of dwellings. The supply of detached housing is much quicker to respond to changes in market demand than multi-unit supply providing there is an available supply of lots for sale. Multi-unit development has a long development timeline and is slow to respond to changes in demand. By the time a developer has secured the land and the necessary development approvals, the market may have changed, and the development may no longer be profitable. Hence, a more efficient land assembly and approval process may help make this type of development more responsive.

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[31] http://www.propertycouncil.com.au/Web/News/Articles/News_listing/Web/Content/News/WA/2016/Majority_of_Local_Governments_Miss_the_Mark_in_Planning_Performance_.aspx

Overall, the development industry can respond much more quickly to negative market changes than positive market changes. The supply of dwellings is inevitably cyclical as a result. The amplitude of the housing market cycle is greater than would otherwise be the case, and there is also therefore greater market volatility. Government can take advantage of the cyclical nature of development by timing their own development activities counter cyclically and securing development deals when builders are at their least active. This strategy has been successfully adopted by the WA Housing Authority.

The availability of finance can be a major barrier to development, particularly for smaller developers. Policy-makers should be aware of the impact the finance industry can have on supply responsiveness.

Similarly, policy-makers should be aware of the impact of uncertainty on developers and development outcomes. The more certainty state and local government can deliver in the development process the greater the supply responsiveness is likely to be, all other things being equal, because profits are more certain.

6 Policy development options

There is a clear and important link between the responsiveness of housing supply and economic development. It has been addressed in the international literature (Glaeser and Gottlieb 2009; Boeri, Ichino et al. 2014), but much less so in Australia. When housing supply in a regional area fails to respond speedily to positive productivity shocks (e.g. discovery of new minerals), the productivity gains can be squandered in the form of rising house prices and catch-up wage increases rather than employment gains. The potentially undesirable consequences are both economic and social in nature, and the two reinforce each other. For instance, in several regional areas where the mining boom or mass tourist development are the source of major economic stimulus, shortages of affordable housing can adversely impact businesses. Those industries resort to 'fly-in fly-out' (FIFO) adjustments that not only add to business costs but may also result in adverse social consequences as FIFO workers are exposed to increased risks of mental health problems, such as depression and suicide. These worrying outcomes have received sustained media coverage over several years (Turner 2011; Colvin 2014). Adverse impacts on the mental health of workers will in turn impose economic costs on businesses in the form of productivity slowdown as higher rates of work absenteeism 'kick-in'. Evidence on the drivers that affect the supply of housing will therefore offer insights into the kind of policy interventions that might aid the housing sector to adjust to demand pressures, and alleviate undesirable economic and social consequences.

In metropolitan areas, housing cost pressures are becoming acute in already large cities such as Sydney, where new housing supply must overcome challenges posed by topographical, infrastructure and policy constraints. Because global transnational service businesses (banks, financial institutions etc.) are concentrated in cities, the issues in metropolitan economies are aggravated by their greater exposure to international competitive pressures.

There are a plethora of policy instruments at federal, state and local levels that influence housing supply responsiveness in Australia. Some of these policies have direct housing objectives such as subsidised affordable rental housing and accommodating planning regulations. On the other hand, fiscal and monetary policy instruments do not have direct housing objectives but nonetheless influence outcomes in the housing market. These include income tax settings, stamp duty and land tax provisions as well as interest rate movements. Hence, housing supply concerns clearly cut across multiple policy portfolios that are administered by different government agencies. Lifting housing supply, particularly at the lower end of the price distribution, will likely entail a combination of policy responses across both Commonwealth departments and state government agencies. The key findings from this report, and their implications for policy development, are detailed in the next subsection.

6.1 Key findings and links to policy development

6.1.1 Is Australian housing supply sufficiently responsive that it will accommodate growing demand without soaring house prices?

Our model results show that the estimated price elasticity of *new* housing supply is 4.7 for houses and 3.9 for units. These supply responsiveness estimates actually imply an increase in *housing stocks* of much smaller percentage increments. Thus a 1 per cent increase in the level of real housing prices will, according to these elasticity estimates, produce a 4.7 per cent (3.9%) increase in new house (unit) supply but a very small expansion in *housing stocks* of between 0.05 and 0.09 per cent. However, caution is warranted when interpreting these estimates since supply modelling is at an early stage of development in Australia. The modelling approach assumes that we have identified the supply side of the housing market, and that price variables can therefore be included as independent variables with coefficients that measure price

elasticities of supply. There are well known identification problems that can undermine efficiency and introduce bias into model estimates. As Australian research in this area matures, new sources of data and technically more robust econometric methods will be applied to address these estimation problems. The present study offers some preliminary evidence suggestive of price inelastic supply, and we hope it will stimulate a future program of research that enriches our understanding of supply-side conditions in Australian housing markets.

6.1.2 Is new housing supply concentrated in relatively low value segments of the market?

Most new housing supply has been supplied in mid-to-high price segments, rather than low price segments. Housing in low priced segments is presumably more affordable, but less than 5 per cent of housing approvals were in the bottom 20 per cent of the house and unit real price distribution in 2005–06, and this remains the case almost a decade later in 2013–14. Housing supply in higher housing price segments does not seem to be triggering a trickle-down effect whereby households buying new relatively expensive housing free up vacancies in the established housing stock that housing stressed households are able to move into at lower prices and rents. Consequently, research studies confirm that low-income households continue to face growing difficulties accessing low cost housing. It would seem that the housing supply issue is more nuanced than commonly thought. While new housing supply has at a *national level* matched population increases over recent years, it has been concentrated in the upper value segments with structural impediments preventing the trickle-down effect which would increase affordable housing opportunities in lower value segments.

There are at least two implications for policy development. First, policy thinking around housing supply has tended to focus on the number of new approvals and completions of houses and units, with the assumption that 'more must be good' because it eases housing market pressures and expands affordable housing opportunities. The results presented in this report suggest that a broader perspective is warranted. Future research might prioritise identification of any possible structural impediments that could weaken the trickle down impact of new housing supply.

Second, such a research agenda could be fruitful in guiding targeted government intervention that helps improve supplies of affordable housing. The measures that are needed in this context should be targeted on the more important structural impediments. Are there barriers that make it especially difficult for urban areas to meet population growth pressures?

Job opportunities and population growth pressures are typically greater in urban areas than regional areas, and our research findings highlight some important barriers impeding housing supply adjustment to these pressures. We find that easing price pressures and expanding affordable housing opportunities will be particularly challenging for policy-makers in *already developed* urban areas. This is because housing supply can only be grown by increasing the density of development, or changing land use. The topography of areas also matter. The gradient of land areas is negatively linked to housing supply, so urban areas that are hemmed in by hilly or mountainous terrain will be especially disadvantaged by topographical constraints. These results suggest that meeting population growth pressures through new *house* supply in urban areas is more difficult. A policy development option in urban areas is to permit even more new supply at higher densities in order to accommodate population growth while easing price pressures.

The supply of *units* appears to be higher (all else equal) in already developed areas. Many of these urban areas with strong growth in the supply of units are job rich. The urban network linking jobs and residences in major cities seems likely to be strengthened as the market penetration of units increases. A by-product is shorter commutes, which can be an important boost to productivity. Measures to further promote the construction of units could prove to be

both productivity enhancing as well as an effective way to ease price pressures and expand affordable housing opportunities.

6.1.3 How do planning regulations influence housing supply responsiveness in Australian housing markets?

Our findings reveal that in terms of *direction* of impact, growth accommodating controls are positively correlated with both house and unit approvals, while growth restricting controls are negatively correlated with both house and unit approvals. However, in terms of *significance* of the impact, only the relationship between growth accommodating controls and approvals is statistically significant; in the case of growth restricting controls, the association is insignificant. Moreover, the size of the impact is marginal for both types of controls as indicated by the small coefficients on both planning variables in our econometric model.

The findings imply that thinking on Australian planning reform as a supply measure should extend beyond the simplistic interpretation which assumes that the mere presence of a control is a barrier to supply. Indeed, our econometric modelling results suggest that planning measures are unlikely to be the key factor influencing housing supply. That part of the project addressing the institutional arrangements governing housing supply argues that restrictive planning policies will only prevent development if they have a negative impact on revenue or raise costs, thereby making development unprofitable. Only a few planning controls will have this impact and they are related to factors such as density, height and possibly parking. Developers are inclined to work through restrictive controls if it means they can generate a profit from the site. For instance, a number of restrictive controls may be outweighed by a single control that permits a developer to make a profit, for example a high density zoning within a strong housing market.

This is not to say that planning regulations necessarily have little impact on housing supply responsiveness in a local area. It may be that other aspects of the planning regulatory framework are more important. Often the most important aspect of the planning system from a developer's point of view is the certainty and consistency of advice provided by planning officers. Planning controls may be generally restrictive but if they are applied consistently the developer can work with them and deliver housing. Hence, policy reform in the planning system may benefit from improving certainty and consistency throughout the planning process.

6.1.4 How do institutional settings affect the responsiveness of housing supply to demand pressures?

Our findings reveal that the supply of units is less responsive to changes in price than houses. The estimated price elasticity of new housing supply is 4.7 for houses and 3.9 for units. This could be attributable to distinct differences in the development processes governing the supply of houses and units that affects the quantity of new supply in response to a price change, and the timeliness of that new supply. The supply of detached housing is much quicker to respond to changes in market demand than multi-unit supply providing there is an available supply of lots for sale. Hence, from a policy development perspective, it is important to ensure such a supply of land will at least deliver a steady supply of such housing. However, multi-unit development has a long development timeline. By the time a developer has secured the land and the necessary development approvals the market may have changed, and the development may no longer be profitable. This affects both the quantity and timeliness of new unit supply when price changes. A more efficient land assembly and approval process would help make this type of development more responsive to changes in price.

There are several other policy development options that will likely improve supply responsiveness on the part of developers. First, even though monetary policy does not have a distinct housing objective, policy-makers need to be aware of the impacts of interest rate

changes on housing supply because the availability of finance can be a major barrier to development, especially for smaller developers. Second, the more certainty government can deliver in the development process the greater the supply responsiveness is likely to be, all other things being equal. Third, it is important to note that developers are profit-maximising agents. Hence, ongoing government intervention will likely be needed to cross-subsidise affordable housing through additional development rights to promote the supply of market housing to the lowest income groups.

Overall, the development industry is extremely diverse and policy-makers need to recognise that policy settings will not have a uniform impact across the development industry. There remains a need to better understand how particular obstacles in the development process affect different sectors of the industry and to pay more attention to how and where new infrastructure is being provided so as to maximise opportunities for development in areas of high demand.

6.2 Final remarks—caveats and future research

In this final section, we offer some concluding remarks that highlight the study's contribution to the existing housing supply literature. However, we also comment on the study's limitations, especially those associated with the econometric modelling. This discussion will help guide future research in an area that remains seriously underdeveloped in Australia.

6.2.1 Contributions to the Australian literature on housing supply

The empirical work is an advance on the handful of past Australian studies that have attempted to model the drivers of housing supply:

1. We offer a more detailed geographical breakdown than the capital city level analysis that McLaughlin (2011, 2012) uses, and a broader Australia-wide perspective as compared to Gitelman and Otto (2012). Model estimation at an LGA level allows identification of more fine-grained differences across housing markets. Furthermore, the impact of local planning controls on housing supply (which we focus on in Chapter 4) can be better captured using LGA rather than city-wide measures.
2. We include a considerably larger number of explanatory variables into model specifications that go beyond those employed by existing Australian studies (see McLaughlin 2011, 2012; Gitelman and Otto 2012). These include distance from the CBD as a crude proxy for construction costs, as well as variables representing land use, climate and topographical constraints. The report is therefore able to present a richer analysis of housing supply.
3. Ours is the first Australian study to include a sophisticated measure of topographical constraint following Saiz's (2010) US study on the geographical determinants of housing supply. For instance, while Gitelman and Otto (2012) acknowledge the potential effects of topography, they account for it by adopting a fixed effects model that assumes topography features remain constant over time. While this is a reasonable assumption, it does not allow the magnitude and significance of topography to be estimated. The topographical variables are in fact statistically significant drivers of housing supply, units being relatively strongly affected.
4. Ours is the first Australian study to measure the impact of planning regulations on the drivers of house and unit supply using the unique AULUPP Australian data, *as well as being the first* to differentiate between the impacts of growth restricting and growth accommodating planning instruments.

6.2.2 Limitations and future research directions

There is a range of drivers that influence the responsiveness of housing supply to demand shocks including price and cost shifters, climate and topography, and planning and land use regulations. A key finding that has emerged from this report, which warrants further investigation, is that the housing industry is extremely diverse. This implies that policy settings will not have a uniform impact across the development industry. In fact, institutional factors can help explain why supply responses are not spatially uniform. For example, an often cited criticism of the planning system is the need for clearer and more consistent advice by planning officers across all LGAs. This is an unobservable and hence unmeasured factor that could undermine the reliability of housing supply model estimates.

The panel nature of our data offers numerous options that permit the above-mentioned difficulty to be addressed in future research. If we assume that the unmeasured influence does not vary over time (a local government that in one year gives unclear advice is likely to also give unclear advice in all other years of the timeframe), it is possible to control for this unobservable effect through the use of a fixed effects model. Alternatively, if there are good grounds for identifying some authorities as prone to engage in this behaviour and others that are free of such behaviour, quasi-experimental modelling techniques can be exploited in future research.

Given the large number of zero monthly unit approvals in our data, an important future research direction will be to test for the validity of our results using alternative specifications that that take into account the censored nature of the supply measure in our models. Experimentation with quarterly, bi-annual and annual measures of housing approvals in our model specifications will reduce, if not eliminate, the number of zeros. The resulting model estimates will tell us whether the periodicity of housing supply measures matters because results are sensitive to the period over which housing supply is measured.

Overall, while the modelling approach adopted in this report does represent an advance on existing Australian models of housing supply, there is scope for adopting more complex panel estimation methods that allows for more robust measurement of the impacts of key drivers. For instance, spatial dependence and regional heterogeneity could be explored in greater detail. The time series properties of the data would also benefit from further exploration to inform the choice of model specification.

The sharp fall in the estimates of price elasticities of supply when planning controls are present in model specifications also deserves further investigation. The sample used to estimate the model specifications with planning controls is smaller and more urban oriented than the model without planning controls. This, rather than the introduction of planning control variables, could be responsible for the change in the size and significance of price coefficients. There are two stage modelling procedures for dealing with such suspected sample selection bias that should be used to address these issues in the future.

In terms of the choice of explanatory variables, there is a lagged relationship between prices and the supply of housing which may extend beyond the five quarters that we have modelled. Furthermore, the supply of houses and units respond at different speeds to changes in the market. The dynamics of this price-supply link varies across diverse dwelling types. The size of the lagged response could also be from a few months to several years depending on various factors such as the status of the land,[32] and the extent to which the decision to develop the land is stimulated by price changes. Such heterogeneity in lags requires further examination to avoid generalising the lagged effect across all dwelling types and land development processes. There

[32] For instance, building approvals can be issued speedily if an individual is purchasing land that already has a title as opposed to a land parcel without a title.

are a variety of different lag structures that can be modelled and that would shed insight into the heterogeneity of development responses.

In addition, some of the chosen explanatory variables represent crude proxies for actual predictors (e.g. distance from CBD as a proxy for construction cost, calendar year dummies as crude proxies for macroeconomic conditions) so would benefit from further variable refinement.

Another important caveat is that before firm conclusions can be made regarding the impact of planning regulations on housing supply, there are potentially serious endogeneity issues that must be addressed in subsequent research. This is once again an issue that can be addressed using quasi-experimental approaches that exploit changes in planning regulations, and comparing pre- and post-change in regulation housing supply outcomes. This change can be exploited to test for pre- and post-change outcomes in an econometric model that controls for other potentially confounding factors.

Finally, while this report has covered significant ground in advancing housing supply analysis in Australia, there is still considerable scope for improving the nuance of the findings by accessing or collecting additional information not captured within this report's data sources. For instance, an important research extension is a more detailed investigation into the links between location, commuting times and productivity. While the report's data sources do not contain this information, future research might be conducted using other data sources such as the unconfidentialised version of the Household, Income and Labour Dynamics in Australia Survey, where the commuting times of people living in LGAs on the urban fringe can be contrasted with the commuting times of those living in units in inner city suburbs. Furthermore, the supply responses of infill versus greenfield sites, as well as units of difference sizes, are likely to differ. Unfortunately, the data that this report draws on is unable to distinguish between housing constructed on infill or greenfield sites. Similarly, the present data is unable to distinguish between units by size or number of bedrooms. However, if future research could seek to identify or collect new sources of data to facilitate such analysis, the findings would be instructive in tailoring policy responses according to the anticipated response of the market segment or site in question.

References

Andrews, D. (2010) *Real House Prices in OECD Countries—The Role of Demand Shocks and Structural and Policy Factors*, OECD Economics Department Working Papers, no. 813, OECD, Paris.

Baker, M. and Johnson, D. (2014) *Submission to the Senate Inquiry into Affordable Housing*, March.

Ball, M., Meen, G. and Nygaard, C. (2010) 'Housing supply price elasticities revisited: Evidence from international, national, local and company data', *Journal of Housing Economics*, vol. 19: 255–268.

Ball, M. (2011) 'Planning delay and the responsiveness of English housing supply', *Urban Studies*, vol. 48, no. 2: 349–362.

Barker, K. (2003) *Review of Housing Supply: Interim Report*, HM Treasury, London.

Barker, K. (2004) *Review of Housing Supply, Final Report*, HM Treasury, London.

Barker, K. (2008) 'Planning policy, planning practice, and housing supply', *Oxford Review of Economic Policy*, vol. 24, no. 1: 34–49.

Boeri, T., Ichino, A. and Moretti, E. (2014) *Housing Prices, Wage and Income Differences in Italy*, Paper presented at the *XVI European Conference of the Fondazione Rodolfo Debenedetti*, 27 June, Rome.

Bramley, G. (2002) 'Planning regulation and housing supply in a market system', in A. O'Sullivan and K. Gibb (eds), *Housing Economics and Public Policy*, Basil Blackwell, Oxford.

Bramley, G. and Watkins, D. (2014) 'Measure twice, cut once'—revisiting the strength and impact of local planning regulation of housing development in England', *Environment and Planning B-Planning & Design*, vol. 41, no. 5: 863–884.

Burke, T. and Hulse, K. (2010): 'The institutional structure of housing and the sub-prime crisis: an Australian case study', *Housing Studies*, vol. 25, no. 6: 821–838.

Cameron, G. and Muellbauer, J. (1998) 'The housing market and regional commuting and migration choices', *Scottish Journal of Political Economy*, vol. 45: 420–446.

Cheshire, P. (2014): 'Turning houses into gold: the failure of British planning', *CentrePiece*, vol. 19, no. 1, accessed 20 September 2015, http://ceplseacuk/pubs/download/cp421pdf.

COAG Reform Council (2012), *Housing Supply and Affordability Reform*, COAG Housing Supply and Affordability Reform Working Party, Canberra,

Colvin, M. (2014) WA inquiry investigates FIFO suicide in the Pilbara', *ABC Online*, 21 August.

Dalton, T. and Nelson, A. (2015) *The Challenge of Suburban Growth: Land Development for Housing in an Australian Suburban City*, Paper presented to European Network for Housing Research, Lisbon, 28 June–1 July 2015.

Dalton, T., Horne, R., Chettri, P. and Corcoran, J. (2013) *Understanding the patterns, characteristics and trends in the housing sector labour force*, AHURI Final Report No. 208,

Australian Housing and Urban Research Institute Limited, Melbourne, http://www.ahuri.edu.au/research/final-reports/208.

Dalton, T., Hurley, J., Gharaie, E., Wakefield, R. and Horne, R. (2013) *Australian Suburban House Building: Industry Organisation, Practices and Constraints*, AHURI Final Report No. 213, Australian Housing and Research Institute Limited, Melbourne, http://www.ahuri.edu.au/research/final-reports/213.

Dalton, T., Chhetri, P., Corcoran, J., Groenhart, L. and Horne, R. (2011) *Understanding the patterns, characteristics and trends in the housing sector labour force in Australia*, AHURI Positioning Paper No. 142, Australian Housing and Urban Research Institute Limited, Melbourne, http://www.ahuri.edu.au/research/position-papers/142.

Department of Social Services (2014) *Submission to the Senate Economics References Committee Inquiry in Affordable Housing*, March.

DiPasquale, D. and Wheaton, W.C. (1994) 'Housing market dynamics and the future of housing prices', *Journal of Urban Economics*, vol. 35: 1–27.

Dockery, A.M., Ong, R., Whelan, S. and Wood, G. (2008) *The relationship between public housing wait lists, public housing tenure and labour market outcomes*, AHURI National Research Venture 1 Research Paper 9, Australian Housing and Urban Research Institute Limited, Melbourne, http://www.ahuri.edu.au/research/nrv-research-papers/nrv1-9.

Dodson, J. (2004) *Is there a spatial mismatch between housing affordability and employment opportunity in Melbourne?* AHURI Final Report No. 80, Australian Housing and Urban Research Institute Limited, Melbourne, http://www.ahuri.edu.au/research/final-reports/80.

Drieman, M. and Follain, R. (2003) *Drawing Inferences about Housing Supply Elasticity from House Price Responses to Income Shocks*, OFHEO Working Paper 03–02.

Fergus, J.T. (1999) 'Where, when, and by how much does abnormal weather affect housing construction?', *Journal of Real Estate Finance and Economics*, vol. 181: 63–87.

Fischel, W.A. (2004) 'An economic history of zoning and a cure for its exclusionary effects', *Urban Studies*, vol. 41, no. 2: 317–340.

Follain, J. (1979) 'The price elasticity of the long run supply of new housing construction', *Land Economics*, vol. 55: 190–199.

Gitelman, E. and Otto, G. (2012) 'Supply elasticity estimates for the Sydney housing market', *Australian Economic Review*, vol. 452: 176–190.

Glaeser, E.L. and Gyourko, J. (2005) 'Urban decline and durable housing', *Journal of Political Economy*, vol. 1132: 345–375.

Glaeser, E. and Gottlieb, J. (2009) 'The wealth of cities: Agglomeration economies and spatial equilibrium in the US', *Journal of Economic Literature*, vol. 47, no. 4: 983–1028.

Girouard, N. (2010) 'Housing and mortgage markets: An OECD perspective', in S. Smith and B. Searle (eds), *The Blackwell Companion to The Economics of Housing: The Housing Wealth of Nations*, Wiley Blackwell, Chichester.

Glaeser, E. L., Ward, B.A. (2009) 'The causes and consequences of land use regulation: Evidence from Greater Boston', *Journal of Urban Economics*, vol. 65, no. 3: 265–278.

Gurran, N., Gilbert, C. and Phibbs, P. (2013) *Planning and the Housing Market: Measuring Regulatory Difference and Implications for Explaining Supply and Affordability Trends*, 7th Australasian Housing Researchers Conference, 6–8 February, Fremantle.

Gurran, N., Gilbert, C. and Phibbs, P. (2014) 'Sustainable development control? Zoning and land use regulations for urban form, biodiversity conservation and green design in Australia', *Journal of Environmental Planning and Management*, ahead-of-print:1–26.

Gyourko, J. 2009, 'Housing supply', *Annual Review of Economics*, vol. 1: 295–318.

Gyourko, J., Saiz, A. and Summers, A. (2008) 'A new measure of the local regulatory environment for housing markets: the Wharton residential land use regulatory index', *Urban Studies*, vol. 45, no. 3: 693–729.

Halvorsen, R. and Palmquist, R. (1980) 'The interpretation of dummy Variables in semilogarithmic equations', *American Economic Review*, vol. 73: 474–475.

Hanak, E. (2008) 'Is water policy limiting residential growth? Evidence from California', *Land Economics*, vol. 841: 31–50.

Hilber, C. and Vermeulen, W. (2010) *The Impacts of Restricting Housing Supply on House Prices and Affordability*, Final Report, Department for Communities and Local Government, London.

Hilber, C.A.L. and Vermeulen, W. (2014) 'The impact of supply constraints on house prices in England', *The Economic Journal*, vol. 126, no. 591: 358–405.

Hincks, S., Leishman, C, and Watkins, C. (2013) 'Planning and housing: concepts, policy instruments and market analysis', *Town Planning Review*, vol. 84, no. 1:1–7.

HM Treasury 2015, *Fixing the Foundations: Creating a More Prosperous Nation*, accessed 20 September 2015, https://wwwgovuk/government/uploads/system/uploads/mattachment_data/file/443898/Productivity_Plan_webpdf.

Housing Industry Association (2014), *Submission to the Senate Economics References Committee on the Inquiry in Affordable Housing*, 25 March.

Hwang, M. and Quigley, J.M. (2006) 'Economic fundamentals in local housing markets: evidence from US metropolitan regions', *Journal of Regional Science*, vol. 463: 425–453.

Ihlanfeldt, K.R. (2004) 'Introduction: Exclusionary land-use regulations', *Urban Studies*, vol. 41, no. 2: 255–259.

Ihlanfeldt, K.R. and Sjoquist, D.L. (1998) 'The spatial mismatch hypothesis: a review of recent studies and their implications for welfare reform', *Housing Policy Debate*, vol. 94: 849–892.

Jericho, G. (2016) 'Apartment building is booming', *Guardian Australia*, accessed 25 February, http://wwwtheguardiancom/business/grogonomics/2016/jan/21/apartment-building-is-booming-so-betting-on-a-rate-cut-isnt-as-safe-as-houses.

Kain, J. (1992) 'The spatial mismatch hypothesis: three decades later', *Housing Policy Debate*, vol. 32: 371–392.

Krugman, P. and Wells, R. (2009) *Economics*, Worth Publishers, New York.

Landis, J.D. (2006) 'Growth management revisited—efficacy, price effects, and displacement', *Journal of the American Planning Association*, vol. 72, no. 4: 411–430.

Leishman, C. and Bramley, G. (2005) 'A local housing market model with spatial interaction and land-use planning controls', *Environment and Planning A*, vol. 37, no. 9:1637–1649.

Maclennan, D. (2010) 'What happened to the housing system?', in S. Smith and B. Searle (eds), *The Blackwell Companion to The Economics of Housing: The Housing Wealth of Nations*, Wiley Blackwell, Chichester.

Maclennan, D., Wood, G. and Ong, R. (2015) *Making Connections: Housing, Productivity and Economic Development*, Final Report No. 251, Australian Housing and Urban Research Institute, Melbourne.

Malpezzi, S. and Maclennan, D. (1994) *The Long Run Price Elasticity of Supply of New Residential Construction in the United States and the United Kingdom*, mimeo, University of Wisconsin.

Malpezzi, S. and Vandell, K. (2002) 'Does the low-income housing tax credit increase the supply of housing?', *Journal of Housing Economics*, vol. 11: 360–380.

Mayer, C.J. and Somerville, C.T. (2000a) 'Land use regulation and new construction', *Regional Science and Urban Economics*, vol. 30: 639–662.

Mayer, C.J. and Somerville, C.T. (2000b) 'Residential construction: Using the urban growth model to estimate housing supply', *Journal of Urban Economics*, vol. 48: 85–109.

McKenzie, F. H., Phillips, R., Rowley, S., Brereton, D. and Birdsall-Jones, C. (2009) *Housing Market Dynamics in Resource Boom Towns*, Final Report No. 135, Australian Housing and Urban Research Institute, Melbourne.

McLaughlin, R. (2011) 'Metropolitan growth policies and new housing supply: evidence from Australia's capital cities', *Australasian Journal of Regional Studies*, vol. 117: 60–80.

McLaughlin, R. (2012) 'New housing supply elasticity in Australia: a comparison of dwelling types', *Annals of Regional Science*, vol. 48: 595–618.

Muth, R.F. (1960) 'The demand for non-farm housing', in A.C. Herberger (ed), *The Demand for Non-Durable Goods*, University Chicago Press, Chicago.

National Housing Supply Council (2014) *State of Supply Report: Change in the How We Live*, accessed 23 August 2016, http://wwwtreasurygovau/PublicationsAndMedia/Publications/2014/NHSC.

Newton, P., Murray, S., Wakefield, R., Murphy, C., Khor, L. and Morgan, T. (2011), *Towards a New Development Model for Housing Regeneration in Greyfield Residential Precincts*, Final Report, No. 171, Australian Housing and Urban Research Institute, Melbourne.

Otto, G. (2007) 'The growth of house prices in Australian capital cities: What do economic fundamentals explain?', *Australian Economic Review* vol. 40, no. 3: 225–238.

OECD (2014) 'House prices—percentage change over the previous period', *Economics: Key Tables from OECD*, OECD Publishing, Paris, accessed 7 July 2015, http://wwwoecd-ilibraryorg/economics/house-prices-2014-1_hsprice-table-2014-1-en.

Overman, H. (2012) 'The UK's housing crises', *Centrepiece*, vol. 17, no. 3, accessed 20 September 2015, http://cep.lse.ac.uk/pubs/download/cp382.pdf.

Pendall, R., Puentes, R. and Martin, J. (2006) *From Traditional to Reformed: A Review of the Land Use Regulations in the Nation's 50 largest Metropolitan Areas*, Brookings Institute, Washington.

Poterba, J. M. (1984) 'Tax subsidies to owner occupied housing: an asset market approach', *Quarterly Journal of Economics*, vol. 94: 729–752.

Productivity Commission (2011) *Performance Benchmarking of Australian Business Regulation: Planning, Zoning and Development Assessments*, Draft Research Report, Productivity Commission, Canberra.

Productivity Commission (2014) *Geographic Labour Mobility*, Research Report, Productivity Commission, Canberra.

Raphael, S. (1998) 'The spatial mismatch hypothesis and black youth joblessness: evidence from the San Francisco Bay area', *Journal of Urban Economics*, vol. 431: 79–111.

Rowley, R. Gurran, N. Gilbert, C. and Phibbs, P. (2016b), *Urban Regulation, Housing Supply and House Prices: Is Australia Different?,* mimeo.

Rowley, S. and Phibbs, P. (2012) *Delivering diverse and affordable housing on infill development sites*, AHURI Final Report No. 193, Australian Housing and Urban Research Institute Limited, Melbourne, http://www.ahuri.edu.au/research/final-reports/193.

Rowley, S., Costello, G., Higgins, D. and Phibbs, P. (2014), *The financing of residential development in Australia,* AHURI Final Report No. 219, Australian Housing and Urban Research Institute Limited, Melbourne, http://www.ahuri.edu.au/research/final-reports/219.

Rowley, S., James, A., Gilbert, C., Gurran, N., Ong, R., Phibbs, P., Rosen, D. and Whitehead, C. (2016a) *Subsidised Affordable Rental Housing: Lessons from Australia and Overseas*, AHURI Final Report No. 267, Australian Housing and Urban Research Institute Limited, Melbourne, http://www.ahuri.edu.au/research/final-reports/267, doi:10.18408/ahuri-8104301.

Saiz, A. (2010) 'The geographic determinants of housing supply', *Quarterly Journal of Economics*, vol. 1253: 1253–1296.

Steering Committee for the Review of Government Service Provision (SCRGSP) (2016) *Report on Government Services 2016*, Productivity Commission, Canberra.

Senate Economics References Committee (2015) *Out of Reach? The Australian Housing Affordability Challenge*, Parliament House, Canberra.

Sinai, T. and Waldfogel, J, (2002) *Do Low-income Housing Subsidies Increase Housing Consumption?*, NBER Working Paper No. 8709.

Sjaastad, L. (1962) 'The costs and returns of human migration', *Journal of Political Economy*, vol. 70: 80–93.

Somerville, C. T. (1999) 'Residential construction costs and the supply of new housing: endogeneity and bias in construction cost indexes', *Journal of Real Estate Finance and Economics*, vol. 181: 43–62.

Somerville, C. T. (2002) 'Permits, starts, and completions: structural relationships versus real options', *Real Estate Economics*, vol. 291: 161–190.

Somerville, C. T. and Holmes, C. (2001) ‘Dynamics of the affordable housing stock: microdata analysis of filtering’, *Journal of Housing Research*, vol. 121: 115–140.

Spiller, M. (2013) *Social division, social housing and productivity, Occasional Paper*, SGS Economics and Planning.

Stover, M.E. (1986) ‘The price elasticity of the supply of single-family detached urban housing’, *Journal of Urban Economics*, vol. 20: 331–340.

Turner, R. (2011) 'Depression the dark side of mining boom', *The Australian*, 12 March.

van den Nouwelant, R., Crommelin, L., Herath, S. and Randolph, B. (2016), *Housing affordability, central city economic productivity and the lower income labour market*, AHURI Final Report No. 261, Australian Housing and Urban Research Institute Limited, Melbourne, http://www.ahuri.edu.au/research/final-reports/261.

White, M. and Allmendinger, P. (2003) ‘Land-use planning and the housing market: A comparative review of the UK and the USA’, *Urban Studies*, vol. 40, no. 5–6: 953–972.

Whitehead, C. M. E. (1974), *The UK Housing Market: An Econometric Model*, Lexington Books, Lexington.

Wood, G. and Ong, R. (2012), *Sustaining home ownership in the 21st century: emerging policy concerns*, AHURI Final Report No. 187, Australian Housing and Urban Research Institute Limited, Melbourne, http://www.ahuri.edu.au/research/final-reports/187.

Wood, G., Ong, R. and McMurray, C. (2011) *The impacts of the henry review recommendations on the private rental market: savings income discount and rent assistance*, AHURI Final Report No. 175, Australian Housing and Urban Research Institute Limited, Melbourne, http://www.ahuri.edu.au/research/final-reports/175.

Wulff, M., Reynolds, M., Arunachalam, D., Hulse, K. and Yates, J. (2011) *Australia’s private rental market: the supply of, and demand for, affordable dwellings*, AHURI Final Report No 168, Australian Housing and Urban Research Institute Limited, Melbourne, http://www.ahuri.edu.au/research/final-reports/168.

Zabel, J.E., Paterson, R.W. (2006) ‘The effects of critical habitat designation on housing supply: an analysis of California housing construction activity’, *Journal of Regional Science*, vol. 461: 67–95.

Appendix 1: Model outcomes and predictors

Table A1: Model outcomes and predictors

Variable name	Variable definition	Source	Continuous (C)* or Binary (B)	Fixed (F) or Time-varying (TV)	Time period
Outcomes (proxies for new housing supply)					
Number of house building approvals (house model only)	Houses are defined as separate houses and semi-detached dwellings, row or terrace houses, and townhouses (any storey). Only new building approvals are counted, therefore extensions and conversions were excluded.	ABS 8731.0—Building Approvals, Australia	C	TV: Monthly	Contemporaneous
Number of unit building approvals (unit model only)	Units are defined as units, flats or apartments (any storey). Only new Building approvals are counted, therefore extensions and conversions were excluded.	ABS 8731.0—Building Approvals, Australia	C	TV: Monthly	Contemporaneous
Predictors					
Change in real house prices between month *t* and *t*-1 (house model only)	The nominal median house price of each LGA in month *t* is inflated to June 2014 real values using an inflator equivalent to the June 2014 national CPI divided by the national CPI from the quarter that month *t* belongs to. The log of real house prices is calculated for month *t* and *t*-1 and the difference in the logs is taken.	RPData	C	TV: Monthly	Contemporaneous

Variable name	Variable definition	Source	Continuous (C)* or Binary (B)	Fixed (F) or Time-varying (TV)	Time period
Change in real house prices between month *t* and *t*-1, one quarter ago (house model only)	As above, but lagged by 3 months	RPData	C	TV: Monthly	Lagged by 3 months
Change in real house prices between month *t* and *t*-1, two quarters ago (house model only)	As above, but lagged by 6 months	RPData	C	TV: Monthly	Lagged by 6 months
Change in real house prices between month *t* and *t*-1, three quarters ago (house model only)	As above, but lagged by 9 months	RPData	C	TV: Monthly	Lagged by 9 months
Change in real house prices between month *t* and *t*-1, in the last four quarters (house model only)	As above, but lagged by 12 months	RPData	C	TV: Monthly	Lagged by 12 months
Change in real house prices between month *t* and *t*-1, in the last five quarters (house model only)	As above, but lagged by 15 months	RPData	C	TV: Monthly	Lagged by 15 months
Change in real unit prices between month *t* and *t*-1 (unit model only)	The nominal median unit price of each LGA in month t is inflated to June 2014 real values using an inflator equivalent to the June 2014 national CPI divided by the national CPI of the LGA's capital city from the quarter that month t belongs to. The log of real house prices is calculated for month t and t-1 and the difference in the logs is taken.	RPData	C	TV: Monthly	Contemporaneous
Change in real unit prices between month *t* and *t*-1, one quarter ago (house model only)	As above, but lagged by 3 months	RPData	C	TV: Monthly	Lagged by 3 months

Variable name	Variable definition	Source	Continuous (C)* or Binary (B)	Fixed (F) or Time-varying (TV)	Time period
Change in real unit prices between month *t* and *t*-1, two quarters ago (house model only)	As above, but lagged by 6 months	RPData	C	TV: Monthly	Lagged by 6 months
Change in real unit prices between month *t* and *t*-1, three quarters ago (house model only)	As above, but lagged by 9 months	RPData	C	TV: Monthly	Lagged by 9 months
Change in real unit prices between month *t* and *t*-1, in the last four quarters (house model only)	As above, but lagged by 12 months	RPData	C	TV: Monthly	Lagged by 12 months
Change in real house prices between month *t* and *t*-1, in the last five quarters (house model only)	As above, but lagged by 15 months	RPData	C	TV: Monthly	Lagged by 15 months
Real construction labour cost	Total spend by the construction industry on employee salaries and wages, divided by the number of employees in the construction industry. This data is only available on a state/territory basis, so all LGAs within a state/territory are assigned the same wage value. The estimates have been converted to real values using the same CPI inflators applied to the price variables described above.	ABS 8155.0—Australian Industry, 2013–14.	C	Quarterly	Closest quarter
Distance from the CBD	Crude proxy for construction costs. Note that an index of construction cost	ArcGIS	C	F	2016

Variable name	Variable definition	Source	Continuous (C)* or Binary (B)	Fixed (F) or Time-varying (TV)	Time period
	materials for residential construction by capital city is available from the ABS' produce price indexes (cat. no. 6427.0). However, it does not capture variability across LGAs and is not available for non-metropolitan areas, Darwin and Canberra. Given these limitations, the distance from CBD measure is used.				
Population in 1991	LGA estimated resident population for 1991	ABS Census	C	F	1991
Per cent area covered by water bodies	Percentage of LGA land area cover by water bodies both natural and artificial. Includes swamps and marshes	ABS 1379.0.55.001—National Regional Profile, 2008 to 2012.	C	F	2008
Per cent area classed as built up	Percentage of LGA land area that has a concentration of buildings, a network of roads and is supported by other relevant infrastructure'	ABS 1379.0.55.001—National Regional Profile, 2008 to 2012.	C	F	2008
Per cent of land area within each LGA with a slope greater than 15%	Each LGA is divided into 90-metre squares. We have sourced (from Geoscience Australia) the maximum elevation above sea level in each square. The Slope tool in ArcGis calculates the maximum rate of change (maximum gradient) between each square and its 8 neighbouring squares (including diagonal neighbouring squares). The land area covered by	ArcMap and Geoscience Australia	C	F	2016

Variable name	Variable definition	Source	Continuous (C)* or Binary (B)	Fixed (F) or Time-varying (TV)	Time period
	squares that have a maximum gradient greater than 15% is divided by the total area of the LGA to determine the percentage area of an LGA with land gradient (slope) above 15%. Generated in ArcMap. Based on 1 second digital elevation maps sourced from Geoscience Australia.				
Mean monthly precipitation	Mean precipitation in an LGA for each month of the year (mm). Based on interpolated weather data from 1950–2000	Collected on ArcMap from interpolated weather maps. Details about the maps: R.J. Hijmans, S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. *International Journal of Climatology*, vol. 25: 1965–1978.	C	TV: Monthly	Contemporaneous based on 1950–2000 interpolated weather data
Annual temperature range	Mean maximum temperature of the warmest month of the year minus the mean minimum temperature of the coldest month of the year for the LGA	Collected on ArcMap from interpolated weather maps. Details about the maps: R.J. Hijmans, S.E. Cameron, J.L. Parra,	C	TV: Yearly	Contemporaneous based on 1950–2000 interpolated weather data

Variable name	Variable definition	Source	Continuous (C)* or Binary (B)	Fixed (F) or Time-varying (TV)	Time period
		P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. *International Journal of Climatology*, vol. 25: 1965–1978.			
Climate zone	Locations with approximately similar climates that have been combined into eight climate zones. An LGA can in principle fall into one of the following climate zones although it was found that none fell within zone 8: Climate zone 1—High humidity summer, warm winter (omitted category) Climate zone 2—Warm humid summer, mild winter Climate zone 3—Hot dry summer, warm winter Climate zone 4—Hot dry summer, cool winter Climate zone 5—Warm temperate Climate zone 6—Mild temperate Climate zone 7—Cool temperate	Australian Building Codes Board: http://www.abcb.gov.au/Resources/Tools-Calculators/Climate-Zone-Map-Australia-Wide	B	TV	Contemporaneous

Variable name	Variable definition	Source	Continuous (C)* or Binary (B)	Fixed (F) or Time-varying (TV)	Time period
	Climate zone 8—Alpine. These eight climate zones are illustrated in the form of a climate zone map which was created using Bureau of Meteorology climatic data with two supplementary zones added to accommodate an additional temperate zone and alpine area. The climate zone boundaries are aligned with LGA boundaries and are therefore subject to change from time to time.				
Calendar year	2005 (omitted) 2006 (omitted) 2007 2008 2009 2010 2011 2012 2013 2014	N/A	B	TV: Yearly	Contemporaneous
State capital	Sydney Melbourne	N/A	B	F	Contemporaneous

Variable name	Variable definition	Source	Continuous (C)* or Binary (B)	Fixed (F) or Time-varying (TV)	Time period
	Brisbane				
	Adelaide				
	Perth				
	Hobart				
	Darwin (omitted)				
Weighted score of growth restricting planning regulations	See Appendix 3	AULUPP survey	C	F	2007–09
Weighted score of growth accommodating planning regulations	See Appendix 3	AULUPP survey	C	F	2007–09

*Note: * Continuous variables are converted into logarithmic form before they are entered into the model.*

Appendix 2: Model of key drivers of housing supply responsiveness (excluding planning variables)

The estimates presented in this appendix relate to the econometric model discussed in Chapter 2.

Table A2: Model of key drivers of housing supply responsiveness (excluding planning variables)

(a) Descriptive statistics of key explanatory variables in the econometric model

	Houses	Units
Mean building approvals (N)	22.1	10.5
Mean annual wage per employee in construction industry ($)	50,045.5	49,240.9
Mean distance from CBD (km)	211.0	144.9
Mean 1991 population (N)	36,675.4	55,318.9
Percentage of area covered by water bodies (%)	1.6	1.8
Percentage of area that is built up (%)	17.0	26.8
Per cent of LGA with slope >15% above sea level (%)	11.4	13.6
Mean monthly precipitation	66.4	75.4
Mean annual temperature range	23.6	22.2
High humidity summer, warm winter (%)	4.0	5.0
Warm humid summer, mild winter (%)	6.0	9.0
Hot dry summer, warm winter (%)	5.0	2.0
Hot dry summer, cool winter (%)	19.0	8.0
Warm temperate (%)	28.0	35.0
Mild temperate (%)	25.0	29.0
Cool temperate (%)	13.0	13.0
2005 (%)	0.0	0.0
2006 (%)	2.0	2.0
2007 (%)	14.0	13.0
2008 (%)	14.0	13.0
2009 (%)	13.0	13.0
2010 (%)	13.0	13.0
2011 (%)	13.0	13.0
2012 (%)	13.0	13.0
2013 (%)	13.0	13.0
2014 (%)	6.0	7.0
Sydney (%)	9.0	15.0
Melbourne (%)	7.0	11.0
Brisbane (%)	2.0	2.0
Adelaide (%)	4.0	7.0
Perth (%)	7.0	10.0
Hobart (%)	1.0	2.0
Darwin (%)	1.0	1.0
Canberra (%)	0.0	0.0

(b) Full set of model coefficients

Explanatory variables	Houses	Units
Price changes		
Change in log price	0.459 ***	0.103
Change in log price (t-1)	0.188	0.982 **
Change in log price (t-2)	0.353 ***	1.036 **
Change in log price (t-3)	0.40 8 ***	1.027 **
Change in log price (t-4)	0.185	0.673
Change in log price (t-5)	0.392 ***	0.672
Change in log price (t-6)	0.488 ***	0.556
Change in log price (t-7)	0.276 **	0.146
Change in log price (t-8)	0.279 **	0.135
Change in log price (t-9)	0.363 ***	0.645
Change in log price (t-10)	0.273 **	0.190
Change in log price (t-11)	0.292 **	0.515
Change in log price (t-12)	0.523 ***	0.455
Change in log price (t-13)	0.316 **	0.872 *
Change in log price (t-14)	0.313 **	0.230
Change in log price (t-15)	0.400 ***	0.700
Construction costs		
Log of wage per employee in construction industry	1.619 ***	0.446 ***
Log of distance from CBD in km (construction cost proxy)	-0.341 ***	-0.049 ***
Population size		
Log of 1991 population	0.969 ***	0.284 ***
Land use and topography		
Log of percentage of area covered by water bodies	0.024 ***	-0.028 ***
Log of percentage of area that is built up	-0.076 ***	0.090 ***
Log of per cent of LGA with slope >15% above sea level	-0.013 ***	-0.059 ***
Climate		
Log of mean monthly precipitation	-0.069 ***	0.001
Log of annual temperature range	-0.741 ***	-0.345 ***
Warm humid summer, mild winter	-0.142 ***	-0.068
Hot dry summer, warm winter	-0.517 ***	-0.180 ***
Hot dry summer, cool winter	-0.647 ***	-0.380 ***
Warm temperate	-0.267 ***	-0.451 ***
Mild temperate	-0.077 ***	-0.474 ***
Cool temperate	-0.404 ***	-0.342 ***
Year and capital city		
2007	-0.002	-0.032
2008	-0.103 ***	-0.065
2009	-0.117 ***	-0.088
2010	-0.140 ***	0.025
2011	-0.353 ***	-0.113 *
2012	-0.515 ***	-0.058

Explanatory variables	Houses		Units	
2013	-0.527	***	-0.069	
2014	-0.509	***	-0.063	
Sydney	-2.772	***	-0.265	
Melbourne	-1.784	***	-0.476	***
Brisbane	-1.181	***	0.117	
Adelaide	-1.540	***	-0.603	***
Perth	-1.618	***	-0.636	***
Hobart	-1.419	***	-0.439	***
Darwin	-1.589	***	-0.164	
Canberra	-0.699	***	2.924	***
Sydney * 2007	-0.008		0.195	
Sydney * 2008	0.005		0.120	
Sydney * 2009	0.114		0.134	
Sydney * 2010	0.203	**	0.214	
Sydney * 2011	0.323	***	0.214	
Sydney * 2012	0.384	***	0.309	**
Sydney * 2013	0.425	***	0.745	***
Sydney * 2014	0.439	***	0.771	***
Melbourne * 2007	0.169		0.092	
Melbourne * 2008	0.233	*	0.132	
Melbourne * 2009	0.160		0.474	***
Melbourne * 2010	0.338	***	0.922	***
Melbourne * 2011	0.345	***	0.771	***
Melbourne * 2012	0.334	***	1.103	***
Melbourne * 2013	0.407	***	1.058	***
Melbourne * 2014	0.468	***	1.004	***
Constant	-19.992	***	-5.519	***
Sample	42880		26721	
F-stat	1554.100	***	136.050	***
Adjusted R-sq	0.692		0.239	

*Note: *** Significant at the 1 per cent level. ** Significant at the 5 per cent level. * Significant at the 10 per cent level. All continuous variables are converted in logarithmic form. In both models, the omitted categories for the binary variables are high humidity summer, warm winter, 2005–06 and areas that lie outside the GCCSAs.*

Source: Authors' own calculations from sources in Appendix Table A1.

Appendix 3: List of growth accommodating and growth restricting planning instruments from the AULUPP

Table A3: List of growth accommodating and growth restricting planning instruments from the AULUPP

(a) Growth accommodating

Planning instrument	Score
Reduced parking requirements for applicable developments in areas near public transport	1
Tradeable development rights	1
Incentives for conservation agreements	1
For social mix	1
Accessory dwellings or granny flats permitted as part of residential development generally	1
Accessory dwellings or granny flats permitted as part of detached residential development	1
Accessory dwellings or granny flats permitted as part of medium density residential development	1
Accessory dwellings or granny flats permitted as part of high density residential development	1
Accessory dwellings or granny flats permitted as part of rural residential development	1
Accessory dwellings or granny flats permitted as part of residential development in a mixed use zone	1
Boarding / rooming houses permitted as part of residential development generally	1
Boarding / rooming houses permitted as part of detached residential development	1
Boarding / rooming houses permitted as part of medium density residential development	1
Boarding / rooming houses permitted as part of high density residential development	1
Boarding / rooming houses permitted as part of rural residential development	1
Boarding / rooming houses permitted as part of residential development in a mixed use zone	1
Dual occupancies permitted as part of residential development generally	1
Dual occupancies permitted as part of detached residential development	1
Dual occupancies permitted as part of medium density development	1
Dual occupancies permitted as part of high density residential development	1
Dual occupancies permitted as part of rural residential development	1
Dual occupancies permitted as part of residential development in a mixed use zone	1
Manufactured homes permitted as part of residential development generally	1
Manufactured homes permitted as part of detached residential development	1
Manufactured homes permitted as part of medium density residential development	1
Manufactured homes permitted as part of high density residential development	1
Manufactured homes permitted as part of rural residential development	1
Manufactured homes permitted as part of residential development in a mixed use zone	1
Dedicated seniors accommodation permitted as part of residential development generally	1

Planning instrument	Score
Dedicated seniors accommodation permitted as part of detached residential development	1
Dedicated seniors accommodation permitted as part of medium density residential development	1
Dedicated seniors accommodation permitted as part of high density residential development	1
Dedicated seniors accommodation permitted as part of rural residential development	1
Dedicated seniors accommodation permitted as part of residential development in a mixed use zone	1
Group homes permitted as part of residential development generally	1
Group homes permitted as part of detached residential development	1
Group homes permitted as part of medium density residential development	1
Group homes permitted as part of high density residential development	1
Group homes permitted as part of rural residential development	1
Group homes permitted as part of residential development in a mixed use zone	1
Caravan parks permitted as part of residential development generally	1
Caravan parks permitted as part of detached residential development	1
Caravan parks permitted as part of medium density residential development	1
Caravan parks permitted as part of high density residential development	1
Caravan parks permitted as part of rural residential development	1
Caravan parks permitted as part of residential development in a mixed use zone	1
Environmental offsets / trade-offs	2
Clustering on less sensitive areas of environmentally significant sites	2
Mixed use zones	3
High / medium density residential development zones in proximity to public transport, major nodes or corridors	3
Incentives for mixed commercial / residential development in well located areas	3
Dedicated zone for medium density residential development	3
Dedicated zone for high density residential development	3
Dedicated mixed use zone	3
For housing diversity	3
Incentives for mixed residential / commercial development	3

(b) Growth restricting

Planning instrument	Score
Requirement for bicycle paths / dedicated lanes for new subdivisions or applicable developments	1
Requirement for bicycle facilities in employment buildings	1
Requirement for footpaths / walkways in new subdivisions or other applicable developments	1
Requirements for passive energy utilisation / energy saving in the design of buildings	1
Requirement for water saving approaches	1
Requirement for water sensitive urban design in new subdivisions / redevelopment areas	1
Requirement for retention / planting of endogenous species in sensitive areas	1
Requirement for waste minimisation strategies in the construction and operation of new developments	1
Protect wildlife habitat—Zone	1
Protect wildlife habitat—Overlay	1
Protect Wetlands—Zone	1
Protect Wetlands—Overlay	1
Protect native vegetation—Zone	1
Protect native vegetation—Overlay	1
Protect catchment values—Zone	1
Protect catchment values—Overlay	1
Protect landscape values—Zone	1
Protect landscape values—Overlay	1
Protect coastal features / processes—Zone	1
Protect coastal features / processes—Overlay	1
Manage interface between protected natural areas and surrounding lands—Zone	1
Manage interface between protected natural areas and surrounding lands—Overlay	1
Climate change adaptation—Zone	1
Climate change adaptation—Overlay	1
Climate change mitigation—Zone	1
Climate change mitigation—Overlay	1
Reduce vulnerability to bushfire—Zone	1
Reduce vulnerability to bushfire—Overlay	1
Green building criteria / performance targets	1
Dedicated zone for detached residential development	1
Use of floor space ratios to control the density of residential development generally	1
Use of floor space ratios to control density of detached residential development	1

Planning instrument	Score
Use of floor space ratios to control density of medium density residential development	1
Use of floor space ratios to control density of high density residential development	1
Use of floor space ratios to control density of rural residential development	1
Use of floor space ratios to control density of residential development in mixed use zone	1
Height controls used to control the number of storeys of residential development generally	1
Height controls used to control the number of storeys of detached residential development	1
Height controls used to control the number of storeys of medium density residential development	1
Height controls used to control the number of storeys of high density residential development	1
Height controls used to control the number of storeys of rural residential development	1
Height controls used to control the number of storeys of residential development in mixed use zone	1
Protect wildlife habitat —EIS / special assessment requirements	2
Protect wildlife habitat—referral to agency	2
Protect wildlife habitat—Other	2
Protect Wetlands—EIS / special assessment requirements	2
Protect Wetlands—Referral to agency	2
Protect Wetlands—Other	2
Protect native vegetation—EIS / special assessment requirements	2
Protect native vegetation—Referral to agency	2
Protect native vegetation—Other	2
Protect catchment values—EIS / special assessment requirements	2
Protect catchment values—Referral to agency	2
Protect catchment values—Other	2
Protect landscape values—EIS / special assessment requirements	2
Protect landscape values—Referral to agency	2
Protect landscape values—Other	2
Protect coastal features / processes—EIS / special assessment requirements	2
Protect coastal features / processes—Referral to other agencies	2
Protect coastal features / processes—Other	2
Manage interface between protected natural areas and surrounding lands—EIS / special assessment requirements	2
Manage interface between protected natural areas and surrounding lands—Referral to other agencies	2
Manage interface between protected natural areas and surrounding lands—Other	2

Planning instrument	Score
Climate change adaptation—EIS / special assessment requirements	2
Climate change adaptation—Referral to other agency	2
Climate change adaptation—Other	2
Climate change mitigation—EIS / special assessment requirements	2
Climate change mitigation—Referral to other agency	2
Climate change mitigation—Other	2
Reduce vulnerability to bushfire—EIS / special assessment requirements	2
Reduce vulnerability to bushfire—Referral to other agencies	2
Reduce vulnerability to bushfire—Other	2
Minimum lot size or erection of a dwelling or residential subdivision applied to residential development generally	2
Minimum lot size or erection of a dwelling or residential subdivision applied to detached residential development	2
Minimum lot size or erection of a dwelling or residential subdivision applied to medium density residential development	2
Minimum lot size or erection of a dwelling or residential subdivision applied to high density residential development	2
Minimum lot size or erection of a dwelling or residential subdivision applied to rural residential development	2
Minimum lot size or erection of a dwelling or residential subdivision applied to residential development in mixed use zone	2
Dwellings attached to places of employment permitted as part of residential development generally	2
Dwellings attached to places of employment permitted as part of detached residential development	2
Dwellings attached to places of employment permitted as part of medium density residential development	2
Dwellings attached to places of employment permitted as part of high density residential development	2
Dwellings attached to places of employment permitted as part of rural residential development	2
Dwellings attached to places of employment permitted as part of residential development in a mixed use zone	2
Protect wildlife habitat—Development Prohibition	3
Protect Wetlands—Development prohibition	3
Protect native vegetation—Development prohibition	3
Protect catchment values—Development prohibition	3
Protect landscape values—Development prohibition	3

Planning instrument	Score
Protect coastal features / processes—Development prohibition	3
Manage interface between protected natural areas and surrounding lands—Development prohibition	3
Climate change adaptation—Development prohibition	3
Climate change mitigation—Development Prohibition	3
Reduce vulnerability to bushfire—Development prohibition	3
Urban growth boundary	3
Population cap	3
Other controls to regulate the density of residential development applied to residential development generally	3
Other controls to regulate the density of residential development applied to detached residential development	3
Other controls to regulate the density of residential development applied to medium density residential development	3
Other controls to regulate the density of residential development applied to high density residential development	3
Other controls to regulate the density of residential development applied to rural residential development	3
Other controls to regulate the density of residential development applied to residential development in mixed use zone	3
To retain or protect affordable housing in the area	3
To achieve adaptable housing	3
Accessibility / adaptability requirements for a proportion of residential dwellings	3
Minimum / maximum bedroom configuration requirements for medium / high density residential developments	3
Limitation on redevelopment of low cost accommodation such as boarding or rooming houses	3
Limitations on redevelopment of caravan parks	3
Social impact analyses for developments that might impact on the housing needs of low income groups	3
Requirement for employee housing	3
Signal that contributions for affordable housing will be sought when applications for residential rezoning / variation of residential development standards are lodged.	3

Appendix 4: Impact of planning regulations on housing supply responsiveness

The estimates presented in this appendix relate to the econometric model discussed in Chapter 4.

Table A4: Impact of planning regulations on housing supply responsiveness

(a) Descriptive statistics of key explanatory variables in the econometric model

	Houses	Units
Mean building approvals (N)	26.9	13.5
Mean annual wage per employee in construction industry ($)	49,066.4	49,543.4
Mean distance from CBD (km)	124.9	67.3
Mean 1991 population (N)	48,642.8	63,095.1
Percentage of area covered by water bodies (%)	1.6	1.7
Percentage of area that is built up (%)	28.9	38.5
Per cent of LGA with slope >15% above sea level (%)	11.4	11.7
Mean monthly precipitation	70.0	75.1
Mean annual temperature range	22.9	21.9
High humidity summer, warm winter (%)	1.2	1.1
Warm humid summer, mild winter (%)	3.6	4.4
Hot dry summer, warm winter (%)	1.6	0.1
Hot dry summer, cool winter (%)	15.8	8.1
Warm temperate (%)	37.5	44.1
Mild temperate (%)	27.3	30.9
Cool temperate (%)	13.0	11.2
2005 (%)	0.0	0.0
2006 (%)	2.2	2.2
2007 (%)	13.2	13.2
2008 (%)	13.2	13.1
2009 (%)	13.1	13.1
2010 (%)	13.0	13.1
2011 (%)	13.0	12.9
2012 (%)	12.9	12.9
2013 (%)	12.9	13.1
2014 (%)	6.5	6.5
Sydney (%)	16.7	22.4
Melbourne (%)	11.9	16.0
Brisbane (%)	1.2	1.6
Adelaide (%)	6.0	8.0

	Houses	Units
Perth (%)	11.8	14.8
Hobart (%)	1.6	2.1
Darwin (%)	1.2	1.1
Canberra (%)	0.0	0.0
Weighted score—growth accommodating planning instruments	15.0	17.0
Weighted score—growth restricting planning instruments	28.8	31.0

(b) Full set of model coefficients

	Houses		Units	
Explanatory variables	**Coef.**	**Sig.**	**Coef.**	**Sig.**
Price changes				
Change in log price (t and t-1)	0.428	**	0.058	
Change in log price (t-1 and t-2)	-0.014		1.086	
Change in log price (t-2 and t-3)	0.287		1.044	
Change in log price (t-3 and t-4)	0.318		1.073	
Change in log price (t-4 and t-5)	0.146		0.876	
Change in log price (t-5) and t-6	0.325	*	0.859	
Change in log price (t-6) and t-7	0.482	**	0.841	
Change in log price (t-7 and t-8)	0.154		0.378	
Change in log price (t-8 and t-9)	0.155		-0.415	
Change in log price (t-9 and t-10)	0.408	**	0.694	
Change in log price (t-10 and t-11)	0.159		0.160	
Change in log price (t-11 and t-12)	0.175		0.900	
Change in log price (t-12 and t-13)	0.513	**	0.563	
Change in log price (t-13 and t-14)	0.181		0.910	
Change in log price (t-14 and t-15)	0.254		0.009	
Change in log price (t-15 and t-16)	0.371	*	1.144	*
Construction costs				
Log of wage per employee in construction industry	1.408	***	0.593	***
Log of distance from CBD in km (construction cost proxy)	-0.337	***	-0.050	
Population size				
Log of 1991 population	1.022	***	0.246	***
Land use and topography				
Log of percentage of area covered by water bodies	0.040	***	-0.063	***
Log of percentage of area that is built up	-0.144	***	0.097	***
Log of per cent of LGA with slope >15% above	-0.040	***	-0.092	***

Explanatory variables	Houses		Units	
	Coef.	Sig.	Coef.	Sig.
sea level				
Planning regulations				***
Log of weighted score—growth accommodating planning instruments	0.041	***	0.081	***
Log of weighted score—growth restricting planning instruments	-0.004		-0.025	
Climate				***
Log of mean monthly precipitation	-0.086	***	0.018	
Log of annual temperature range	-0.734	***	-0.171	
Warm humid summer, mild winter	0.285	***	0.049	
Hot dry summer, warm winter	0.000		0.441	
Hot dry summer, cool winter	-0.005		-0.132	
Warm temperate	0.311	***	-0.202	
Mild temperate	0.607	***	-0.280	
Cool temperate	0.282	***	-0.119	
Year and capital city				
2007	-0.008		-0.107	
2008	-0.120	**	-0.092	
2009	-0.112	**	-0.133	
2010	-0.127	**	-0.019	
2011	-0.341	***	-0.166	*
2012	-0.493	***	-0.105	
2013	-0.449	***	-0.128	
2014	-0.411	***	-0.077	
Sydney	-2.491	***	-0.317	
Melbourne	-1.630	***	-0.517	**
Brisbane	-0.853	***	0.781	***
Adelaide	-1.229	***	-0.602	***
Perth	-1.204	***	-0.779	***
Hobart	-1.219	***	-0.318	*
Darwin	-0.839	***		
Sydney * 2007	0.008		0.225	
Sydney * 2008	0.045		0.110	
Sydney * 2009	0.116		0.165	
Sydney * 2010	0.210	*	0.233	
Sydney * 2011	0.325	***	0.216	
Sydney * 2012	0.377	***	0.329	*

Explanatory variables	Houses		Units	
	Coef.	Sig.	Coef.	Sig.
Sydney * 2013	0.368	***	0.740	***
Sydney * 2014	0.376	***	0.720	***
Melbourne * 2007	0.190		0.169	
Melbourne * 2008	0.263	**	0.156	
Melbourne * 2009	0.166		0.527	***
Melbourne * 2010	0.346	**	0.985	***
Melbourne * 2011	0.358	***	0.837	***
Melbourne * 2012	0.338	**	1.167	***
Melbourne * 2013	0.363	***	1.136	***
Melbourne * 2014	0.405	***	1.032	***
Constant	-18.981	***	-7.571	***
Sample	23,144		17,255	
F-stat	781.79	***	75.04	***
Adjusted R-sq	0.677		0.210	

*Note: *** Significant at the 1 per cent level. ** Significant at the 5 per cent level. * Significant at the 10 per cent level. All continuous variables are converted in logarithmic form. In both models, the omitted categories for the binary variables are high humidity summer, warm winter, 2005–06 and areas that lie outside the GCCSAs. In the house (unit) model, Canberra (Hobart and Canberra) are also omitted due to insufficient sample sizes in these categories.*

Source: Authors' own calculations from sources in Appendix Table A1.

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Australian Housing and Urban Research Institute

Level 1
114 Flinders Street
Melbourne Victoria 3000

T +61 3 9660 2300
E information@ahuri.edu.au

ahuri.edu.au

ACN 090 448 918

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