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Commuting burden and housing affordability for low-income renters

From the AHURI Inquiry: Urban productivity and affordable rental housing supply

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Acronyms and abbreviations used in this report

3D	Three Dimensional
ABS	Australian Bureau of Statistics
AHURI	Australian Housing and Urban Research Institute Limited
CBD	Central Business District
DELWP	Department of Environment, Land, Water and Planning
DIRDC	Department of Infrastructure, Regional Development, and Cities
EC	Employment Centre
GRZ	General Residential Zone
GSC	Greater Sydney Commission
IA	Infrastructure Australia
Q1	Income Quintile 1
Q2	Income Quintile 2
JTW	Journey To Work
LDRZ	Low-density residential zone
MB	Mesh Block
NRMA	National Roads and Motorists' Association
NRZ	Neighbourhood residential zone
OD	Origin-Destination
PC	Productivity Commission
PT	Public Transport
RGZ	Residential growth zone
SA2	Statistical Area 2
SRP	Supporting Research Project A
UGZ	Urban Growth zone
VFE	Vehicle Fuel Efficiency

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

- There is a need to better understand the contribution of urban spatial labour markets to urban productivity, particularly in relation to job access cost of commuting. Policy needs to improve its framing of urban productivity in relation to job access and, in turn, the contribution that urban labour markets make to urban productivity.
- On average, commuting burdens comprise 9.4 per cent of income for Q2 renters in Melbourne, and 8.6 per cent for Q2 renters in Sydney. The total number of Q2 renters who have commuting burdens greater than the average is no more than 12,000 for each city.
- Of the no more than 12,000 Q2 renters with an above-average commuting burden in each of Sydney or Melbourne, fewer than 5,000 commuters in each city travel to the top 10 employment destinations for this group. This dispersed spatial pattern of employment makes locationally targeted policy difficult to apply.
- There are comparatively few sites within 10 kilometres of the top 10 locations for Q2 renter employment where the current rental market conditions make new market-priced housing development feasible to the extent that it overcomes commuting burdens.
- There is extensive market underutilisation of residentially zoned land in Sydney and Melbourne. The planning system clearly intends that residential development should occur at much higher average dwelling yields per unit area of land than the market is supplying under present conditions. The reasons for this underutilisation deserve further investigation.

Key findings

Improving understanding of urban spatial labour market

This project argues that there is a need to better understand the contribution of urban spatial labour markets to urban productivity, particularly in relation to the cost of commuting. There is relatively limited international literature that seeks to understand urban labour markets from a theoretical perspective that is oriented to the productivity benefits of agglomeration. There is almost no work that has directly investigated such questions in the Australian context. Policy understandings of urban productivity are underdeveloped with little appreciation of issues beyond 'congestion' or 'access'. Given the increasing recognition of the importance of urban productivity in Australia's major urban areas, there is an urgent need to improve research and policy knowledge of this area. Policy needs to improve its framing of urban productivity and, in turn, the contribution that urban labour markets make to urban productivity. This includes going beyond simple framings of agglomeration theory around labour market depth, breadth and access, to a more nuanced understanding of the total cost of work access relative to economic value produced. State metropolitan planning policies and federal infrastructure and productivity policies require improved understanding of these questions.

High commuting burdens affect a minor proportion of Q2 renters

On average, commuting burdens comprise 9.4 per cent of income for Q2 renters in Melbourne, and 8.6 per cent of income for Q2 renters in Sydney. Based on our model, the total number of Q2 renters who have commuting burdens greater than these levels is no more than 12,000 for each city. These relatively small proportions and absolute numbers for above-average commuting cost Q2 renters suggest that the impacts of higher than average commuting burdens are likely to be modest. Policy that improves overall metropolitan accessibility in an affordable way would benefit all workers (and firms), including Q2 renters.

Dispersed workplace locations constrain customised accessibility policies for Q2 renters

Of the no more than 12,000 above-average commuting burden Q2 renters in each of Sydney or Melbourne, fewer than 5,000 commuters in each city in total travel to the top 10 employment destinations for this group. This dispersed spatial pattern of employment makes locationally targeted policy to address Q2 renter burdens difficult to apply. While it is possible to focus future affordable housing development around Q2 renter employment concentration locations, the targeting of such housing to this worker category may not benefit all Q2 renters. Policies that improve housing affordability for renters generally around Q2 employment nodes, particularly at the lower end of the market, are likely to be supportive of wider efforts to improve Q2 renter housing and commuting affordability. Similarly, policies to improve commuting access to dispersed employment, such as via better overall public transport network coordination may improve overall accessibility for Q2 renters, while also benefitting other worker cohorts.

Limited site options for affordable market housing meaning non-market support is needed

There are comparatively few sites within 10 kilometres of the top 10 locations for Q2 renter employment where the current rental market conditions make new market-priced housing development feasible to the extent that it overcomes commuting burdens. A larger number of sites, however, become feasible for development at 75 per cent of market rental pricing. If policy is to target Q2 renters through delivery of new stock proximate to Q2 renter employment concentrations, then delivery vehicles that are able to operate with some shielding from market cost pressures (such as community housing organisations) are likely to be required.

Extensive market underutilisation of zoned residential land

The analysis presented in this study suggests there is extensive market underutilisation of residentially zoned land in Sydney and Melbourne. The planning system clearly intends that residential development should occur at much higher average dwelling yields per unit area of land than the market is supplying under present conditions. This suggests that strategies involving relaxation of residential zoning regulations may not be as effective as policies to encourage intensification of current residential zones to dwelling densities that are closer to the 75th percentile. Intensification would also generally support improved work access for Q2 renters.

Policy development options

The study

This report is structured in three main parts: Chapter One, Chapter Two, and Chapter Three.

Chapter one

Chapter one sets the policy context for the research, discusses existing research and details the research methods through which the study was undertaken.

The review of the policy context in Chapter one shows that there is a growing appreciation among policy and advisory organisations at both state and federal levels that the productivity of Australia's major cities is an important contributor to overall economic growth and productivity. However, despite urban productivity becoming a recognised issue, the conceptualisation of productivity within policy is underdeveloped. Typically, versions of agglomeration theory are applied to urban productivity but with limited further elaboration. Often, Australian urban policy cleaves to concern with 'congestion' as a policy issue or to general statements about labour market accessibility. While these issues may affect urban productivity, both the conceptual and empirical mechanisms are not well understood.

The review of existing research shows that there has been considerable attention to theories and evidence of urban productivity in recent decades, principally around the advantages that firms enjoy in co-locating within urban agglomerations. These benefits include access to larger specialised labour markets, sharing of infrastructure and knowledge spillovers. However, the literature has not yet offered a sophisticated understanding of how commuting patterns contribute to urban productivity in terms of labour market matching at the individual worker level or at the aggregate for a given metropolitan region. The focus on second-income-quintile renter workers presented in the existing research is intended to advance the understanding of this question.

The final part of chapter one details the research methods used. Three main approaches are applied. First, the study undertakes analysis of journey to work patterns for Sydney and Melbourne for Q2 renter workers. This analysis is based on a specially requested ABS Census dataset and assesses the costs of commuting by public transport and private motor vehicle. Next, the study assesses the rental costs for Q2 renters relative to commuting costs using ABS Census data. An appraisal is then made of the major commuting destinations for Q2 renters in each of Sydney and Melbourne, identifying the top 10 destinations. Assessments are then made of land-use capacity for residential intensification within 10 kilometres of these top 10 destinations to reduce commuting burdens. Last, scenarios are applied to identify specific sites that could be redeveloped to deliver new affordable housing to Q2 renter workers.

Chapter two

Chapter two presents the results of the research study. The chapter begins with a review of existing knowledge of commuting burdens in Australian cities. This review demonstrates that while there has been occasional attention to commuting burdens within the literature, this attention has not focused on particular productivity issues or on the experience of particular subgroups such as Q2 renters.

Next, the chapter calculates commuting burdens for Q2 renters. This is achieved by determining the distance between their origin SA2 and workplace SA2 and applying weightings according to travel mode, including distance travelled, motor vehicle fuel efficiency and fixed cost factors. The method for calculation of public transport travel is detailed, including the assignment of route and fare costs. The analysis identifies a moderate inverse relationship between rent paid by Q2 workers and the costs of commuting. This appears to have the character of a bid-rent curve relationship. In general, a gain in rent of approximately AU\$100 per week resulted in a reduction in commuting costs of approximately AU\$3 per day (AU\$15 per five-day week), which implies that rents for Q2 renters capitalise more than a commuting expenditure versus rent trade-off.

The chapter then identifies the main locations for affordable housing supply based on a combination of planning zoning and market conditions. This analysis was initially undertaken using rental data for Sydney and Melbourne based on the 2016 Census which revealed the distribution of rents across each city, as well as the distribution of Q2 renters. The research then creates and applies a scenario-based model to identify suitable sites for provision of affordable housing for Q2 renters based on mesh blocks where dwelling densities were less than the 75th and 90th percentile for residentially zoned land in each of Sydney and Melbourne. Potential suitable locations for affordable housing were identified based on a combination of proximity to Q2 renter employment destinations, dwelling densities less than the 75th percentile for residential zones and where market rents for current stock were no greater than for the existing locations of current Q2 renters working in those employment destinations. This analysis identified many, though often isolated, locations across Melbourne and Sydney that would be suitable for affordable housing development targeting Q2 renters.

The chapter also identified the main locations to which Q2 renters travel for work, using a sophisticated journey to work model of specialised ABS Census data tables. This analysis focused on the top 10 commuting destinations for Q2 renters. It demonstrated that Q2 renter commuting is spatially concentrated around a limited number of employment centres. In Sydney, this was principally the CBD and immediately adjacent inner-urban localities. In Melbourne, Q2 renter commuting destination patterns were more polycentric, with a number of middle suburban sites serving as major commuting foci, in addition to the Melbourne CBD.

Next, Chapter two investigated commuting patterns in two metropolitan-adjacent satellite cities: Wollongong adjacent to Sydney and Geelong adjacent to Melbourne. The analysis investigated self-containment rates for Wollongong and Geelong, and found that for Q2 renters there is a high degree of self-containment within each city and the largest work destination zone is the satellite city's CBD. The relatively modest rents expended by satellite city Q2 renters and the lesser distances traveled by the satellite city Q2 renters in accessing work (compared to metropolitan peers) implies that issues of rental affordability and commuting burden are not a priority for policy attention.

Chapter three

Chapter three of the report assesses the key questions the research answers. The chapter identifies a series of findings, including: improved understanding of the urban spatial labour market in Sydney and Melbourne; better knowledge of the proportion of Q2 renters with high commuting burdens; insight into the issues posed by dispersed Q2 renter commuting patterns; appreciation of the relatively limited sites for new employment-proximate Q2 renter affordable housing development; and the extensive market underutilisation of residentially zoned land.

The chapter includes a series of policy development options, including: policies to address employment distribution; transport networks to respond to dispersed commuting patterns, and; new vehicles for affordable housing delivery.

1. Low-income renters, commuting and urban productivity

- **The spatial productivity of Australia's cities is now a major policy concern with implications for national productivity.**
- **Commuting is the mechanism through which workers access employment. Commuting patterns are influenced by housing markets (in terms of the residential location of workers) and land markets (in terms of firms' locational selections).**
- **Urban productivity depends, in part, on efficient labour markets that provide:**
 - Firms with a wide and deep pool of workers to best match workers to jobs
 - Workers with good spatial job access, delivering benefits such as improved employment opportunities and wages
- **Research and policy concerns have been raised that housing market spatial structures may result in low-income workers residing in locations that are remote from employment concentrations, leading to weaker worker-job matching and worker exclusion from opportunity.**
- **The research addresses these issues by investigating:**
 - The distribution of affordable rental housing in Sydney and Melbourne
 - Whether low-income households experience exclusionary housing markets relative to employment access
 - Scenarios for affordable housing supply to reduce commuting burdens for low-income renters

1.1 Why this research was conducted

1.1.1 Inquiry problem

This research addresses the important problem of advancing the understanding of the spatial productivity of Australia's metropolitan areas to support the broader goal of enhancing national economic performance. In this study, spatial productivity is defined as "the aggregate relationship between metropolitan scale inputs, in terms of labour and capital, and outputs, in terms of metropolitan product". A city that is able to produce more output for a given level of labour and capital input will be more productive than a city that produces less output for the same inputs, other factors being equal. Labour inputs include workers, while capital inputs include infrastructure and production capital, such as roads, rail and workplaces.

A major component of this spatial productivity challenge is ensuring urban labour markets are efficient in matching workers to jobs both in terms of skill matching and in the costs of work access. A city that experiences poor worker-job matching at high commuting cost may experience poorer economic performance than a city that is able to match its workers to jobs more effectively and at a lower access cost. Therefore, a better understanding of the spatial dynamics of labour market accessibility within cities can aid the development of policy approaches to improve urban productivity.

Commuting has two spatial components: a worker's residential origin and their workplace destination. Worker selection of residential location is subject to complex trade-offs based on such factors as household composition, house prices and locational attributes. Conversely, workplace location arises from firms' optimisation of access to suppliers, markets or clients with access to labour markets. In large metropolitan regions, the spatial coordination of residential locations and workplaces may be subject to complex dynamics. Not all of these may be efficient, particularly for workers who have limited options in terms of their residential location within spatial housing markets relative to employment locations. Workers in lower income tiers may be particularly exposed to exclusionary housing market dynamics.

The research focuses on the experience in accessing employment of workers in income quintile two (Q2) who are renting their dwellings. These Q2 workers are positioned between the lowest 20 per cent and highest 60 per cent of workers by income. Although there is no formal descriptor as to their position in the labour market, they may generally be considered as 'low-income'. Because of their modest incomes, such workers potentially occupy a particularly pressured position in the housing market. In terms of urban housing markets, such workers are above the threshold of income and capability for most forms of housing assistance, particularly access to public housing or to rent assistance. Yet, they have less income than 60 per cent of workers and are therefore potentially subject to spatial housing market allocation pressures that may limit their locational choices. Such pressures are likely to be more acute for renter households than owner occupiers as the latter group are relatively insulated from housing market price changes once they have purchased their dwelling. By comparison, renter households are exposed to housing market price changes on a generally continuing basis and may experience ongoing exclusionary housing market pressures. This means that the choice of residential location relative to workplace location may be successively constrained for renters during periods of house price inflation. This may lead to progressive exclusion from locations with concentrated employment access. While other income quintile and tenure groups may have relevance to advancing the understanding of urban spatial productivity, the AHURI brief for this research and subsequent focus of this study, is solely Q2 renters.

The research literature has sometimes investigated these questions of employment accessibility via the concept of 'spatial mismatch' between where low-income workers can afford to live and where their employment is located. The notion of spatial mismatch was initially proposed to explain the disadvantaged labour market position experienced by African American workers located within the inner areas of US cities in the late-1960s following a rapid process of suburbanisation from the late-1940s to the mid-1960s (Brueckner and Zenou 2003; Holzer 1991; Kain 1968). Employment in US cities generally suburbanised along with residential activity such that employment within inner and central city locations declined in relative terms. The term spatial mismatch has since been used to understand wider problems of spatial labour market access for lower income or lower skilled workers.

The spatial mismatch hypothesis has been investigated in Australia by Dodson and Berry (2005) who found there was limited evidence for exclusionary labour market effects of housing markets on low-income workers in Melbourne. This is because labour markets tended to sort spatially by wage, employment sector and occupational category, such that there was extensive and dispersed employment in suburbia that was comparatively accessible to lower income workers (such as Q2s). Nonetheless, as Australia's major cities grow in population and spatial extent, there remains a risk that lower income workers will be spatially disadvantaged in terms of labour market access. While low-income worker access to employment has welfare implications, it is also an economic issue in terms of ensuring that workers are well-matched to their jobs at any wage level, thus enabling firms to optimise their productivity.

1.1.2 Purpose of this research

This project seeks to identify the spatial commuting patterns of Q2 renters to understand the extent to which they are exposed to exclusionary housing market pressures in relation to workplace location. The project addresses the Principal Research Question (PRQ) of:

- **PRQ:** How does the changing supply of affordable rental housing for the second lowest income quintile households in Australian cities relate to employment location, including job accessibility and commuting cost burden?

The project is supported by three Supporting Research Questions (SRQ):

- **SRQ1:** How is affordable rental housing distributed spatially in major and satellite Australian cities in relation to employment location for working Q2 renters?
- **SRQ2:** To what extent do Q2 households in more and less affordable housing locations experience relative disadvantage in relation to spatial employment access and commuting costs?
- **SRQ3:** How might alternative scenarios for the location of affordable rental housing and employment in Australian cities support improved overall urban productivity by efficiently connecting working Q2 renters and jobs?

The research was undertaken via a combination of spatial analytical methods based on a dedicated ABS Census dataset of origins and destinations for Q2 renters, obtained by special requests. Further detail on methods is provided in Section 1.4 below.

A caveat is necessary regarding the status of individual workers who commute to work within the context of their household situation. Many workers are positioned within households with more than one income-earner such that individuals' labour market position may not directly translate into their housing market position, all things being equal. This sharing effect within households is likely to moderate the effects of housing markets for low-income workers within medium to high overall income households. Conversely, there may be compounding effects for single-income Q2 households, particularly for those with more than one household member and for which rent and subsistence costs are likely to be high relative to income. Current datasets are not able to offer close residence-workplace matching at scale. Thus, this individual/household problem is difficult to overcome methodologically. In this study, we have focused on the incomes of individuals while recognising that their housing market position in many cases may be moderated by the wider composition and overall income of their household.

1.2 Policy context

1.2.1 Commonwealth policy

Australian urban policy at state and federal levels has recently begun to consider questions of productivity within Australia's cities. The high level of urbanisation within Australia is accompanied by a disproportionately high share of national economic activity being undertaken within the major cities. Cities accommodate approximately 75 per cent of Australia's national population, but account for 80 per cent of economic activity (Major Cities Unit 2012). Although much of Australia's long-run policy imagination has considered the national economy to be based on rural primary production (such as mining and agriculture), there is growing realisation among policy makers that activity within the major cities is crucial to national economic performance (Infrastructure Australia 2018; Productivity Commission 2017). Improving the productivity of Australia's cities offers potential to improve overall economic performance given the disproportionate share of economic activity that occurs within cities. This concern sits within wider debates about slowing productivity growth (Garnaut 2013; Brennan 2019).

Despite productivity becoming a considerable concern in Australian discussions, the policy understanding of the concept remains under-developed. Furthermore, there is a distinction to be made between the conceptual discussions that have been undertaken among advisory agencies such as the Productivity Commission or Infrastructure Australia, relative to the substantive policies and programs that have been implemented to advance urban productivity. Both areas of activity may be treated as representing urban productivity policy.

Within the economics literature, productivity is typically taken to describe the relationship between the volume of inputs in the form of labour time or capital advanced, relative to the volume of output. A firm or economy that is able to produce more outputs than another firm or economy for the same level of labour or capital utilisation may be deemed more productive. At the metropolitan scale, one city is likely to be more productive than another if it can produce more outputs overall for a given level of labour or capital input.

Theories of agglomeration economics suggest that firms co-locate within cities to leverage inter-firm externalities that generate productivity gains through sharing of labour and infrastructure and through knowledge spillovers (McCann and van Oort 2009; Rosenthal and Strange 2001). In terms of agglomeration theory, commuting contributes to productivity primarily through the access of labour to employment. This in turn ensures the availability to firms of deep labour pools and in turn better matching of workers to jobs. That further potentially supports greater intra-firm productivity, and thus greater productivity of the total set of firms within the metropolitan economy. Put conceptually, commuting is specific form of accessibility, which in the transport literature has been understood as the relative ease of access to employment and services experienced by the residents and workers within a city. It is generally assumed that greater accessibility equates to greater urban productivity.

Commonwealth policy discussion

While there is recognition within Australian urban policy of the importance of urban productivity to national economic performance, the formal conceptualisation of what productivity means in the context of Australia's cities remains underdeveloped. Various agencies have sought to understand urban productivity via background policy discussion, but these efforts have so far failed to yield a high level of conceptual clarity. The Productivity Commission (2017) assessed the productivity challenges for cities but focused on very applied questions rather than offering a clear theoretical conceptualisation of what productivity means for cities or urban policy. Rather, the Productivity Commission offered a set of attributes deemed beneficial for city functioning, such as good mobility and provision of long-term opportunities for all workers by labour markets. To the extent that labour market matching was considered by the Productivity Commission (2017) it was in terms of 'congestion', principally road congestion for private motor vehicles. Road traffic congestion aligns indirectly with agglomeration-based theories of productivity in relation to labour market access, but understanding of this relationship is underdeveloped.

Further discussion of urban productivity questions has been offered by Infrastructure Australia (2018) in an assessment of the future needs of Australia's cities. Following the Productivity Commission's avoidance of a clear conceptual framing of productivity, the Infrastructure Australia report also failed to offer a definition of urban productivity. Instead, the Infrastructure Australia report referenced a report by Kelly et al. (2013). Kelly et al. (2013) observed that labour productivity is a relation of hours worked to the value of an employee's output. But while Kelly et al. (2013) made a number of conceptual observations about the contribution of various aspects of urban system function to productivity (such as providing knowledge-intensive firms greater access to more workers), they did not offer insight into how to measure urban productivity.

Both Kelly et al. (2013) and Infrastructure Australia (2018) did offer empirical insights into productivity via the lens of spatial access to employment in relation to worker residential locations, their skill levels and access to employment locations. Kelly et al. (2013) demonstrated that central residential locations had greater relative access to jobs across the metropolitan area than more peripheral sites. Although, they did not offer any specific productivity conclusions from this analysis. Infrastructure Australia (2018) undertook spatial analysis of Melbourne and Sydney to assess the effects of three alternative spatial employment locational scenarios on accessibility of employment:

1. expanded low residential densities
2. increased middle and central residential densities, and
3. concentrated suburban densification.

The results of the Infrastructure Australia models demonstrated that business-as-usual 'unplanned' urban development would, on average, generate lower travel times and journey costs for car travel than the alternative three 'planned' strategies. However, in contrast, travel times for public transport would be reduced among the latter three strategies (Infrastructure Australia 2018). The conclusion offered by Infrastructure Australia is that population growth is likely to generate growth in demand for car travel leading to productivity-limiting congestion. However, strategies to better serve the city's population by public transport can reduce travel times and thus enhance productivity. Infrastructure Australia (2018) did not, however, consider the distributional dimensions of these imputed productivity changes. Thus, there was no effort to differentiate the commuting experience of workers by income category, nor housing tenure.

City Deals

A further area of applied federal policy is the suite of City Deals that are being rolled out nationally. City Deals provide for integrated packages of infrastructure and spatial planning for cities or submetropolitan regions. To date, seven City Deals have been established, with two further in development. The focus so far has been on medium-sized capitals and regional cities, such as Townsville, Darwin and Launceston. At the time of writing, City Deals were in preparation for South East Queensland and Adelaide. However, the only concluded City Deal for a major metropolitan area is that for Western Sydney, which was agreed in 2018.

The Western Sydney City Deal focuses on employment expansion within the Western Parkland subregion, principally around the new Western Sydney Airport with a further 200,000 jobs expected supported by new rail infrastructure and research facilities (DIRDC 2018). The City Deal anticipates state and local land-use planning provisions to enable development of housing within the region, though this is principally via regulatory and governance mechanisms rather than direct housing investment. The plan does not specifically address housing affordability or employment access issues for low-income renter households. However, it might be reasonably interpreted that this cohort is at least partly envisaged as benefiting from the employment, transport and liveability elements of the overall plan. We note that further discussion of City Deals is provided in a companion study to this report entitled *Strategic planning, 'city deals' and affordable housing*.

Summary

The brief survey of current federal policy offered above suggests that, while spatial accessibility and labour market issues are a policy concern, they are not being expressed in a way that considers the specific circumstances of Q2 renter households. It might be presumed that policy is not concerned with this set of households specifically, but is rather more generally targeted at overall households and in relation to employment accessibility generally.

1.2.2 Metropolitan policy

Formal metropolitan policies for Australia's two largest urban metropolitan regions reflect concerns about urban productivity, though typically in an indirect way. Two main sets of documents are most relevant: metropolitan plans prepared by state planning authorities, and Commonwealth urban program documents. This section discusses metropolitan planning documents for Melbourne and Sydney to assess how they link productivity with labour market access for low-income households, both conceptually and practically.

Melbourne

The development of Melbourne is governed by the *Plan Melbourne* metropolitan strategy (DELWP 2017). In relation to urban productivity this plan expects that:

“Increasing the number and diversity of jobs closer to where people live—in places such as suburban employment clusters, health and education precincts and industrial precincts—will help make Melbourne more productive and competitive.” (DELWP 2017: 8)

The land-use elements set out in section one of the *Plan Melbourne* strategy seek to facilitate the spatial development of what it terms national employment clusters distributed across the city and along high capacity transport networks. The intent of this planning approach is to ‘close to where people live’. These clusters are proposed to be complemented by a set of activity centres linked by transport networks. The transport elements of the plan treat transport network enhancement as a productivity measure, by linking people to jobs and businesses to markets.

One of the feature constructs within *Plan Melbourne* is the notion of the ‘20-minute neighbourhood’ which proposes to design local neighbourhoods within which residents are able to access employment and services within a 20-minute travel time (DELWP 2017: 47). The Plan seems unsure whether the 20-minute neighbourhood model comprises a productivity measure, arguing that local 20-minute travel is different to work-related travel (DELWP 2017: 72). Similarly, such neighbourhoods are more intended to support inclusion, cohesion and a ‘vibrant’—rather than ‘productive’—local economy (DELWP 2017: 99).

In terms of relevance to the present study, *Plan Melbourne* does not specifically target particular income or tenure categories in its spatial plans. Affordable and social housing is identified as an objective of the Plan, particularly to relieve problems for low-income households. Although, the plan does mention Centrelink-income households, which tend to be within the first income quintile (Q1). Nor is there specific attention to the spatial distribution of affordable housing for low-income households other than general references to using local neighbourhoods and activity centres to facilitate diverse housing. Thus, while elements of *Plan Melbourne* may assist Q2 renters with their housing affordability and job access, this is likely to be only indirectly in the context of the wider, more general, components of the Plan.

Sydney

The current *Sydney Region Plan* (GSC 2018) envisages the Sydney metropolitan region as organised spatially into three subregions: Western Parkland, Central River and Eastern Harbour. These are organised respectively around the proposed Western Sydney 'aerotropolis', the existing Parramatta major activity centre and the current Sydney central business district. The Plan emphasises Sydney's role within the Australian national economy as the location for advanced financial services, as well as education, research and manufacturing (GSC 2018: 79), implicitly highlighting the high productivity of these sectors.

However, the *Sydney Region Plan* does not offer a specific conceptualisation of productivity, rather preferring to identify a set of actions that will improve productivity (GSC 2018: 83). The Plan assumes that Sydney can be made more productive via a combination of concentrated sites of employment and services connected to each other and to residential areas by fast public transport links. It notes that a bias of employment to the east of the city is constraining job choice for residents of western zones. The Plan anticipates that a more polycentric urban structure will "enhance business access to a greater number of skilled workers, which increases their employment opportunities and productivity" (GSC 2018: 84), though the focus is on firms not on employees.

Reduced travel times assumed to arise from a more polycentric urban structure are reflected in the Sydney version of the Melbourne 20-minute neighbourhood construct, adjusted to a '30-minute city' notion. This anticipates that:

"...most people can travel to their nearest metropolitan centre or cluster by public transport within 30 minutes; and where everyone can travel to their nearest strategic centre by public transport seven days a week to access jobs, shops and services" (GSC 2018: 80).

As with the Melbourne Plan, there is no specific reference to lower income households, such as Q2 renters, though it does recognise that "[a]n absence of affordable housing often results in workers having to commute for long distances" (GSC 2018: 68). Thus, while the Sydney Plan identifies the need for housing measures specifically for low-income housing groups, it does not explain this requirement explicitly in productivity terms, nor does it focus on renters. Productivity, it seems, is not strongly conceptually linked to housing affordability for low-income workers in existing Sydney metropolitan policy.

Summary

The framing of affordable housing as a social inclusion measure, rather than a productivity concern, is common to both the Sydney and Melbourne metropolitan plans. It appears that productivity arguments in favour of affordable housing have not yet gained strong purchase in metropolitan planning in the regions where exclusionary affordability effects on workers have become most pronounced. Rather, affordable housing policy remains framed through a social inclusionary lens. Clearly, further conceptual work is required that better ties the provision of affordable, well-located housing for low-income workers to productivity effects for metropolitan economies.

1.3 Existing research

Urban economics, agglomeration and productivity

Since the late-1990s attention within economic geography has increasingly focused on the contribution of cities to economic productivity. An extensive literature has emerged that has sought to understand the factors that enhance urban productivity. Productivity is conventionally defined as the relationship between economic inputs and economic outputs (e.g. OECD 2016). An economic system is more productive if it can produce more output for a given level of inputs than another system. The variables used to measure productivity are typically the volume of labour time (total hours worked), or capital utilised, to produce a given volume of outputs (Green 2012).

With an increasing share of population dwelling in cities and, in turn, concentrating economic growth within cities, the urban literature has sought to describe and understand the factors that support higher urban productivity. Much of the discussion has emphasised agglomeration economies which are understood to underpin the co-location of firms in geographic space (Rosenthal and Strange 2000), particularly those reliant on knowledge work (Mori and Turrini 2005). According to this agglomeration framing, firms co-locate to take advantage of three factors that reduce the inputs required for a given level of output. First, when firms co-locate they attract a larger pool of labour from which they can draw workers, enabling better matching between worker skills and job requirements, leading to greater output per hours worked of labour input. Second, firms are able to share infrastructure, such as transportation, telecommunications, water and energy services and networks, thus reducing per-firm costs of capital inputs to production. Last, firms benefit from knowledge spillover effects, including transmission of ideas and techniques between firms and between workers. Together, these labour market and knowledge effects are purported to result in economies of scale. Every additional firm within an urban economy potentially adds to the labour pool, reduces relative costs of infrastructure provision, and contributes its knowledge to the wider business environment. Estimates of the elasticity of productivity in relation to urban jobs density sit between 4 per cent and 6 per cent (Ciccone 2002; Harris and Loannides 2000; Rice, Venables, and Patacchini 2006).

The literature on the urban agglomeration economics of work access has typically focused on the overall cohort of workers. Some studies have focused on income effects of agglomeration (Eriksson, Lindgren and Malmberg 2008; Partridge and Rickman 2008). There are relatively few studies that have investigated the experience of job access for workers in particular subcategories, such as those on low-incomes who are likely to face housing market pressures in larger cities (Mori and Turrini 2005). Studies that seek to enumerate the productivity effects of improving such workers' job access are rare.

Although underdeveloped, the literature generally agrees that there is a relationship between urban structure, travel cost, distance and time, and workplace and residential locations, that influences the productivity of cities overall (Arbues, Banos and Mayor 2015). In this study, we use the term spatial productivity to refer to the way these relationships affect the overall productivity of the city.

Transport, accessibility urban productivity

The transport system can be taken as influencing productivity through two principal factors relating to labour markets and infrastructure. First, in most cities, workplaces and residences are separated in space, either via preferential self-sorting through land markets or, more typically, via land-use regulation. Where workplaces and residences are spatially separated, workers will need to travel between their home and workplace to access employment. Consequently, this work-related travel generates demand for transportation networks and services. This study focuses on the productivity of commuting as a major input into metropolitan production. In this context we use productivity to mean the relative cost of commuting inputs (direct commuting costs) to outputs, measured in worker's wages. This use differs from the typical measure of input-output in economic analysis and is expressed as a 'burden' on workers arising from the spatial structure of the city.

A metropolitan transport network that allows workers to access workplaces with little friction will widen and deepen an urban labour market in comparison to a transport network that imposes access frictions on workers. Where employment is unevenly distributed within a city, a 'spatial mismatch' may occur under which workers may experience differentiated access to jobs (Brueckner and Zenou 2003; Ihlanfeldt and Sjoquist 1998). While this phenomenon has been observed as particularly pronounced for minority and lower income groups in US cities, there is limited evidence apparent in Australian cities (Dodson and Berry 2005). By 'urban productivity' we refer to the overall capacity of the city to derive a volume of outputs from a given set of inputs. Commuting costs are a form of input (infrastructure, fuel, vehicles). Hence, it may be assumed a city that can get its workers to their workplaces for a lower input level will, other factors being equal, be more productive than a city that requires a higher overall level of commuting inputs. This assumption focuses on the transport inputs, but does not offer a perspective on the at-work productivity of commuters.

Some scholarship has sought to understand the effects of transport systems on workers' workplace productivity. Access to a wider and deeper labour pool should, according to theories of urban economic agglomeration, also enable firms to better match workers' skills to job needs (Venables 2011) thus enabling workers to be more productive *at work*. The literature has referred to this relationship as one of increased 'effective job density' (Venables 2007). Where a network becomes congested, such as through traffic volumes that exceed road network capacity, or via overcrowding on public transport networks, the degree of access enjoyed by workers to a wide array of workplaces may be constrained. In the absence of compensating spatial adjustments by workers and firms this may lead to reduced skills-jobs matching and effective labour underutilisation (Venables 2011). This effect has implication for rates of unemployment. Norman and Anderstig (2017) found there was a negative relationship between spatial labour market accessibility and unemployment rate for low-income workers, with effects strongest for the lowest-education worker groups.

The second influence of transport networks on productivity relates to the use of infrastructure. As a large form of fixed capital, infrastructure is financially costly and complex to procure. The greater the utilisation of infrastructure across a cohort of firms, the larger the pool of contributions to the fixed costs is likely to be. This reduces the average costs per firm and potentially ensures closer matching of infrastructure demand to supply. Like increasing the number of firms, improving urban access through infrastructure also increases effective jobs density. However, as infrastructure is expensive, the optimisation of infrastructure provision so that sufficient capacity is provided to meet demand but that no underutilisation occurs is thus anticipated by agglomeration theory (though not necessarily guaranteed in practice). However, caveats do apply. Given network effects, provision of infrastructure assumes a mechanism, such as specialised infrastructure firms or a similar state authority, through which infrastructure demand can be met (Vickrey 1977).

There is some literature which argues that transport networks can modify the structure of agglomeration economies. Some authors have argued that traffic congestion raises costs to business and effectively shrinks business market areas, reducing agglomeration economies (Weisbrod, Vary and Treyz 2003). Other literature suggests that public transport investments can expand the scale of agglomeration economy by better connecting a wider pool of workers to firms (Chatman and Noland 2011; 2014). Song et al. (2012) investigated links between agglomeration and transport accessibility in Seoul. Their study found that accessibility generally has a positive association with agglomeration, and transit accessibility exhibits an especially strong relationship with industrial agglomeration. Song et al. (2012) emphasised investment in transit as a conclusion.

Clearly, there is a relationship between transport networks, employment accessibility and the spatial productivity of cities. However, housing has not yet been systematically investigated in relation to these patterns.

Housing and urban productivity

The literature on housing and productivity is underdeveloped. Studies directly investigating housing costs in relation to urban spatial productivity are sparse. This contrasts with the extensive literature that considers indirect productivity effects arising from perceived constraints on housing supply due to land-use regulations. This includes extensive argument from first principles and models, though with fewer empirical assessments.

Some studies have linked housing to urban productivity at a general scale (Albouy 2016; Glaeser, Gyourko and Saks 2006; Kim 2011; Knaap 1985; Quigley and Rosenthal 2005). Albouy (2016), for example, suggests that wage and housing cost differences across US metropolitan areas are accounted for more by productivity than quality-of-life (amenity) measures. Although, this analysis was more at a macro scale than the submetropolitan level. Glaeser, Gyourko and Saks (2006) suggest that urban success is related to the housing supply in divergent ways: where limited regulation and low-density facilitate new housing construction, population growth is the principal success marker. In contrast, cities with high-density and high regulation urban success (e.g. higher productivity) are likely to be marked by higher house prices and incomes. Glaeser, Gyourko and Saks (2006) caution that productivity cannot be considered in isolation from housing markets.

Kim (2011) assesses how land-use regulation affects regional prosperity, arguing that land-use regulations have countervailing regional economic effects. First land-use regulation can support regional productivity through constraints on negative externalities, ensuring efficient compact development and providing certainty. Conversely, regulation may reduce site use flexibility and generate disequilibria between demand and supply. Quigley and Rosenthal (2005) offer a comparable critical perspective on assumptions about linear effects from land-use regulation on house prices. They argue that even where land-use regulation may purport to limit housing supply, this is often not the case in practice, due to poor implementation. They also suggest that places with higher productivity tend to experience higher incomes, which may be associated with preferences for greater land-use regulation to preserve amenity. Knaap's (1985) study of an early urban growth boundary application in Portland found that while the boundary did raise internal land prices, it also led to higher rates of internal intensification, which was a deliberate policy objective. Hence, the price effect was intentional, not inadvertent.

Some of the literature has considered the Australian context. Moran (2007) is an example of the argument that land-use regulation limits land supply and dwelling supply, which results in higher prices being paid for housing than would otherwise be the case if the regulation was absent. The consequence, Moran (2007) argues, is that rather than savings being used for productive investment they are directed to land purchase. By implication therefore, the city may become less productive as rents siphon off from effective incomes. This contention is not about urban productivity specifically in that it does not offer an account of how outputs within the urban economy will be lower due to high rents from land-use regulation. A converse view could be that high land prices in cities serve as a market signal as to the value embodied in land as a bundle of attributes, irrespective of the degree of land-use constraint. Firms wishing to reduce land costs could relocate to zones that are less highly priced.

The thesis that land-use regulation results in higher land prices and thus higher rents is debated within the Australian research literature. Gurran and Phibbs (2013; 2016) have argued that while media and industry claim that planning regulations limit housing supply, the supporting evidence has not yet been assembled. Rather, they argue that the efforts to respond to this critique generate uncertainty in the development sector that limits positive action to support supply expansion. In an assessment of how housing links to productivity, Gurran et al. (2015) suggested that concerns about housing supply effects on labour market participation and mobility, urban congestion, and wider economic costs had been raised in Australia. The authors noted, however, that these concerns were founded on a limited empirical evidence base that could support policy development in this area. Gurran et al. (2015) argued that part of the problem is definitional; the literature and policy sphere do not have a sufficient comprehension of key measures of supply performance diagnosis and response, which limits the potential for clear insight. Further appraisal was offered by Ong et al. (2017) who assessed the productivity implications of insufficiently elastic housing supply response to demand. Ong et al. (2017) linked urban productivity to housing supply such that, where improved productivity is associated with house price inflation, the economic gains may be squandered (due to transfers as rents). Ong et al. (2017) estimated that a 1 per cent increase in the level of real housing prices would produce a 4.7 per cent gain in house supply and a 3.9 per cent gain for units, albeit resulting in a very small expansion of housing stocks. They did not offer detailed discussion of the implications for productivity from such findings, but did note that further work on links between commuting and productivity, in relation to residential location, was merited. In a more general study of planning regulation in Melbourne, Buxton and Taylor (2011) tested the proposition that the city's urban growth boundary led to land price inflation. They found that there is no clear evidence for inflationary effects from the growth boundary, thus complicating claims that the boundary increases land prices.

From the Australian literature discussed immediately above, it is apparent that there are a number of weaknesses in current knowledge. Empirical support for theoretical claims, such as Moran (2007), that planning regulation limits housing supply and imperils urban productivity is currently weak. Moreover, the literature signals that further conceptual and methodological work is needed to more adequately understand the relationship between housing and urban productivity.

Some of this conceptual work has been offered by Maclennan et al. (2019) in an assessment of the links between housing and urban productivity. The authors ask how agglomeration economies could be shaped by housing investment and residential densities, measured by travel time savings. They used a Cadence Economics General Equilibrium Model (CEGEM) to measure a 'better housing outcomes' scenario against business-as-usual for Sydney, defined as 125,000 additional dwellings located in 'well-serviced, accessible' locations, which were principally locations with high 'effective jobs density' (Maclennan et al. 2019). Maclennan et al. (2019) calculated that AU\$31 billion in economic benefits were to be gained from the 'better housing outcomes' scenario, which also yielded a cost-benefit ratio of 2.95. It deserves note that the Maclennan et al. (2019) model included a cost for the provision of affordable housing in the 'better housing outcome' localities. Of further note is the generality of the targeting of the Maclennan et al. (2019) model; no disaggregation of population was undertaken such that travel time savings were calculated for the workforce overall, not for income-specific or tenure-specific subpopulations, such as Q2 renters. Reflecting observations offered in this study, Maclennan et al. (2019) also mused that a number of deficits afflict spatial analysis of housing and urban productivity in Australia, in terms of data, models and research capacity. However, a weakness of the Maclennan et al. (2019) study is that the authors adopt a normative stance that new housing must be located within employment centres in order to yield productivity gains ('better housing outcomes'). Agglomeration theory is largely agnostic as to submetropolitan centring as it prioritises overall labour market accessibility. Thus, jobs do not necessarily need to be located in centres, as long as they are accessible to the widest potential pool of metropolitan workers via the transport network. Indeed, concentrating more workers in employment centres where rents are already high may result in cost inflation in such locations, or pose additional costs where an affordable housing vehicle is used as a supply mechanism.

Summary

The research literature has made various efforts to understand the role of transport networks and housing in shaping urban productivity. Extensive attention has been dedicated to understanding how agglomeration effects influence productivity. Some consideration has been presented in relation to transport networks, particularly the potential for improved transport accessibility to increase the effective spatial labour market of a city. However, few, if any, studies have focused on specific subgroups with particular circumstances, such as low-income renters. Likewise, in the housing literature there has been relatively limited attention to productivity dimensions of housing supply. Much of the debate over the past decade has been entangled in the contestation of planning regulation without great attention to the productivity dimensions of such interventions. At best, the conclusions from this effort are modest. Planning regulation may limit housing supply and place pressure on house prices but any relationship is complex, non-linear and subject to countervailing positive effects that may moderate the effects of higher prices. Throughout this literature, productivity remains an elusive concept, with only Maclennan et al. (2019) appearing to have taken due care to offer clear conceptualisation. Therefore, the present study has a constructive role to play in attending to the potential productivity implications for the specific Q2 renter subgroup while avoiding focus on the restrictive role of planning regulation.

1.4 Research approach

1.4.1 Data

This project made extensive use of spatial data to identify and analyse the commuting patterns of Q2 renters and their housing and transport costs (Table 1). Three main datasets were used in the research to assess the commuting burdens and housing cost for Q2 renters:

1. **Transport:** journey to work (JTW), transport infrastructure.
2. **Demographic and household:** individual income, household rent.
3. **Land uses:** land-use classification, dwelling unit data.

Journey to work (JTW) data and transport datasets

A customised JTW dataset for Q2 renters in the Sydney and Melbourne metropolitan areas was obtained from the ABS via a special data request. This dataset provided detailed spatial information on JTW origins and destinations, as well as trip mode, for all Q2 workers. We used the Statistical Area Level 2 (SA2) spatial unit to represent the origin and destination zones. Further data used to model the transport cost of commuting included land-use data, transport networks, private vehicle fleet fuel efficiency data, fuel price, and public transport (PT) fare structure data.

Individual weekly income and household weekly rent

The data for the average personal income and household weekly rent payments for Q2 renters (SA2 level) was obtained from ABS through our special data request. The count of Q2 employed persons and Q2 households for SA2 was also provided. The ratio between employed person and household who are in Q2 renter category was calculated for each SA2. This ratio was then used to calculate the Q2 household income at SA2 level (using the known Q2 renter personal income).

Land-use category and dwelling

Residential land-use data for Sydney and Melbourne was used in our analysis of housing capacity in each city. Two types of datasets were used to identify residential land uses. The first was the land-use classification at mesh block (MB) level provided by ABS. MBs are the smallest spatial unit for which dwelling counts and land uses are provided for the five ABS urban land-use classes (residential, commercial, service, industrial, and open-space). The residential zoning distributions and boundaries detailing zoning for a greater range of land-use categories were obtained from the Victorian and New South Wales state governments. The dwelling density in a MB was measured by the total dwelling count divided by the size of the area of the MB, where it is categorised as residential land-use.

Household weekly rent payments from the 2016 ABS Census were used to calculate rental market cost for each of Sydney and Melbourne, at fine spatial scale. In order to capture variation in housing costs at close spatial resolution, rental costs were calculated at Statistical Area Level 1 (SA1). The ABS Census data only provided frequency data for weekly rent payments by equal-width rental cost classes, so we used these to calculate the relative weight of each rental cost class. The weights were assigned to the mean of each class and an estimate of household housing expenditure for each SA1 was then calculated using the weighted means of rent classes. Although this approach does not capture the variation in spending within each class, we consider that the overall mean for a sufficient number of classes (e.g. 26 classes) should effectively capture the spatial variation in housing rental cost.

Table 1: Spatial data used in the analysis, for Victoria

Data	Purpose	Sources
Employment statistics by place of work (separated by industry, occupation)	Measure job density and employment composition in an area	ABS Census 2016
Journey to work origin-destination matrix separated by travel mode	Measure number of trips and travel distance between the trip origin and destination	ABS Census 2016
Road network with travel speed, public transport routes and stops	Measure commuting distance and travel time on road networks	Department of Transport, Victoria
Motor vehicle registration, Green Vehicle guide	Measure the level of fuel consumption of private vehicles within a suburb	VicRoads
Public transport fare scheme and zoning	Calculate public transport fares for a given trip origin and destination	Public Transport Victoria
Parcel level land-use category data	Estimate the job density; estimate trip origin and destination in a suburb	Victorian Government

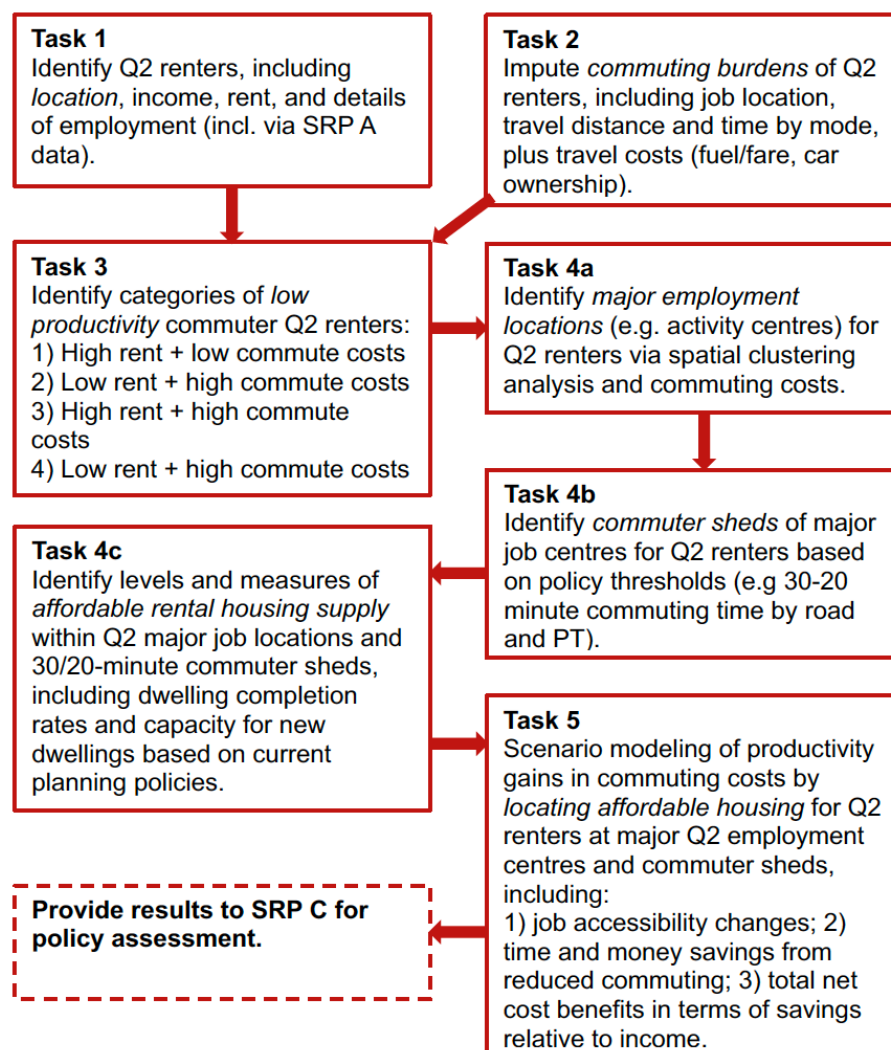
Source: Authors.

1.4.2 Methodology

The conceptual framework for the project is illustrated in Figure 1 with tasks described as follows:

- **Task One:** Draw on SRP A results and customised ABS data to identify numbers of Q2 renters in the study areas living in affordable and unaffordable housing.
- **Task Two:** Measure the commuting patterns, transport costs, and rent for Q2 renters in these locations.
- **Task Three:** Identify Q2 renters with high commuting burdens.
- **Task Four:** Identify employment locations of low productivity Q2 renters, and assess current occupancy and the capacity of affordable housing supply in the job accessible zones.
- **Task Five:** Evaluate potential gains from increasing the supply of affordable renting house to current low productivity Q2 renters.

Figure 1: Flowchart of project tasks



Source: Authors.

Task 1: Identify Q2 renters in study areas

The first task identified Q2 renters for the study city at SA2 level, including count, average income, weekly rent, industry type, journey to work destinations and travel mode. The data was obtained by special query of customised ABS datasets.

Task 2: Modelling commuting costs of Q2 renters by travel mode

This task assessed Q2 renters' employment and commuting costs for different transport modes. Drawing on methodologies developed in previous research (Li et al. 2013; 2015; 2017) our model measured the effective costs of commuting travels to workers by combining workers' origin-destination travel with standard fuel efficiency for private vehicles to estimate the level of fuel consumption and monetary costs for commuting travels. Similarly, our model calculated costs of travel by public transport using the relevant fare structure for each city.

Task 3: Identify Q2 renters with high commuting burdens

This task compared the commuting costs for Q2 renters with their income to identify their relative expenditure patterns and the resulting transport and housing cost pressures. We identified Q2 renters who experience high commuting cost relative to total income. Those Q2 renters paying a high proportion of their income on commuting costs are considered to be under high economic pressure and appear to be less productive (in terms of overall urban system performance) relative to income based on current spending-income ratio. By capturing categories and productivity of commuting, we were able to identify geographical or transport frictions between the residential location of Q2 renters and their jobs, whereby a possible improvement to this relationship might make their commuting more productive (both individually and for the transport system overall).

Task 4: Identify job locations of Q2 renters who are under high commuting burdens and current occupancy and capacity of affordable renting in nearby areas

This task identified the major job locations of less productive Q2 renters (who spend a high proportion of income on commuting). This task then analysed each category of low productive Q2 renters separately and discussed their characteristics and how their economic burdens may be mitigated by improved affordable housing supply. The areas within the radius of the main job concentrations for Q2 renters were then identified based on current travel patterns (e.g. mean travel distance) and policy threshold. Potential housing supply opportunities in the identified areas attracting a high number of Q2 renters were assessed against current housing stock, occupancy, and development capacity (local planning scheme including housing redevelopment potential).

Task 5: Evaluate potential gains from increasing the supply of affordable renting house to current low productivity Q2 renters

This task discussed the effects of affordable housing supply on commuting burdens. It estimated the productivity gain by relocating low productive Q2 renters to new affordable renting dwellings in more job accessible zones (identified in task 4) by measuring:

1. number of relocation (based on supply capacity),
2. jobs access change,
3. time/money saving from commuting, and
4. total transport energy/emission reduction.

2. Results and analysis

- **The literature on commuting patterns in Australian cities is under-developed. There is relatively limited knowledge of the commuting patterns of low-income workers, nor of their housing tenure status.**
- **Some studies have investigated commuting costs burdens focusing on social inclusion rather than urban productivity. Most such studies do not specifically differentiate workers by tenure or income status.**
- **The research investigates commuting costs based on specialised ABS Census journey to work origin-destination matrices for second-income-quintile workers in Sydney and Melbourne.**
- **The research investigates the spatial distribution of affordable rental housing supply in Sydney and Melbourne.**
- **The research identifies the top 10 commuting destinations for Q2 workers with high commuting burdens for Sydney and Melbourne. In Sydney, the main job location was the CBD. In Melbourne, Q2 worker job locations with high burdens had a limited polycentric pattern.**
- **The research identifies extensive housing market underutilisation of land for residential dwellings in Sydney and Melbourne based on existing residential zoning.**

- **The research identifies average commuting costs for Q2 workers in each of Sydney and Melbourne, finding average income-relative burdens of 8.6 per cent and 9.4 per cent respectively.**
- **There is a moderate relationship between rents and commuting costs in Sydney and Melbourne which has the appearance of a bid-rent curve.**
- **Commuting does not appear to be a major cost issue for commuters in the satellite cities of Wollongong and Geelong, both of which have high rates of commuting self-containment.**

2.1 Low-income renter commuting and housing patterns in Australian cities

The literature on commuting patterns in Australian cities includes a number of studies of commuting dynamics. Although, the set of studies of commuting costs is relatively few, partly due to the problems of obtaining parameters for the cost of commuting. Manning's (1978) text was the first to systematically use newly available Census-based data to understand the basic structure and dynamics of commuting patterns. Investigation supported by AHURI in the 1990s (Gipps, Brothie, Henshaw, Newton and O'Connor, 1997) undertook extensive appraisal of the journey to work (JTW) in Australian cities. However, this was focused more on the structure of employment than on the distribution of commuting dynamics. Although it provided estimates of travel times at the aggregate, this work did not systematically consider the costs of commuting, nor disaggregated to particular submetropolitan dynamics or specific worker categories. Healy and O'Connor (2001) assessed the distribution of employment across Melbourne, seeking to understand the extent of spatial access of local residential populations to jobs in newer economic sectors considered to have strong future prospect. While that work offered observations of the uneven distribution of such access, it did not seek to chart commuting patterns. As noted previously, Dodson and Berry (2005) sought to understand the degree of spatial mismatch in Melbourne. However, that study was focused more on spatial proximity of residential locations relative to employment locations, rather than direct measurement of commuting patterns per se.

Further studies of commuting patterns have been undertaken more recently in some Australian cities. Mitchell and Watts (2010) undertook analysis of 'functional economic regions' across Australia based on cluster analysis of commuting flows. This work investigated major clusters of work travel through which the structure of employment and residential location can be observed. For example, in Melbourne, six functional economic regions were identified by Mitchell and Watts (2010). However, this analysis was focused on aggregated spatial commuting structures, not individual-scale commuting and did not differentiate commuting patterns by worker category. Li et al. (2015) investigated commuting patterns in South East Queensland using sophisticated analytical techniques to assess changes in commuting distance over time. Li et al. (2015) noted that the decade timeframe over which their study spanned was not sufficient to detect sizeable commuting flow shifts. While they were able to identify new growth areas and similar 'hotspots' there was little disaggregation of flows by worker income category, nor attention to housing tenure questions.

Studies of commuting that attended to income, travel and housing cost questions have been investigated have by Li et al. (2018) and Saberi et al. (2017). Li et al. (2018) were concerned with the distribution of households in terms of JTW costs by motor vehicle and the likely consequences of an increase in fuel costs from either rising oil prices or carbon pricing. They analysed JTW data for Brisbane to calculate like cost pressures on households in terms of residential location relative to work location and the likelihood of higher fuel prices motivating residential relocation to more travel-cost efficient zones (Li et al. 2018). Saberi et al. (2017) investigated household travel and housing costs to better understand the dynamic relation between housing and transport locational choices. They found that households in outer urban areas of Melbourne tended to face the highest transportation costs (Saberi et al. 2017) while those in the inner eastern zones of the tended to face the highest combined transport and housing costs. This indicated that housing costs tend to be higher than commuting costs. Thus, for outer urban households, high transport costs were compensated for by proportionally much lower housing costs.

While the Li et al. (2018) and Saberi (2017) studies offered new insight into the trade-offs made by households in balancing housing and transportation costs within major Australian cities, they typically aggregated households at the metropolitan scale with little differentiation by socio-economic characteristics, such as income (other than in the cost burden calculation) or housing tenure. There appears to be little precedent therefore for the present research which focuses on Q2 households who are renters. This provides an opportunity to focus on the Q2 category on the assumption that those in the Q2 category are among the lowest income group, are unlikely to be receiving substantial state transfer payments, and are also in the most precarious housing tenure. The following sections detail the results of the analysis undertaken of the housing and commuting patterns of Q2 renters and the potential to respond to locationally cost pressures they may be facing.

2.2 Commuting burdens

2.2.1 Commuting burden of Q2 renters

Commuting distance

The first task we undertook was to calculate commuting distances for sets of origin-destination pairs. The commuting distance of Q2 renters was calculated from information about the origin and destination of workers' trips to work at the SA2 scale. Spatial filtering was applied to ensure accurate representation of origins and destinations within SA2s. The (mesh block) MB land-use data from ABS was used to identify accurately the origin and destination of workers' trips within an SA2. The origin of the commute was identified by calculating the mean centre (centroid) of MB within an SA2 that were classified as residential use. The location of the mean centre was weighted by the population of each MB. Trip destinations within an SA2 were identified by calculating the weighted mean of all MBs within the SA2 that were associated with service, commercial, or industrial land uses. Using land-use datasets to identify the origin and destination of trips within an SA2 also helped to estimate the distance of trips within an SA2 (internal trips).

Next, we calculated the length of the route workers travelled from their origin and destination using road network data. We sought to ensure this provided as spatially and temporally accurate representation of likely real commutes as possible. Rather than calculating the shortest path, we modelled routes using total travel time. To do so we used the 'speed sign' data and the data for 'peak hour travel speed' to generate potential speed profiles for each road link at peak hour. Then we calculated the travel time for all road links, based on speed. The collection of road links that offered the shortest travel time for a given trip was used as the travel path for that trip. We note, however, that travel time was not a factor in the calculation of travel cost, which is focused on direct, rather than indirect, costs.

Commuting cost by private vehicles

The next task was to use the origin-destination distances to calculate trip cost. The transport cost for commuting using a private vehicle was estimated based on three factors: length of vehicular trip, per kilometre fuel consumption rate and fuel prices. Length of vehicular trip was calculated as the length of the 'quickest path' between the origin and destination. The average fuel consumption for car commuting in a SA2 was calculated by multiplying the average travel distance (kilometres) and the average VFE (litres of fuel per 100 kilometres travelled) for each SA2, and price per litre of fuel. The average fuel consumption rate for the vehicle fleet within each SA2 was calculated through an analysis of private vehicle registration data combined with Australian Green Vehicle Guide data, which provided standard vehicle fuel efficiency (VFE) data (litres of fuel per 100 kilometres travelled) for a great range of vehicle makes and models in the registration (Li et al. 2013). Because the original VFE measures provided by the Green Vehicle Guide tend to be higher than actual on-road fuel consumption, the standard fuel consumption rate was increased by 20 per cent to account for additional fuel consumption in stop-start traffic. This adjusted VFE was then applied to the vehicular trip length to calculate the fuel consumed for the actual kilometres travelled. A uniform fuel price (AU\$1.30 per litre) that reflected market pricing was used to generate the monetary per unit cost of fuel consumed by a car, based on distance and VFE.

In addition to the vehicular fuel costs, we added in the fixed vehicle ownership costs including annual vehicle plate registration, insurance, and maintenance and service costs. The average fixed cost associated with a medium-sized private passenger vehicle is estimated at AU\$45 per week (RACV, 2019; NRMA, 2019). Some private vehicle trips may also incur parking costs. Such costs were not included in the total per household cost of vehicle transport because the paid parking zones are mainly concentrated in the CBD and are only used for a small proportion of private vehicle trips. It is possible that for trips involving parking the cost of this trip component may exceed that of the on-road travel component. However, using current data it is not possible to obtain Census-scale information on the parking component of work travel cost.

Commuting cost by Public Transport

The datasets for all JTW trips made using public transport (PT) (train, tram and bus) were used to calculate average PT trip costs. In Melbourne, the PT fare for each trip was calculated from the transit zones traversed and the standard fare for the zones travelled. The PT fares were charged separately for two transit zones: Zone 1 and Zone 2 (Public Transport Victoria, 2017). Trips starting and ending within Zone 1 or Zone 2 are charged at the standard price for the relevant zone (AU\$4.10, AU\$5.60). If a trip starts in Zone 1 and ends in Zone 2 (or vice versa) then a two-zone price is charged. In January 2015, the Transport Department of Victoria changed the fare structure, since then all PT travels within Zone 1 and between Zone 1 and Zone 2 have been charged at one zone price (AU\$4.10), with the total fare capped at AU\$8.20 per day.

Rather than using transit zones, PT fares in Sydney are charged based on zones that largely reflect the distance travelled. The fare estimation for Sydney PT trips is more complex, because the PT fares are charged at different rate for train and bus. Because the requested JTW data for Sydney only reports the aggregate PT trips (not separated by train and bus), additional effort was used to disaggregate the PT trips into separate modes: trip by bus and trip by train. This was done by calculating the travel distance and travel time of each PT trips (OD) via road networks and rail networks separately, and then comparing the respective travel time of the trips using each mode. The travel time is estimated by dividing the travel distance by the standard speed of travel by train (43.3 kilometres per hour) and by car (road specific) in Sydney. We only consider the PT trips having both their origin and destination located within 1.5 kilometres (a threshold of walking distance) from a train station in this analysis. The remainder of PT trips are determined using bus fares because there is no nearby rail service supply. Then the rule of splitting the PT trips is that if the total travel time of one trip by rail is 45 per cent less than the total travel time of the same trip by road, that trip is identified as a bus trip. If the travel time for a trip by rail is not 45 per cent slower than that by road it is then classified as a trip using train. The percentage threshold (45 per cent) is determined by the resultant total share of train and car trips for the whole city that are closest possible to the total mode share reported by ABS. Although this project did not explore other methods to find an optimal percentage threshold, this is a simple and generally effective way of splitting PT trips spatially by road and rail. The results have been randomly validated using a number of sampled PT trips and with few errors identified.

Once the mode specific commuting costs were estimated, we calculated the overall commuting cost measured in dollars per day (AU\$/day) for each SA2 by taking the weighted mean of total car trip cost and PT trip cost. The weights of car trip cost and PT trip cost are determined by the proportion of Q2 commuters in a SA2 commuting using car or PT.

Economic burdens of commuting

The economic burden of commuting for Q2 renters is assessed by comparing the total commuting cost relative to personal income. In order to relate an individual's income, which is available on a weekly basis in the Census, we first converted this value to a daily income figure by dividing the number of days a worker commutes in a week (five days). A higher value of the commuting economic burden means the Q2 renter is under higher economic pressure from commuting cost.

2.2.2 Identify the location for affordable rental supply

One objective of this project is to identify suitable locations for affordable rental housing that would reduce the high commuting burdens of Q2 renters. We find that a high number of Q2 renters in Melbourne and Sydney generally pay a proportion of their income on housing rent that is greater than 45 per cent. In such circumstance, other costs relating to commuting and transport further compound cost pressures, resulting in severe overall household affordability pressures from housing and transport cost. We assume Q2 workers whose commuting burden is higher than the mean level have the greater need (or motivation) to shift their current residential and commuting patterns. Given such pressures, planning for affordable rental houses with improved proximity to major job locations could potentially relieve the commuting burden of Q2 workers and improve the productivity of their work related travel, in cost burden terms.

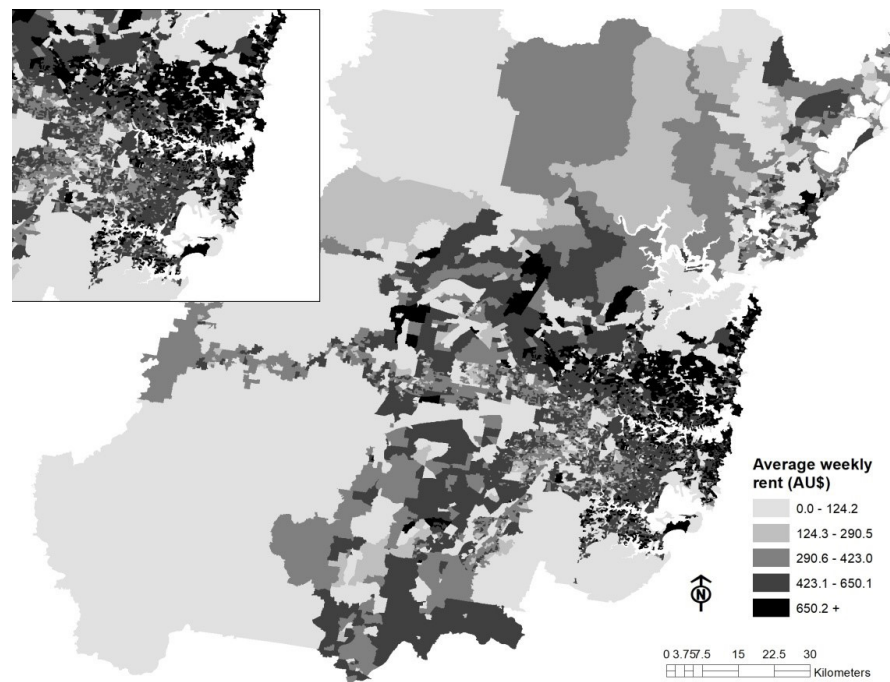
The calculated dwelling rental costs for Sydney and Melbourne are displayed in Figure 2 and Figure 3 respectively. We note that the calculations underpinning these figures are not weighted by hedonic dwelling variables as such a model was beyond the scope of this study.

Figure 2: Average weekly rent for residential dwellings in Melbourne (SA1)



Source: Authors based on ABS Census data.

Figure 3: Average weekly rent for residential dwellings in Sydney (SA1)



Source: Authors based on ABS Census data.

To undertake this task, a basic filtering model to identify suitable locations for affordable housing supply was created. The location for affordable renting supply was identified based on three factors:

1. Improved access (proximity) to jobs for Q2 renters.
2. Available capacity for new housing, measured by the current build-out of local residential zones relative to regulated maximum.
3. Reduced rental (market) cost relative to current residence of Q2 renters.

Improved access to jobs

In this study, we focused on the 10 most frequent trip destinations reported by Q2 renters who are in the top 10 per cent of high commuting burdens. Around each key employment destination, we defined a job catchment zone, the size of which was determined by the average commuting distance of Q2 renters. This was 10.1 kilometres for Melbourne and 9.3 kilometres for Sydney. Next we selected land-parcels (at the MB scale) within these job catchment zones which are deemed suitable for affordable rental housing development. Selection was based on parcel land prices being lower than the average for the origins of the Q2 renters travelling to that employment centre and which have underutilised capacity in terms of housing build-out. We suggest that supplying affordable rental houses for Q2 renters within the more job accessible areas may reduce commuting burdens for Q2 workers who currently experience high commuting costs.

Land capacity for new housing

The housing capacity in a locality is calculated using two datasets:

1. current dwelling density; and
2. the expected dwelling density threshold associated with the planning classification.

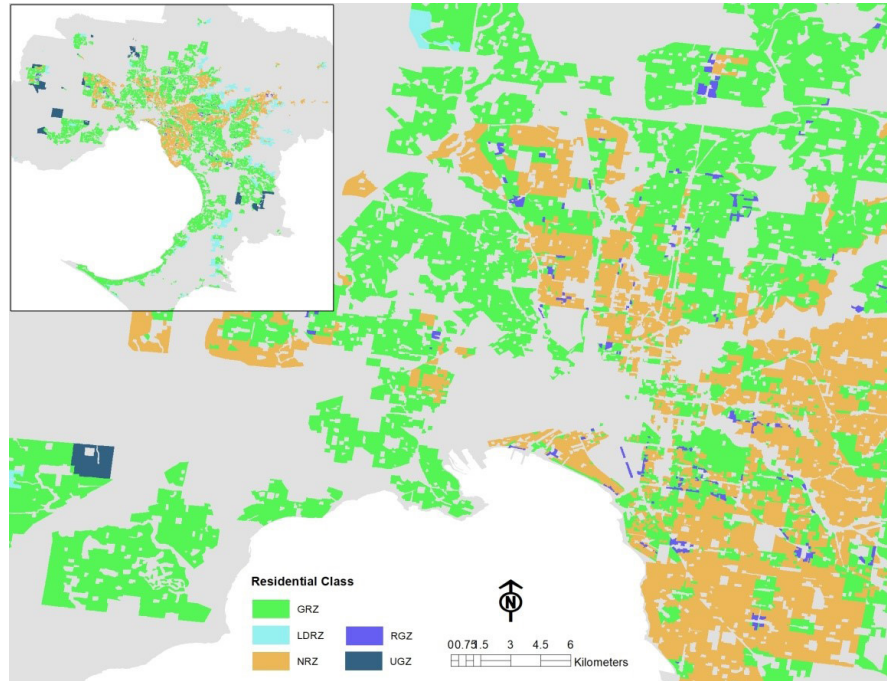
The residential land-use classifications in Melbourne and Sydney are listed in Table 2, and their spatial distribution are displayed in Figure 4 and Figure 5. While we recognise that some dwellings are constructed in other zones, particularly mixed-use zones, it is not possible to use these categories as guides for potential maximum dwelling densities as the uncertainty around the proportion of non-dwelling uses is too great. These residential land classes and zoning are defined by the state government based on each city's strategic growth plan.

Table 2: Residential land-use classes, equivalents in Melbourne and Sydney

Melbourne	Sydney
General residential zone (GRZ)	General residential zone
Low-density residential zone (LDRZ)	Low-density residential zone
Neighbourhood residential zone (NRZ)	Medium-density residential zone
Residential growth zone (RGZ)	High-density residential zone
Urban growth zone (UGZ)	

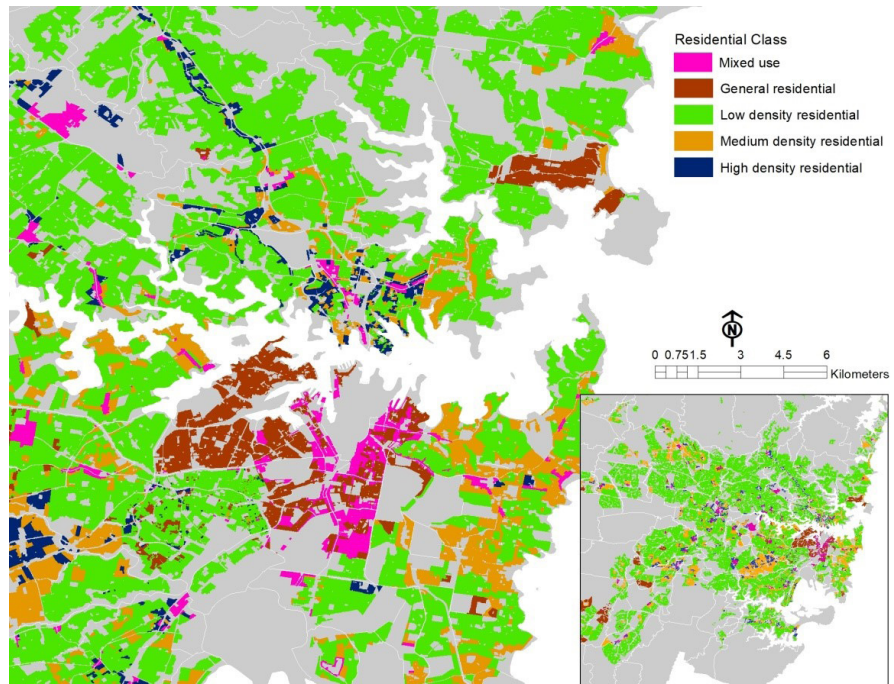
Source: Authors compiled from Victorian and New South Wales government datasets.

Figure 4: Residential zones in Melbourne



Source: Authors compiled from Victorian government data.

Figure 5: Residential zones in Sydney



Source: Authors compiled from New South Wales government data.

The capacity of land for new housing is calculated at the mesh block (MB) level using following steps:

1. Current dwelling density (dwellings per hectare) for each MB is calculated for Sydney and Melbourne.
2. Analyse the spatial distribution of dwelling density of MBs within each residential classification.
3. Calculate the 75th and 90th percentiles of dwelling density of MBs for the major residential classification (planning) zones in each city. The 'possible density' of each MB is the 90th or 75th percentile of density for that zone overall, that is, the top 10 per cent or top 25 per cent. This is justified on the basis that density is distributed across residential zones, despite their uniform regulations, as to the maximum size and scale to which dwellings may be built. Calculations of revealed dwelling density show the potential practical maximum yield from a residential zone, with any zone showing revealed density lower than this level having spare capacity. That is, the market has not yet built to the maximum practically feasible density of dwellings within that zone, as revealed by comparator higher density MBs within the same zoning category. We note, however, that this approach does not consider heritage and other overlays that may restrict development scale.
4. Calculate 'housing capacity' as the difference between the possible density at 90th and 75th percentiles (Table 6, Table 7 and Table 8), and the current density in that MB, multiplied by the size of the MB. For example, in Sydney, the 90th percentile of density for 'medium-density residential' zone is 82.35 dwellings per hectare. If a given MB in that zone has a density of 39.29 dwellings per hectare and an area of 1.12 hectares then the difference in density between the MB and the possible density is 43.06 dwellings per hectare. Multiplying this by 1.12 hectares the mesh block has a 'capacity' based on its zoning, of 48.12 dwellings.

The resultant housing capacity will be used as a threshold factor to identify the suitable land for affordable rental housing supply in each city. Zoned residential MB which have dwelling densities below the threshold percentile are presumed to have underutilised capacity for housing.

Reduced rental cost

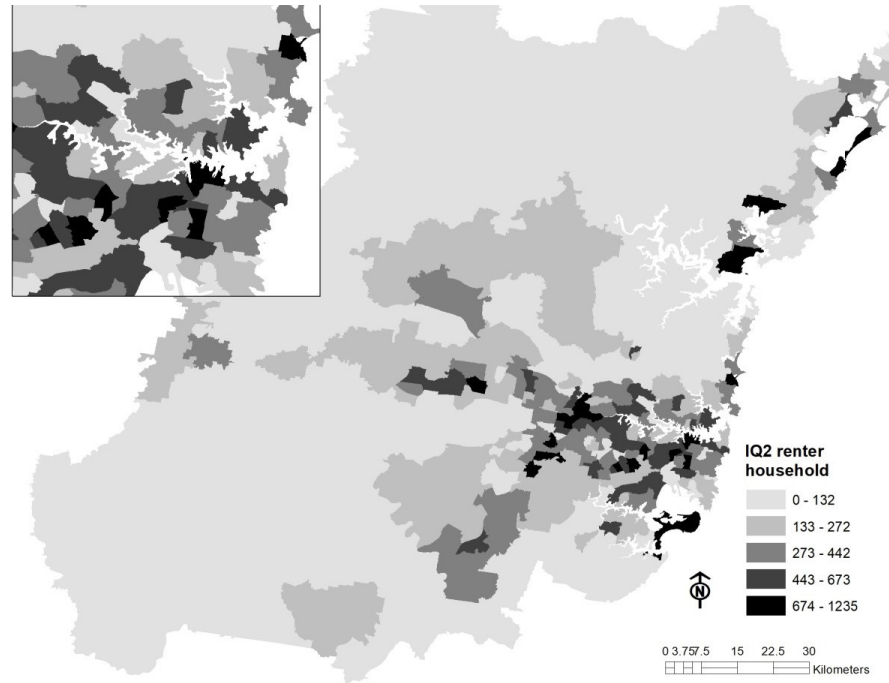
Once the housing capacity for locations within the accessible zones is identified, we selected the areas of the highest housing capacity within each residential land-use classes. Then we compared the housing rental cost of each area with the average rental cost in the current residence of Q2 renters who commute to the respective ECs. The purpose of this step is to exclude the areas in the high rental market and ensure the new rental houses in the proposed neighbourhood are affordable and on average will not add additional cost to Q2 renters after relocation. From a developer's perspective, the areas of low cost are considered most feasible to develop for new affordable housing program given their comparatively low cost for investment and development compared with other areas in the higher rental markets. This step is further justified on the basis that if policy presumes to relocate Q2 renters from existing residential locations to employment-proximate locations then the latter need to offer lower rental costs, other factors being equal, than the original residential location, commuting cost savings notwithstanding. This approach however does not take into account potential subsidies that might accrue to institutionally developed affordable housing, such as provided by a non-profit community housing provider which accesses the charitable tax deduction that allows supply of housing at a rental discount.

2.2.3 Results

2.2.3.1 Distribution of Q2 renters on urban areas

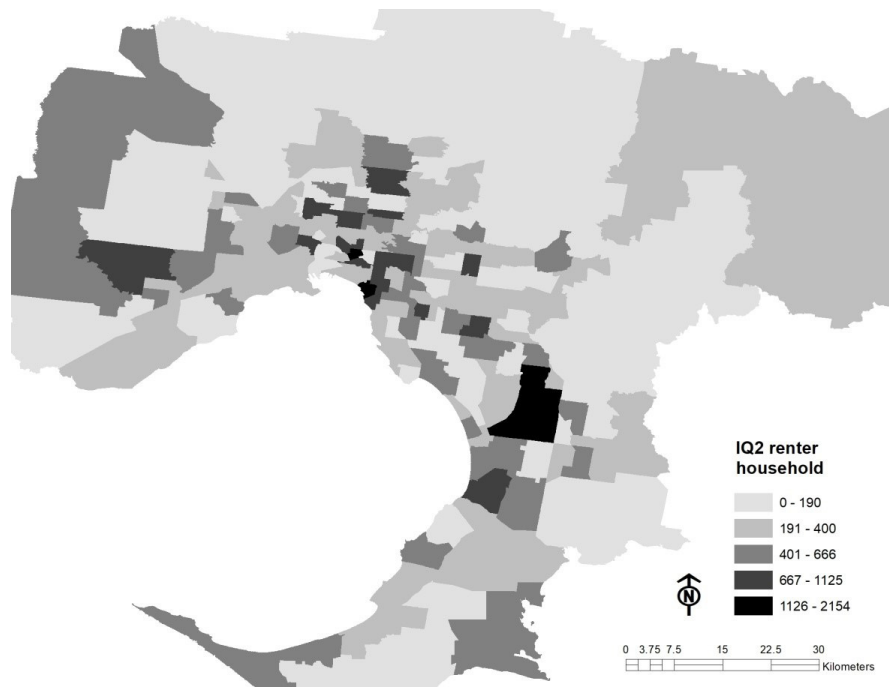
The spatial distribution of Q2 renters in Sydney and Melbourne is presented in Figures 6 and Figure 7. The majority Q2 renters in Sydney are located in the inner-middle urban areas with higher concentrations in the city south and city west, as well as some areas near the north shore and south shore of Parramatta river. By comparison, the distribution of Q2 renters in Melbourne is rather dispersed throughout the suburban areas. The high level of concentration of Q2 renters is found in several key centres in Melbourne's' far south and far west, such as Frankston, Dandenong and Werribee.

Figure 6: Spatial distribution of Q2 renter households in Sydney (SA2)



Source: Authors compiled from ABS Census data.

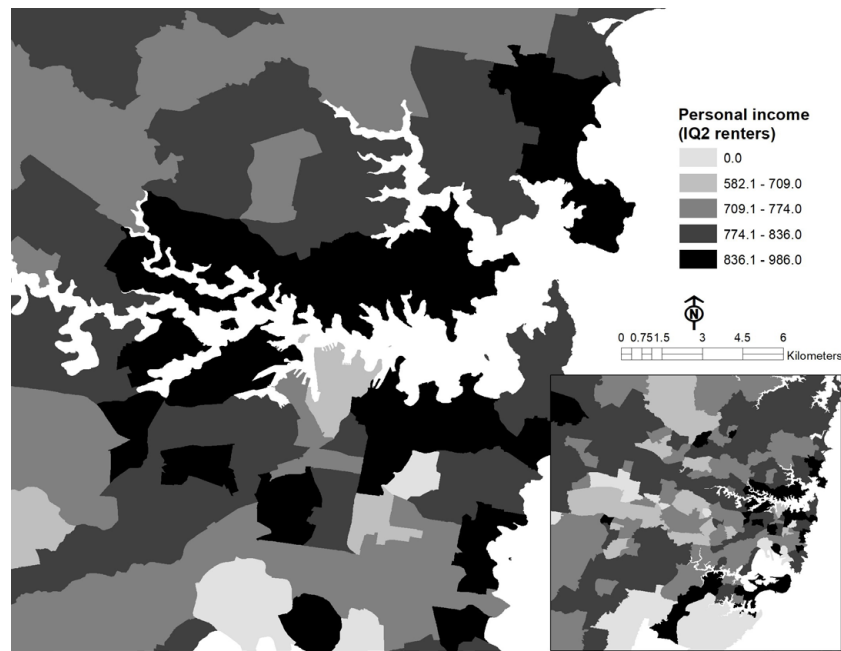
Figure 7: Spatial distribution of Q2 renter households in Melbourne (SA2)



Source: Authors compiled from ABS Census data.

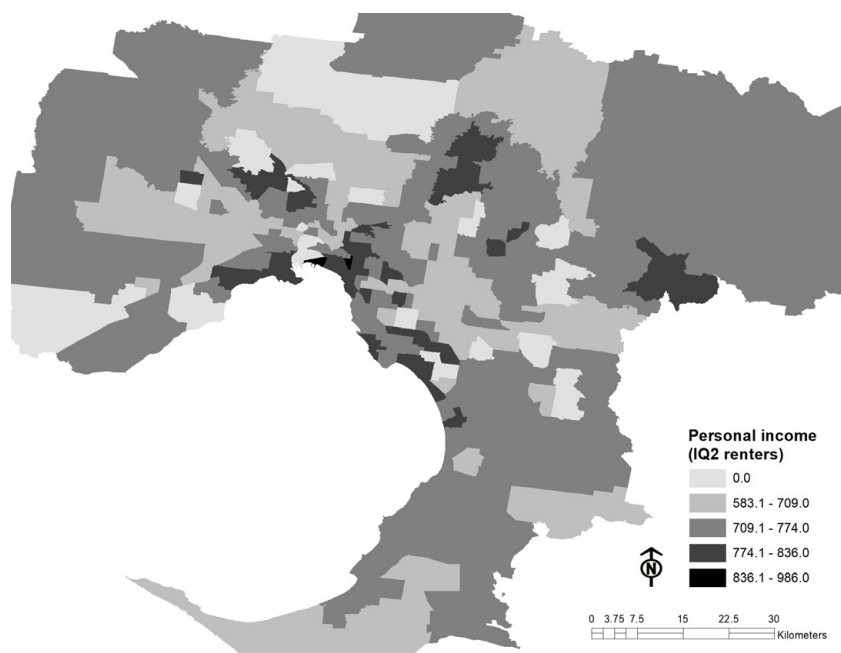
Figure 8 shows the average personal income for Q2 renters is unevenly distributed in Sydney. People living in the inner urban zones earn slightly more, while those in the lowest ranges are found to a higher degree in the city's south-west. The income distribution for Q2 renters in Melbourne shows a similar trend but with a different pattern of concentration (Figure 9). Renters at the higher end of the Q2 band are mainly found in the inner urban zones. Those with a low level of income are found in northern, southern, and western suburbs.

Figure 8: Personal income of individuals in Q2 renter household in Sydney at SA2 level (AU\$)



Source: Authors compiled from ABS Census data.

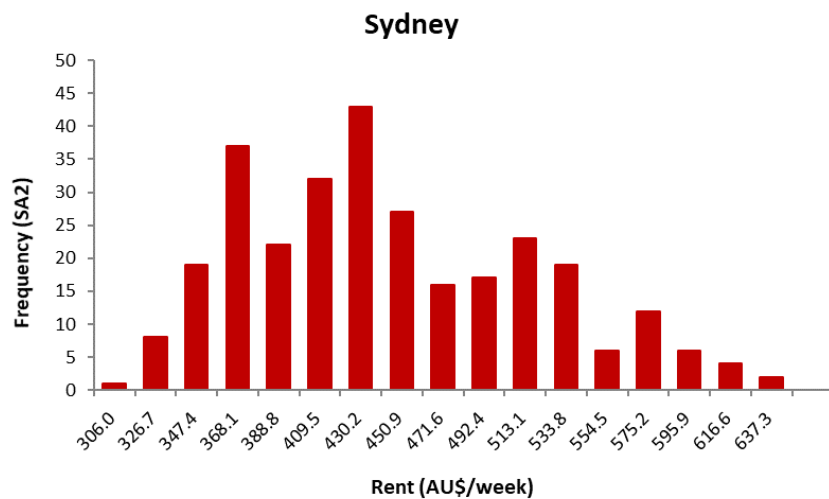
Figure 9: Personal income of individuals in Q2 renter household in Melbourne at SA2 level (AU\$)



Source: Authors compiled from ABS Census data.

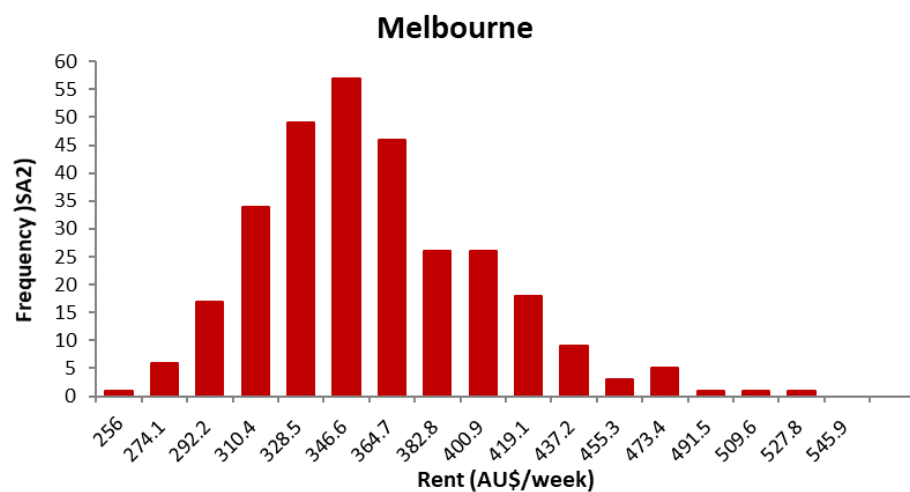
The frequency distributions of weekly rent for Q2 renters in Melbourne and Sydney are presented in Figure 10 and Figure 11. Compared with Melbourne, the distribution of rental cost in Sydney is more dispersed. This mean housing rents in Sydney are higher (AU\$429.10) than Melbourne (AU\$348.40), resulting in a greater number of Q2 renters who are paying more than AU\$500 per week. Geographically, the rental costs in both Melbourne and Sydney present a strong pattern, which is highly coincident with the housing market structure in each city. The higher rental cost in Melbourne is concentrated in the CBD and surrounds, and then decreases further away from the city centre. In addition, people in the eastern and south-eastern suburbs generally pay a higher rent than those living in the north or west. Rental costs are also higher in some coastal zones and areas around transport corridors, given the higher residential density and more convenient transport access at local level. The highest rental markets in Sydney are mainly in the inner urban areas, coastal zones, and a cluster of suburbs in the middle north and west. People living in the southern regions of Sydney generally pay lower rent than those in the north.

Figure 10: Frequency of weekly rent for Q2 renter households in Sydney



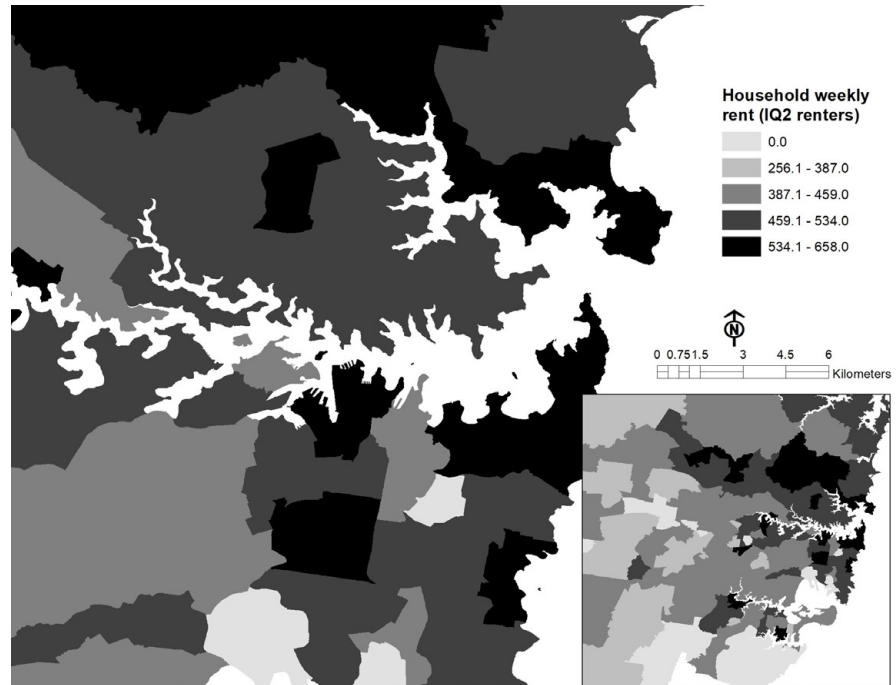
Source: Authors compiled from ABS Census data.

Figure 11: Frequency of weekly rent for Q2 renter households in Melbourne



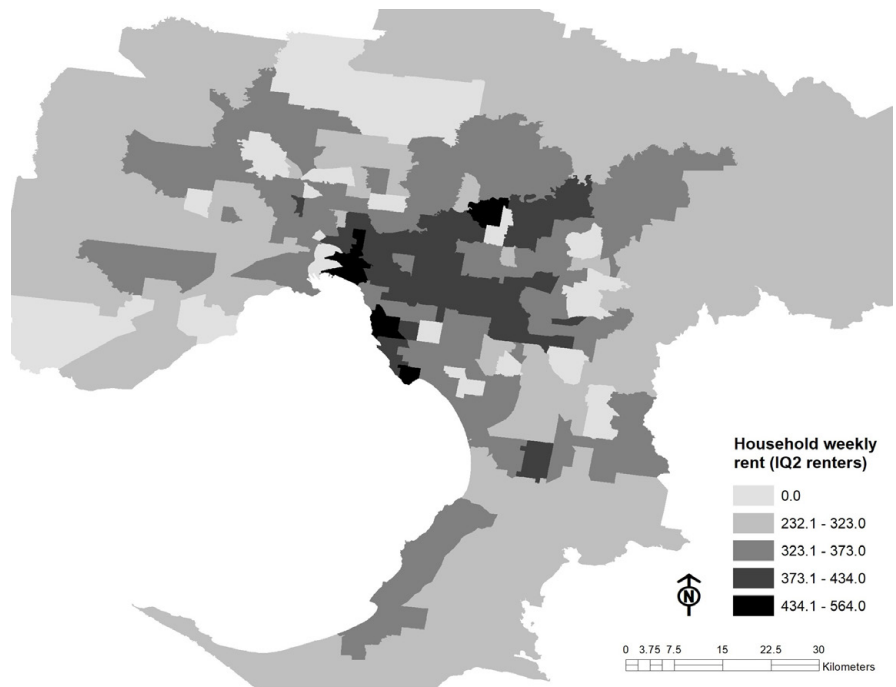
Source: Authors compiled from ABS Census data.

Figure 12: Average weekly rent (AU\$) for Q2 renter households in Sydney (SA2)



Source: Authors compiled from ABS Census data.

Figure 13: Average weekly rent (AU\$) for Q2 renter households in Melbourne (SA2)



Source: Authors compiled from ABS Census data.

2.2.3.2 Commuting flows and commuting costs

Commuting flows and origin-destination travel costs were calculated for Sydney and Melbourne. The distribution of commuting cost for Q2 renters in Sydney and Melbourne is presented in Figure 14 and Figure 15. In both cities, trip costs for Q2 renters have a mode of AU\$9.50 per trip. The average trip cost in Sydney is slightly lower than that in Melbourne, with more trips in the lower cost category (<AU\$8 per trip) and fewer in the higher cost category (>AU\$14 per trip). The main reason for this relative difference seems to be the overall shorter distance travelled by Sydney Q2 commuters (9.3 kilometres) compared to their Melbourne counterparts (10.1 kilometres), and the higher proportion of trips by PT in Sydney compared to Melbourne. In addition, due to variations in income, the commuting burden threshold for Q2 workers is slightly lower in Sydney (8.6%) than in Melbourne (9.4%). A statistical summary for Q2 renters income, housing and commuting costs in Melbourne and Sydney is given in Table 3, including income, housing rent, commuting cost and economic burdens.

Table 3: Statistic summary for Q2 renters

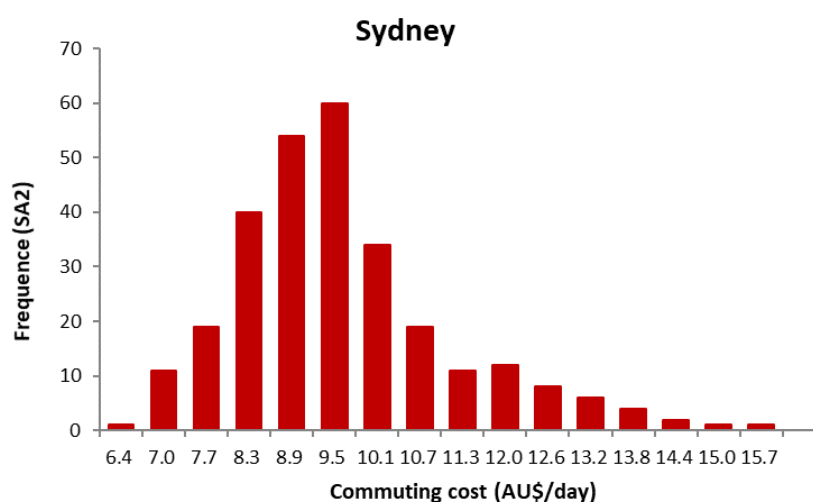
Q2 renters	Melbourne	Sydney
Average personal income (AU\$/week)	726.7	778.4
Average household income* (AU\$/week)	727.0	751.1
Average housing rent (AU\$/week)	348.4	429.1
Average JTW distance (kilometres)	10.1	9.3
Average commuting cost by car (AU\$/day)	8.8	9.0
Average commuting cost by PT (AU\$/day)	8.1	8.1
Average commuting burdens**	9.4%	8.6%
Workers under higher commuting burden (greater than the mean)	11,729	11,310
Workers under higher commuting burden and work in the top 10 job destinations	3,859	4,880

* Includes Q2 renter households with 'zero' income (no employed person).

** Commuting burden = individual commuting cost / personal income (per day).

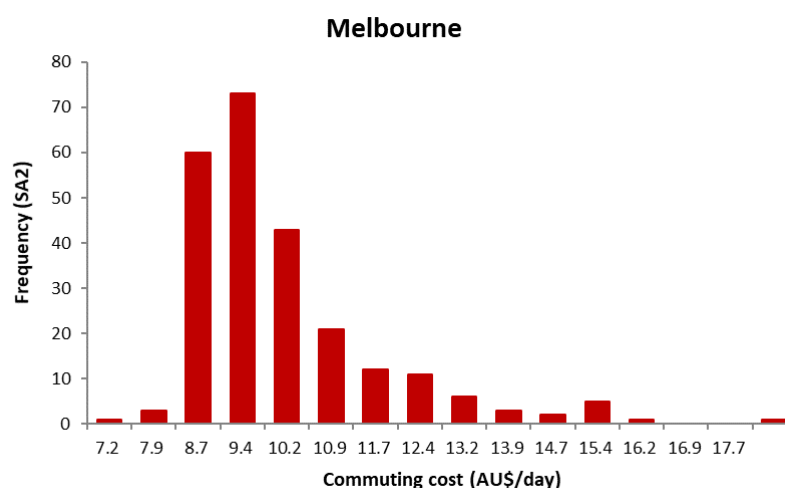
Source: Authors compiled from ABS Census and motor vehicle fuel efficiency data.

Figure 14: Distribution of commuting cost for Q2 renters in Sydney



Source: Authors compiled from ABS Census and motor vehicle fuel efficiency data.

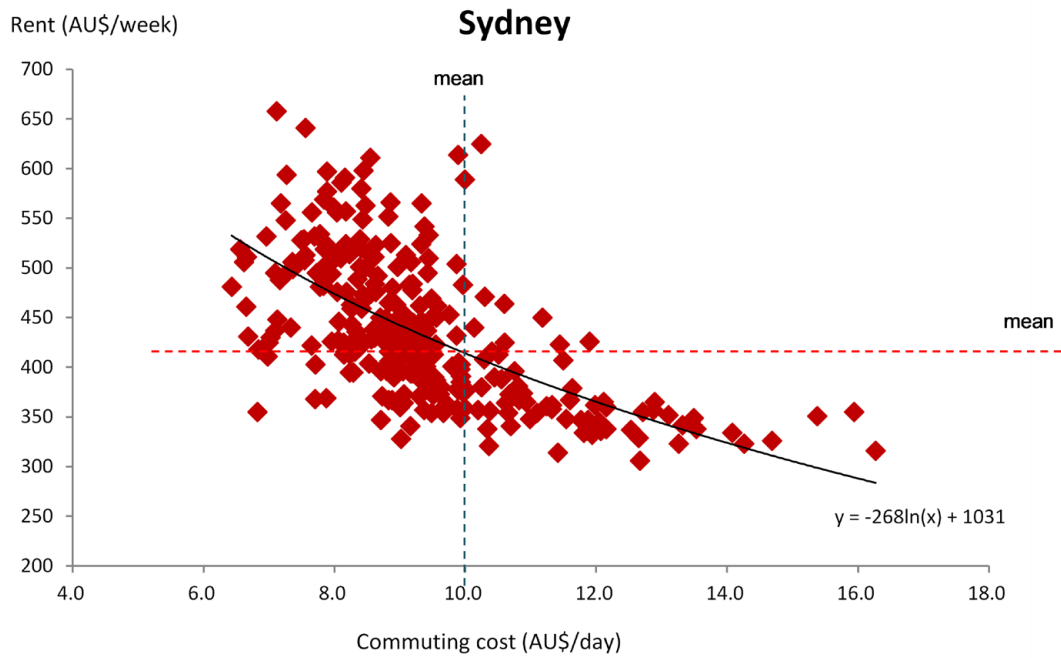
Figure 15: Distribution of commuting cost for Q2 renters in Melbourne



Source: Authors calculated from ABS Census and motor vehicle fuel efficiency data.

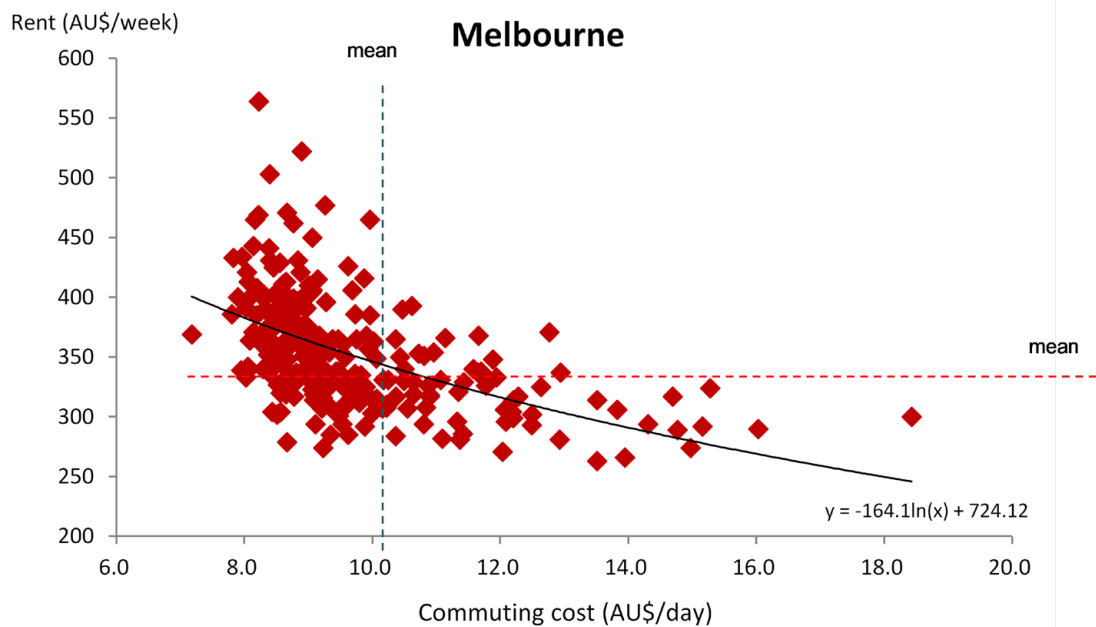
The scatter plots between average rental cost and commuting cost for Q2 renters (at SA2 level) for Sydney and Melbourne are presented in Figure 16 and Figure 17. In both cities, people with lower commuting costs are typically paying higher housing rent, or vice versa. People trade-off the costs between housing and commuting because they often have a fixed total budget for living and transport relative to income (e.g. 50% of income spent on housing and transport). Those households who have either high housing costs or high commuting costs, often minimise the cost of one factor over another to minimise their total living expenses. Nevertheless, there are still a number of areas (SA2) where people are paying both higher housing costs and commuting costs. People in those areas are considered under higher economic burden, and at higher risk of being less productive given the lower net wage earned. These scatter plots have the appearance of bid-rent curves, which are well known in urban economic discussions whereby locational rents follow a relationship of inverse proportionality to the distance from a central point such as a CBD. However, Figure 16 and Figure 17 differ from bid-rent curves as they are not necessarily spatially structured around a central location, nor is commuting cost necessarily a spatial measure (as it incorporates other costs such as fuel or public transport fares).

Figure 16: Scatter plot of weekly rent and commuting cost for Q2 renters in Sydney (SA2)



Source: Authors calculated from ABS Census and motor vehicle fuel efficiency data.

Figure 17: Scatter plot of weekly rent and commuting cost for Q2 renters in Melbourne (SA2)

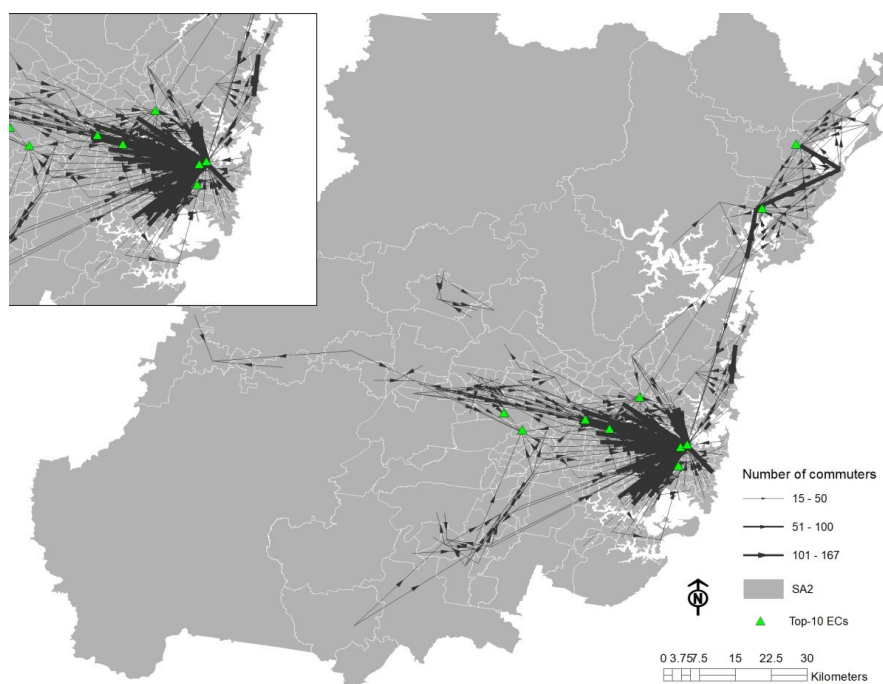


Source: Authors calculated from ABS Census and motor vehicle fuel efficiency data.

Figure 18 and Figure 19 visualise the commuting flows for Q2 workers in Melbourne and Sydney who are under high commuting burdens. For clarity, the visualisations depict commuting between pairs of SA2s only where at least 15 journeys are undertaken. Figure 18 shows that commuting for Q2 renters in Sydney is highly centralised at the CBD and its surrounds (Ultimo and Alexandria). These areas in total offered more than 40 per cent of jobs for Q2 renters under high commuting burdens. In addition, significant commuting movements are found in the far north region near Gosford, that in aggregate form suggest strong self-contained spatial labour markets. Very few Q2 workers commute to Sydney from north of the Hawkesbury River.

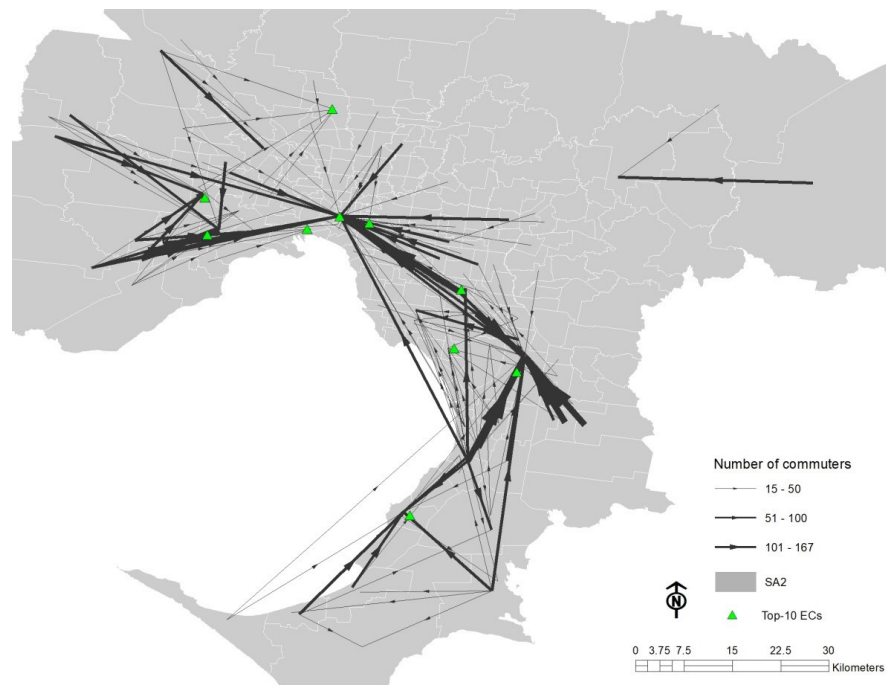
Compared with Sydney, commuting flows for Q2 workers in Melbourne are less centralised (Figure 19). In addition to the CBD and surrounds, including Docklands and Richmond, a set of other significant trip destinations for Q2 renters are apparent, including Dandenong and Laverton. Trips to these zones are typically long, compared to the average, and car-based.

Figure 18: Commuting trips for Q2 renters in Sydney under high commuting burdens



Source: Authors calculated from ABS data.

Figure 19: Commuting trips for Q2 renters in Melbourne under high commuting burdens



Source: Authors calculated from ABS data.

The top 10 trip destinations (SA2) for Q2 renters under high commuting burdens are listed in Table 4. We found a great number of Q2 renters work in the major employment centres in each city (32.9% in Melbourne and 43.1% in Sydney). This implies that many Q2 workers are skilled and thus contribute to the large and productive agglomeration economy of each city. However, those who are able to work in the higher productivity zones typically experience among the highest commuting burdens for their income group. In this context, we note that our measure of above-average commuting burden is relatively simplistic and reflects current patterns. It is based on descriptive data rather, than adopting a normative perspective on desirable maximum commuting burdens for this worker group.

Table 4: Top 10 employment locations for Q2 renters under high commuting burdens, Melbourne and Sydney

Melbourne				
Work destination		Commuting cost (AU\$/day)	Trip arrivals (Q2 renters under higher commuting burdens)	% of Q2 renters under higher commuting burden
1	Melbourne CBD	10.6	758	6.4
2	Dandenong	12.5	1,039	8.8
3	Clayton	13.1	258	2.1
4	Richmond	11.8	304	2.5
5	Port Melbourne Industrial	13.2	240	2.0
6	Docklands	12.6	159	1.3
7	Southbank	11.2	212	1.8
8	Laverton	12.5	321	2.7
9	Keilor	12.2	201	1.7
10	Campbellfield	12.3	244	2.1

Sydney		Commuting cost (AUS/day)	Trip arrival (Q2 renters under higher commuting burdens)	% of Q2 workers under higher commuting burden
Suburb				
1	Sydney CBD	9.7	3,941	34.8
2	Parramatta	10.9	526	4.7
3	Springfield (Gosford)	12.2	380	3.4
4	Wetherill Park Industrial	11.7	374	3.3
5	Macquarie Park	10.8	388	3.4
6	Silverwater	10.9	333	2.9
7	Kangy Angy (Tuggerah)	11.1	258	2.3
8	Prospect Reservoir	11.1	360	3.2
9	Alexandria	10.4	311	2.7
10	Ultimo	9.9	340	3.0

Source: Authors calculated from ABS Census and motor vehicle fuel efficiency data.

2.2.3.3 Land capacity around the key employment centres

This section discusses the results of our housing capacity analysis. The land capacity of existing residential zones in Melbourne and Sydney is presented in Figure 20 and Figure 21. In each map, the lighter coloured zones represent MBs of residentially zoned land for which dwelling densities are below the 75th percentile for the respective residential zones. The deeper coloured areas are residential MBs that have exceeded the 75th percentile of housing density for Melbourne, but are below the 90th percentile of density in the respective residential zones, therefore have unused capacity at this higher threshold. Thresholds for the 75th percentile and 90th percentile of dwelling density for Sydney and Melbourne are presented in Table 5.

As Figure 20 and Figure 21 reveal, there are extensive areas across both Sydney and Melbourne where the intensity of residential development has not reached either the 75th or 90th percentile of feasible dwelling density for residential zones. Much of Melbourne's inner west, inner north and inner east has been developed to an intensity between the 75th and 90th percentile of revealed dwelling density. Beyond these zones, nearly all suburban areas have been developed at densities below the 75th percentile, or 17.3 dwellings per hectare. This analysis implies that there is extensive underutilisation of residentially zoned land in Melbourne.

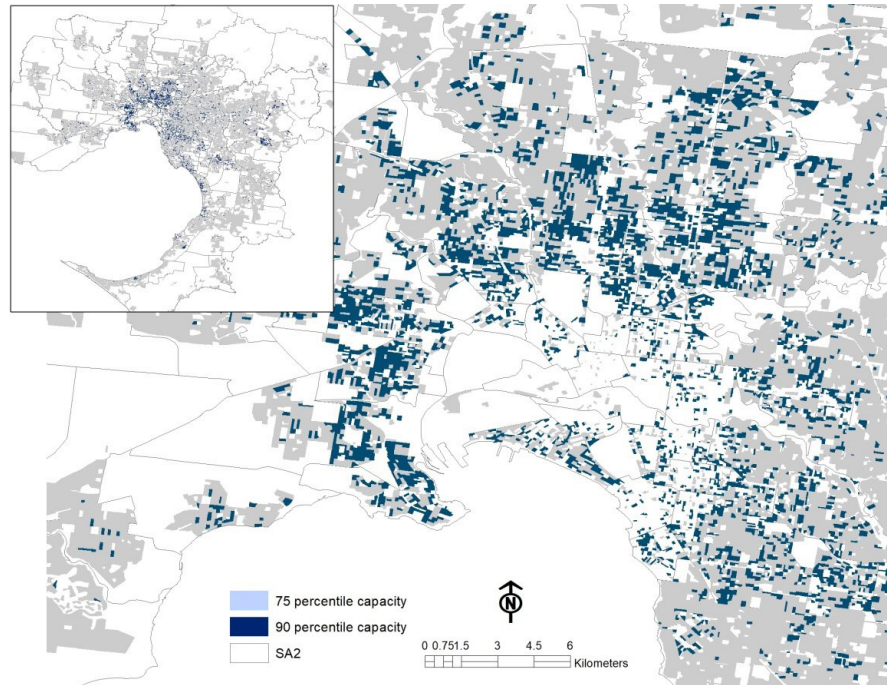
Development intensity patterns for Sydney are much higher overall than for Melbourne, with a 75th per centile figure of 33.1 dwellings per hectare and a 90th percentile figure of 75.8 dwellings per hectare. The distribution of MBs that have been built to an intensity between the 75th and 90th percentile is largely around the Sydney CBD and along the harbourside zones to the north, west, south and east of the CBD, with some broadening into the inner west. There appears to be a degree of alignment between higher density development and Sydney rail lines, particularly in middle western and northern locations. However, this effect appears to dwindle within distance from the CBD, particularly to the west. The relativity of internal metropolitan intensity calculations means it is not directly feasible to compare residential zones across the two cities. However, it does appear that Sydney is being developed to a higher residential density than Melbourne.

Table 5: Dwelling density percentile thresholds in Melbourne and Sydney, dwellings per hectare

Dwelling density threshold	Melbourne	Sydney
90 th percentile density	29.9	75.8
75 th percentile density	17.3	33.1

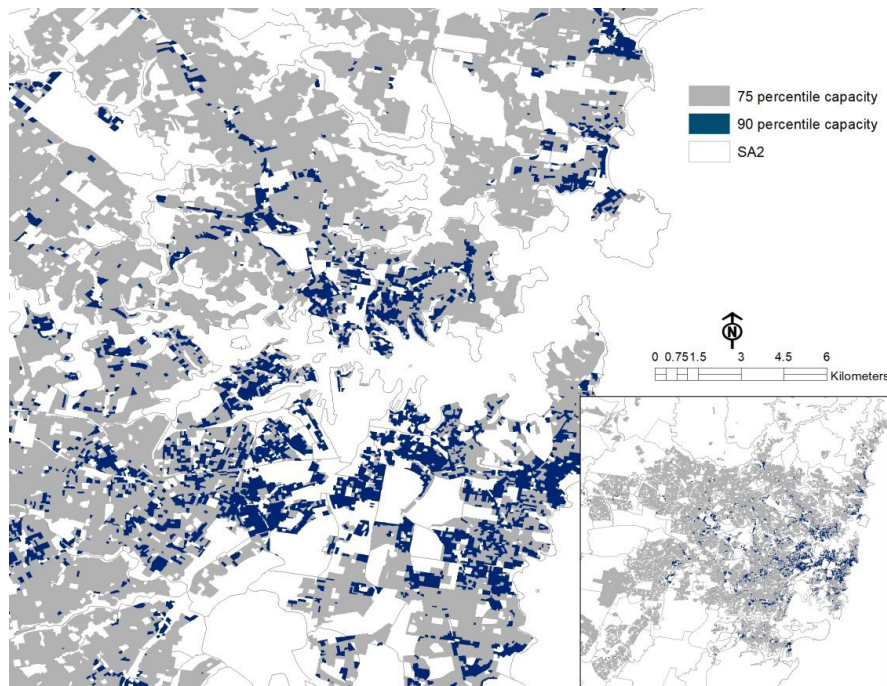
Source: Authors calculated from ABS Census data.

Figure 20: Housing capacity in Melbourne residential areas



Source: Authors calculated from ABS Census and residential zone data.

Figure 21: Housing capacity in Sydney residential areas



Source: Authors calculated from ABS Census and residential zone data.

2.2.3.4 Scenario identification of sites for affordable rental dwelling development

The survey of underutilised residentially zoned land for each of Sydney and Melbourne allows the assessment of sites that would be suitable for the provision of housing for Q2 renters in each city. We have identified suitable sites based on a three-criteria scenario:

1. The site must be within accessible distance to a key employment centre for Q2 workers.
2. The site must have a high land capacity for additional dwelling development to bring it to the 75th percentile dwelling density in the respective residential classification.
3. The current local rental cost must be lower than the average rent of the suburb where Q2 workers who travel to that employment centre currently live.

The land sites (MB scale) identified as suitable for building affordable rental houses for Q2 workers in Melbourne and Sydney are illustrated in Figure 22 and Figure 23 respectively. In order to better visualise the variations in land capacity over urban space, 3D mapping is used. The 3D mapping of land capacity around top 10 employment centers in Melbourne and Sydney is provided separately from Figure 27 to Figure 36. The higher and darker colored volumetric bar in each map represents an area that:

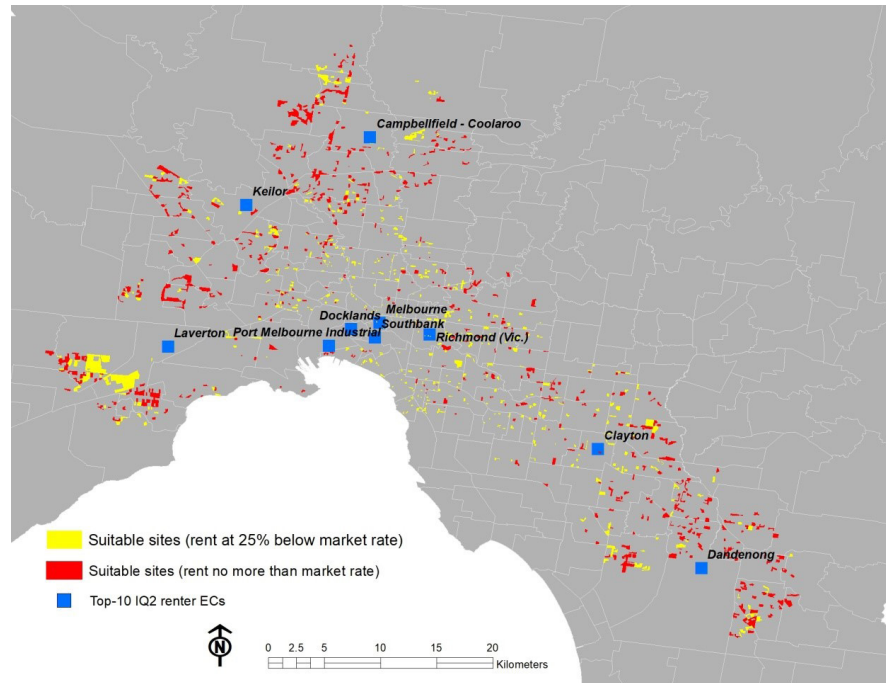
1. is locationally suitable for development, and
2. has high capacity for new dwelling development.

Under this scenario, we assessed housing capacity for Q2 workers in Melbourne and Sydney. In Melbourne housing capacity is generally limited in the CBD and surrounding areas (Richmond, Port Melbourne, South Bank and Docklands) and within the main job catchment areas for that group of workers (Figure 22). There are few land blocks available near Richmond, but most are distributed in the north-east side of the city centre. An important factor leading to this outcome is the high local rental cost. In most areas, the local rental cost is higher than the areas where Q2 workers currently live. This makes these areas economically unsuitable for Q2 rental houses, based on prevailing pricing of development costs; they are not going to relieve the economic burden of Q2 workers after relocation. Given the paucity of suitable sites for Q2 renter housing development at prevailing market rates, it is likely that if housing was to be provided, there would be a need for programs that provide affordable rental houses, not exposed to private rental market pricing. Notably, there are fewer suitable sites to be found in Melbourne's west. This pattern arises because the area is dominated by industrial and mixed land uses, though some of those areas are experiencing significant transition and re-development.

Comparably, there are more suitable sites for rental houses to be found around the ECs in suburbs, especially in the outer suburban areas. On the far north-west side, in places such as Keilor and Campbellfield, the majority of available sites are distributed near to the urban fringe. For housing to serve Dandenong and Clayton workers, most available sites are found on the eastern side of the railway, and fewer sites are available in the western part of this catchment. In the Melbourne's west, the suitable sites are mainly distributed on the northern and southern part of Laverton, which are highly integrated with the new residential development in those areas.

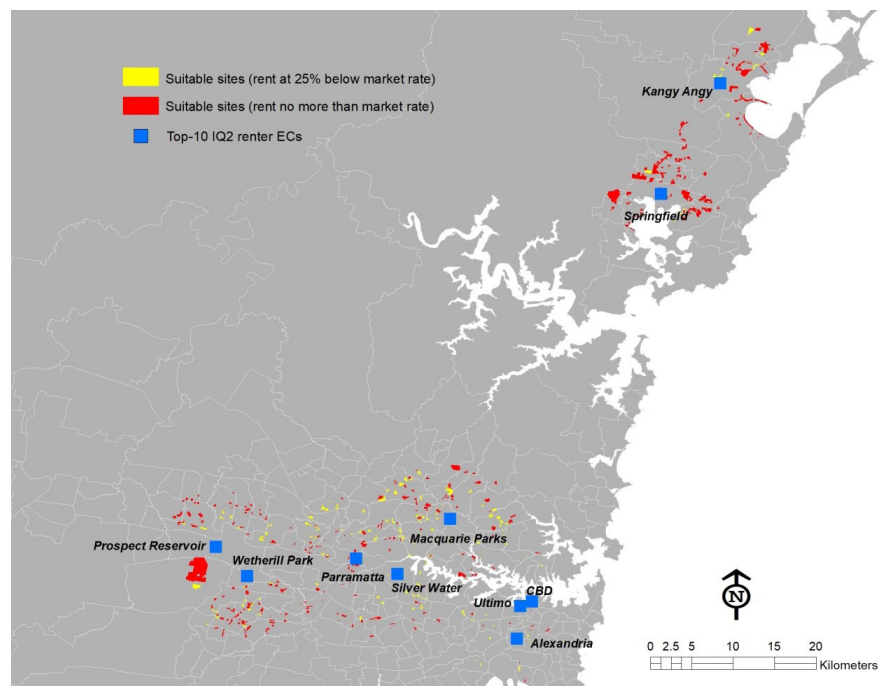
Patterns in Sydney are similar to those found in the Melbourne land market. There are very few sites to be found in the areas with a close proximity to the Sydney CBD and Alexandria (Figure 23). This effect is largely due to the current high housing density and high rental cost in Sydney's inner and middle urban suburbs. A higher number of more suitable sites are observable within the catchment areas from the suburban Employment Centres (ECs), including the northern side of Macquarie Park and Silverwater, and among both the northern and southern sides of the Wetherill Park Industrial and Prospect Reservoir in the far west. Many sites are available on the northern side of the two far outer northern ECs of Gosford and Tuggerah.

Figure 22: Suitable sites for affordable rental housing supply adjacent to Q2 renter employment concentrations, at MB scale greater Melbourne



Source: Authors calculated from ABS Census and residential zone data.

Figure 23: Suitable sites for affordable rental housing supply adjacent to Q2 renter employment concentrations, at mesh block scale, greater Sydney



Source: Authors calculated from ABS Census and residential zone data.

Dwelling yields under alternative Q2 renter housing affordability thresholds and scenarios

The identification of potential sites for affordable housing development for Q2 renters can be used to calculate possible dwelling yields if these sites were developed for housing up to the dwelling densities per hectare achieved for residential zones generally across each of Melbourne and Sydney.

Two scenarios were assessed:

1. potential capacity based on supply at prevailing market rates for land and rents, and
2. potential capacity based on supply at prevailing market rates for land and rents discounted by 25 per cent on assumption of delivery by an affordable housing vehicle.

For each scenario potential additional dwelling yields were calculated at the 75th and 90th percentile for each city.

Scenario 1

The calculations (Table 6) for Scenario 1 show that there is substantial potential capacity for delivery of additional dwellings in locations proximate to the ECs of Q2 renters at prevailing market rates in Melbourne. If development occurred to the 75th percentile of dwelling yield per hectare currently realised by Melbourne residential zones then a further 13,781 lots could be provided. Were development to occur up to the current 90th percentile of dwelling yield per hectare currently realised for residential zones in Melbourne the potential additional yield would be 25,942 dwellings.

The calculations (Table 6) for Scenario 1 also show that there is moderate potential capacity for delivery of additional dwellings in locations proximate to the main ECs for Q2 renters at prevailing market rates in Sydney. If development was undertaken to the 75th percentile of dwelling yield per hectare presently realised by Sydney residential zones then an additional 6,594 lots could be provided. Were development to occur up to the current 90th percentile of dwelling yield per hectare currently realised for residential zones in Melbourne, the potential additional yield would be 16,802 dwellings.

Table 6: Potential dwelling yields at 75th and 90th percentile dwelling density thresholds for areas adjacent to Q2 renter employment centres, with rent no more than market rate paid by current Q2 renters

	Melbourne	Sydney
75 th percentile	13,781	6,594
90 th percentile	25,942	16,802

* Total dwelling capacity is calculated for lands within the job catchment areas around the top 10 Q2 ECs.

** Current rent of Q2 renters.

Source: Authors calculated from ABS Census and residential zone data.

Scenario 2

The calculations (Table 7) for Scenario 2 show that there is substantial potential capacity for delivery of additional dwellings in locations proximate to the main ECs for Q2 renters for rents where the property is eligible for a 25 per cent charitable discount in Melbourne. If development occurred to the 75th percentile of dwelling yield per hectare currently realised by Melbourne residential zones then a further 26,113 lots could be provided. Were development to occur up to the current 90th percentile of dwelling yield per hectare currently realised for residential zones in Melbourne, assuming a 25 per cent development discount, the potential additional yield would be 48,219 dwellings.

The calculations (Table 7) for Scenario 2 also show that there is moderate potential capacity for delivery of additional dwellings in locations proximate to the main ECs for Q2 renters where development occurs at 25 per cent charitable discount in Sydney. If development was undertaken to the 75th percentile of dwelling yield per hectare presently realised by Sydney residential zones, then an additional 9,727 lots could be provided. Were development to occur up to the current 90th percentile of dwelling yield per hectare currently realised for residential zones in Sydney, assuming a 25 per cent development discount, the potential additional yield would be 24,698 dwellings.

Table 7: Total dwelling capacity to achieve dwelling density thresholds for areas adjacent to Q2 renter employment centres, with rent 25 per cent less than market rate paid by current Q2 renters

	Melbourne	Sydney
75 th percentile	26,113	9,727
90 th percentile	48,219	24,698

* Total dwelling capacity is calculated for lands within the job catchment areas around the top 10 Q2 ECs.

** Current rent of Q2 renters.

Source: Authors calculated from ABS Census and residential zone data.

The method we have used also allows a basic calculation of estimated spare dwelling capacity if existing residential zones were developed up to the dwelling density at the level of the current overall 75th and 90th percentiles for the entire metropolitan area of each of Melbourne and Sydney (Table 8). This analysis shows that there is extensive underutilisation of residential land for dwellings in Melbourne, relative to the permitted dwelling density that can be achieved under current zoning prescriptions. If residential areas in Melbourne were developed up to the 75th percentile level (17.3 dwellings per hectare) rather than current (2016) levels, a further 245,983 dwellings could be accommodated without requirement for land-use zoning change. This figure rises to 660,469 if residential zones were developed to the current 90th percentile density of 29.9 dwellings per hectare, a number equivalent to one third of the total dwelling count in the greater Melbourne area. If this latter figure is used, then it is clear the market is preferring not to utilise residential land to the full extent permitted by the planning system.

Residential land utilisation relative to the current 75th and 90th dwelling density percentiles is greater in Sydney than in Melbourne (Table 8). In Sydney, a further 52,000 dwellings could be accommodated if dwelling densities on residentially zoned land were increased to the current 75th percentile level of 33.1 dwellings per hectare. A further 167,0942 dwellings could be accommodated in Sydney within current residential zonings at the current 90th percentile density of 75.8 dwellings per hectare. This latter capacity volume is approximately equivalent to 9 per cent of the current Sydney dwelling stock. It deserves noting that the analysis we have undertaken does not incorporate mixed-use land zonings due to the more complex methodological task of enumerating potential dwelling densities within these zones, arising from the multiple uses to which they may be put.

Table 8: Total dwelling capacity to achieve dwelling density targets for all residential zones

Percentile threshold	Melbourne	Sydney
75 th percentile	245,983	52,0973
90 th percentile	660,469	167,0942

Source: Authors calculated from ABS Census and residential zone data.

2.2.3.5 Q2 workers in selected satellite cities

One objective of this project was to investigate housing market pressures and commuting costs for Q2 renters in two large satellite cities, Wollongong and Geelong. Wollongong is approximately 80 kilometres south of Sydney's CBD, while Geelong is approximately 75 kilometres south-west of the Melbourne CBD. The rationale for this intent was to assess whether satellite cities offer a better matching between Q2 renters and their employment locations, in terms of commuting costs.

There is a scale difference between the two cities within each of the selected metropolis-satellite pairs. The population of greater Sydney in 2016 was 4,823,991. The Wollongong significant urban area had a population of 285,678, equivalent to slightly less than 6 per cent of Sydney (ABS Census Quickstats 2018). In 2016, Greater Melbourne had a population of 4,485,211. The Geelong significant urban area had a population of 247,459, equivalent to slightly more than 5 per cent of Melbourne's population. Wollongong comprises just eight SA2 areas, while Geelong comprises 20 SA2 zones, though many of these cover the hinterland of the main urbanised part of the city. Although commuting distances for some workers within regional city commutershed may be burdensome, overall it is to be expected that the smaller scale of the regional cities would result in shorter commuting distances than those found in the nearby metropolis. Regional rents are also more likely to be lower than metropolitan rents, further offsetting overall housing and commuting costs. Hence, the potential for regional Q2 workers to experience high rental costs and high commuting burdens is likely to be lower than those in metropolitan areas, suggesting a relatively lesser need for policy attention.

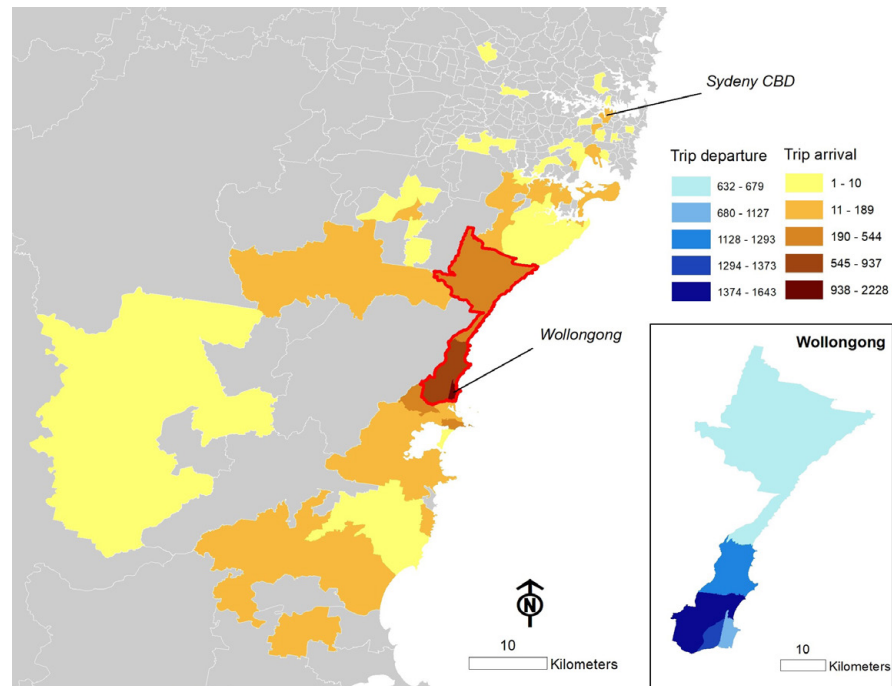
Given the difference in scale between each of the regional satellites to their respective metropolises, we adopted a different methodology to assess housing and commuting patterns in Geelong and Wollongong than was applied for Sydney and Melbourne. We used measures of Q2 renter commuting self-containment for each of the Wollongong and Geelong SA2s.

The distribution of commute departure and commute arrival SA2 for Q2 workers in Wollongong is visualised in Figure 24. It shows that most Q2 workers in Wollongong live and work within the region. Some workers travel to work in the surrounding regions, but comparatively few travel to Sydney for work. The economic activities for Q2 workers in Wollongong appear to be generally self-contained, with few traveling beyond the local region to access employment. The job-to-worker ratio within each Wollongong SA2 is presented in Figure 25. We find that every SA2 in Wollongong offers local jobs that are suitable for Q2 workers. Of all SA2s, Wollongong East attracts the highest number of Q2 workers in the region.

Although there is a known commuting interaction between Geelong and Melbourne, most Q2 workers in Geelong travel to work within the local Geelong SA2s. There is a small number of workers who travel to work in proximate ex-Geelong regions (Werribee), and some industrial zones in Melbourne's west (Figure 26). Figure 27 shows that similar to Wollongong, each SA2 in Geelong has both high level of commuting departures and arrivals by Q2 workers. As the largest centre in the Geelong region, the Geelong CBD is the commuting destination that attracts the highest number of Geelong Q2 workers.

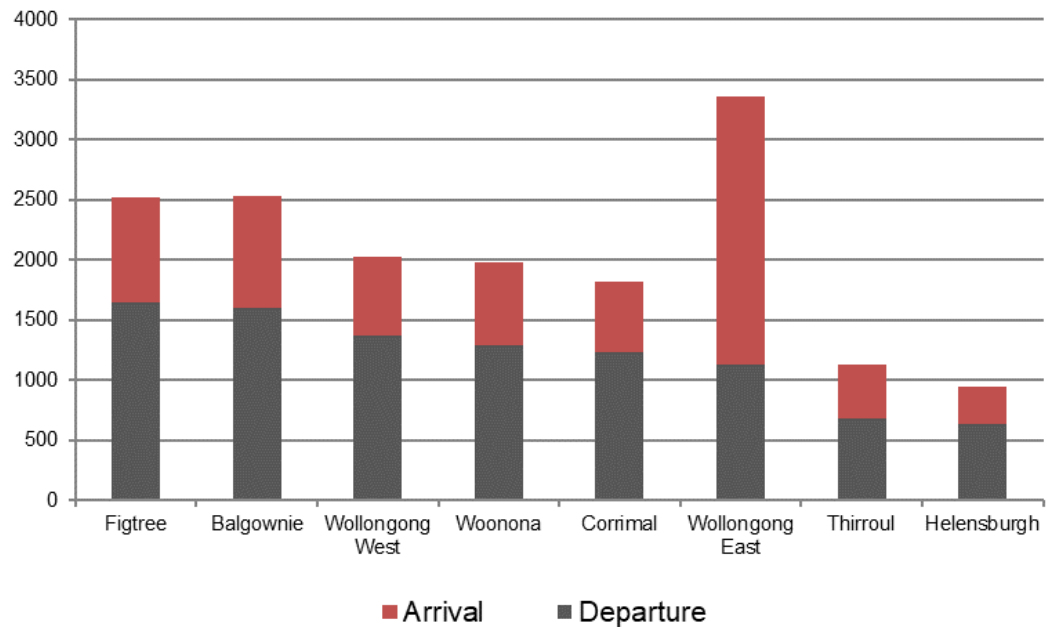
The results from Wollongong and Geelong indicate that the housing markets in satellite cities do not present a similar degree of scale or spatial variation to the major cities of Sydney and Melbourne, and consequently do not result in a high degree of separation between jobs and workers on low incomes. Most Q2 workers in the satellite cities are able to live relatively close to work, pay regional rents for their dwellings, and do not experience a high commuting burden in contrast to the experience of a sizeable proportion of Q2 renters in Melbourne and Sydney. Accordingly, we do not consider that Q2 workers in Wollongong and Geelong experience commuting burdens that are of a magnitude or frequency that deserve special policy attention.

Figure 24: Total commute trip departures and trip arrival volumes for Wollongong Q2 workers (SA2)



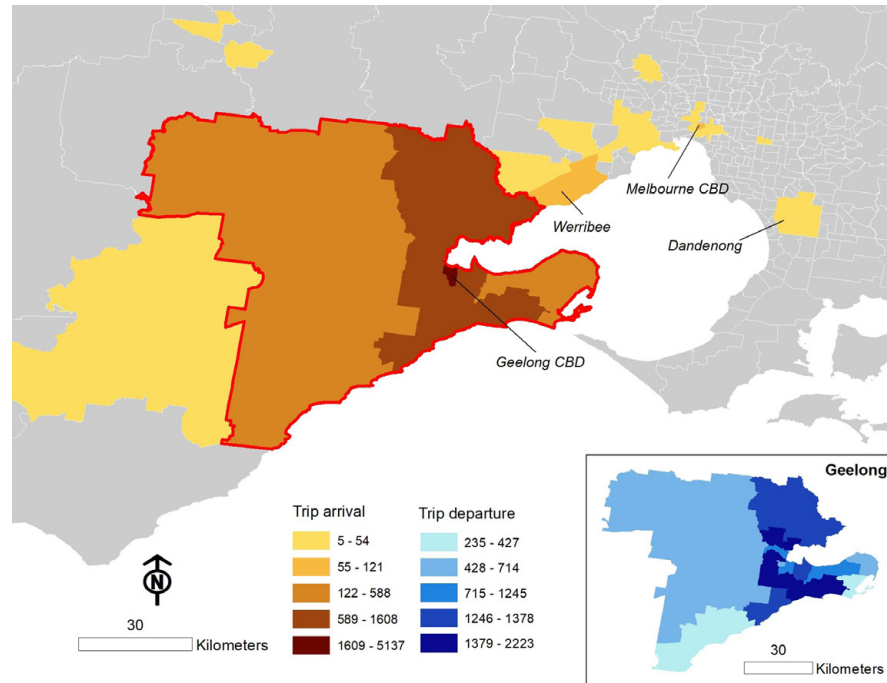
Source: Authors calculated from ABS Census data.

Figure 25: Total commute trip departures and trip arrival volumes for Wollongong SA2s



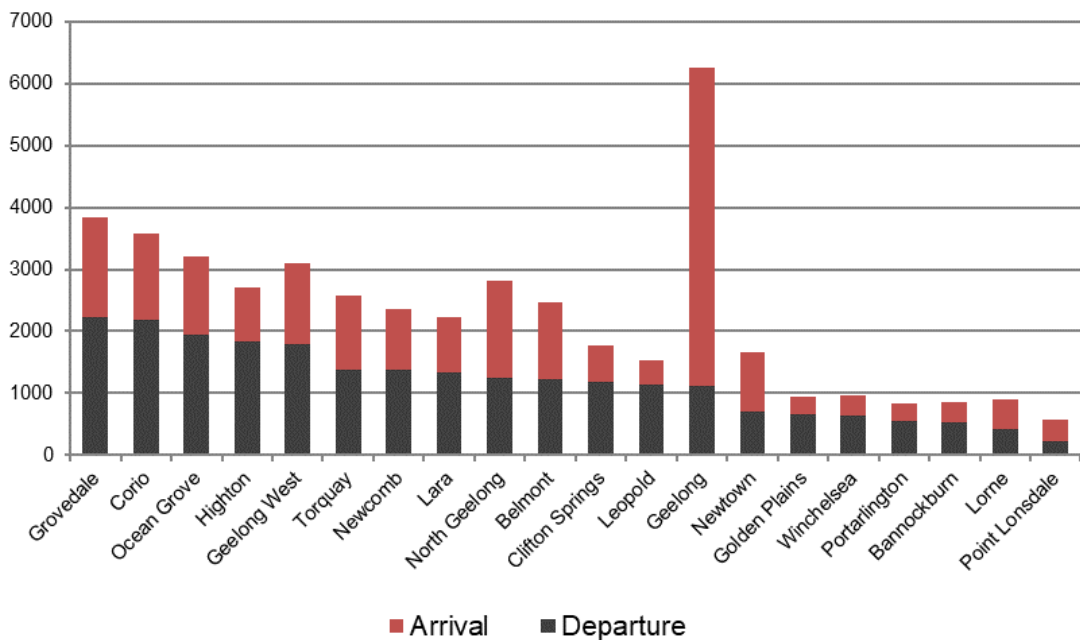
Source: Authors calculated from ABS Census data.

Figure 26: Total commute trip departures and trip arrival volumes for Geelong Q2 workers (SA2)



Source: Authors calculated from ABS Census data.

Figure 27: Total commute departure and arrival for Geelong SA2s



Source: Authors calculated from ABS Census data.

Summary of satellite city commuting pressures of Q2 renters

The analysis we have offered of commuting patterns for Q2 renters in Wollongong and Geelong indicates that the distance of each of these cities from either of Sydney or Melbourne respectively has led to a high degree of self-containment for Q2 workers at the city level. Subregions within these satellite cities also display a strong degree of self-containment. The main destination for most work travel for Q2 workers beyond their local SA2 in Wollongong and Geelong is to the respective CBD of each city. Given the relative cost of regional rents for Wollongong and Geelong and the moderate commuting distances, plus the relatively smaller scale of Q2 working population, we conclude that the pressures on workers in these cities are not of a magnitude that deserves additional policy consideration. We note that this analysis does not in itself suggest that moving Q2 workers from the metropolis to a regional city could alleviate high metropolitan commuting burdens for Q2 workers. This is because the availability and quality of jobs in the regional city deserves appraisal to better understand the dynamics of labour market demand for jobs in the Q2 income category.

3. Policy implications

3.1 Responding to Q2 renter commuting and housing pressures

3.1.1 Improving understanding of urban spatial labour markets, housing and commuting

This project has argued that there is a need to better understand the contribution of urban spatial labour markets to urban productivity, particularly in relation to the cost of commuting. There is a relatively limited international literature that seeks to understand urban labour markets, housing and commuting patterns from a theoretical perspective that is oriented to the productivity benefits of agglomeration. There is almost no work that has directly investigated such questions in the Australian context. Policy understandings of urban productivity are underdeveloped with little appreciation of issues beyond 'congestion' or 'access'. Given the increasing recognition of the importance of urban productivity in Australia's major urban areas, there is an urgent need to improve research and policy knowledge of this area. Policy needs to improve its framing of urban productivity and, in turn, the contribution that urban labour markets contribute to urban productivity. This includes going beyond simple framings of agglomeration theory around labour market depth, breadth and access, to a more nuanced understanding of the total cost of work access relative to economic value produced. State metropolitan planning policies and federal infrastructure and productivity policies require improved understanding of these questions. Agencies such as the Productivity Commission and Infrastructure Australia have an implicit responsibility for this effort, given that they are the principal promoters of a productivity oriented approach to the managing of Australia's major cities.

3.1.2 High commuting burdens affect a minor proportion of Q2 renters

On average, commuting burdens comprise 9.4 per cent of income for Q2 renters in Melbourne, and 8.6 per cent of income for Q2 renters in Sydney. Based on our model, the total number of Q2 renters who have commuting burdens greater than 10 per cent of income is no more than 12,000 for each city. These relatively small proportions and absolute numbers for above-average commuting cost Q2 renters suggest that the impacts of higher than average commuting burdens are likely to be modest. Policy that improves overall metropolitan accessibility in an affordable way would benefit all workers (and firms) including Q2 renters. Current policy settings do not specify benchmark levels of commuting burden, in contrast to housing affordability benchmarks, such as the widely used threshold of no more than 30 per cent of income spent on housing costs for households in the lowest two income quintiles. The question of an appropriate commuting burden benchmark is a complex area of debate and beyond the scope of this project to resolve.

3.1.3 Dispersed workplace locations constrain targeted accessibility interventions for Q2 renters

Of the no more than 12,000 above-average commuting burden Q2 renters in each of Sydney or Melbourne, fewer than 5,000 commuters in each city travel to the top 10 employment destinations for this group. This dispersed spatial pattern of employment makes locationally targeted policy difficult to apply. While it is possible to focus future affordable housing development around Q2 renter employment concentration locations, the targeting of such housing to this worker category may not benefit all Q2 renters. Policies that improve housing affordability for renters generally around Q2 employment nodes, particularly at the lower end of the market, are likely to be supportive of wider efforts to improve Q2 renter housing and commuting affordability. Similarly, policies to improve commuting access to dispersed employment, such as via better overall public transport network coordination, may improve overall accessibility for Q2 renters, while also having benefits for other worker cohorts.

3.1.4 Limited site options for affordable market housing meaning non-market support is needed

There are comparatively few sites within 10 kilometres of the top 10 locations for Q2 renter employment where the current rental market conditions make new market-priced housing development feasible to the extent it overcomes commuting burdens. However, a larger number of sites become feasible for development at a 75 per cent of market rental pricing. If policy is to target Q2 renters through delivery of new stock proximate to Q2 renter employment concentrations, then delivery mechanisms that are able to operate with some shielding from market cost pressures (such as community housing organisations) are likely to be required.

3.1.5 Extensive market underutilisation of zoned residential land

The analysis we have undertaken suggests there is extensive market underutilisation of residentially zoned land in Sydney and Melbourne with potentially hundreds of thousands of additional dwellings potentially able to be constructed without rezoning. The planning system clearly intends that residential development should occur at much higher average dwelling yields per unit area of land than the market is supplying under present conditions. This suggests that strategies involving relaxation of residential zoning regulations may not be as effective as policies to encourage intensification of current residential zones to dwelling densities that are closer to the 75th percentile. Intensification would also generally support improved work access for Q2 renters.

3.2 Policy development options

The project findings can be used to inform three main areas of policy development.

3.2.1 Employment distribution

Policy attention to the distribution of work locations for Q2 renters may be merited. The project demonstrates that Q2 renters are residentially dispersed across Melbourne and Sydney but tend to correlate with areas of moderate rental costs. In terms of employment locations for Q2 renters there are important differences between Melbourne and Sydney. In Sydney Q2 renters have especially concentrated commuting patterns around the Sydney CBD. Consequently CBD-oriented trips contribute disproportionately to the high cost burdens for some Q2 renters. Managing the metropolitan distribution of employment so to shift Q2 renter CBD employment to other sites, particularly those closer to Q2 residential locations, may reduce the number of high cost burden commutes for this cohort in Sydney.

This problem of uneven Q2 renter employment location concentration is less marked in Melbourne where there is a more polycentric metropolitan distribution of employment for Q2 renters. Consequently, employment distribution may already be moderating commuting cost burdens for Melbourne Q2 renters. However, there is countervailing evidence that this dispersion is accompanied by greater work travel distances, given the higher average commuting burden for such workers in Melbourne.

3.2.2 Transport networks

Policy should consider options to improve transport networks in Sydney and Melbourne so they can better serve the dispersed employment patterns of Q2 commuters. Public transport may merit particular attention. In Melbourne and Sydney the average commuting costs for Q2 renters by public transport were AU\$8.10, which is less than the respective AU\$8.80 and AU\$9.00 cost for car travel in each city respectively. Public transport thus appears to be more productive than car travel for Q2 renters. In the context of rapidly growing populations and the difficulties of creating additional road capacity, improving accessibility by public transport is likely to be beneficial. Certainly there is a case to be made that a more even quality of public transport service enhances generalised labour market access across the Melbourne and Sydney metropolitan regions.

3.2.3 Affordable housing provision

The analysis presented in this study has shown that there are sites, that would support housing development that could be affordable to Q2 renters, present close to employment nodes under prevailing zoning and housing market conditions. However, the number of sites is not large and these cannot automatically be assumed to be able to generate future affordable housing through market processes. If such sites are to be developed for affordable Q2 renter housing that relieves commuting burdens it is likely that a dedicated affordable housing agency would be required to undertake the development. In turn this implies a form of subsidisation to provide the dwellings at rents lower than the prevailing market level. Whether the provision of affordable housing for Q2 renters is a pressing policy need was not investigated by this project.

3.3 Final remarks

The policy issue to which this study responds concerns the role of affordable rental housing supply (for Q2 renters) in the productivity of cities. The question was posed whether cities, or hubs within them, can obtain a productivity dividend from having an effective supply of affordable housing for those in the second income quintile, and what policies can support this.

This study has found that there is a subtle relationship between housing location, household income, commuting costs and employment location for Q2 workers. The study shows that there is no simple binary between affordable-unaffordable housing, high-low commuting costs and well-located or poorly located employment. The study finds that there is self-sorting within the urban system between Q2 renters, the locations in which they can afford to reside and the location in which they are employed that moderates extreme commuting costs. In general, lower cost rental housing tends to be located in outer and fringe suburban locations, which is where a high proportion of Q2 renters also live. The type of employment from which they earn their income tends also to be suburbanised, though more in the middle-outer zone, rather than the fringe. Consequently the commuting burdens on Q2 renters in outer and fringe zones where rental housing is cheaper are not necessarily high where the jobs in which they are employed are also located in these broad zones. For Q2 renters employed nearer to CBD or inner locations the dynamic is less benign. These Q2 workers may experience higher rental burdens because of the high housing prices in such locations. Some may also experience high commuting burdens for CBD employment.

Policy responses can be simplified to four principal options:

1. Incomes can be raised to improve affordability of both housing and commuting. While this is desirable such a change might simply result in bidding up of housing prices if income gains are generalised. Mechanisms to grow wages are currently subject to debate nationally and options to address income growth are as yet unsettled.
2. Affordable housing can be provided near where Q2 renters work, to reduce commuting burdens. In many cases, particularly in Sydney, this response would require some form of subsidy to cover the gap between the market costs of housing development and the affordable rent for Q2 renters, especially for those with high commuting burdens who work in or near the Sydney CBD.

3. Employment locations can be dispersed to sites closer to where Q2 renters live. This approach is anticipated by current metropolitan policy, such as the three-cities Sydney scheme or the mix of employment and activity centres in *Plan Melbourne*. Such policy would, however, run against the current market tendency for high value employment to locate in CBD sites where infrastructure focuses activity around historic administrative cores. Investment to make non-CBD sites attractive to current CBD-based businesses would likely be required, at scale, to achieve discernible effect for Q2 renters.
4. Transport systems may be improved to reduce commuting distances and costs such that location becomes less of a determinant of employment access than at present. Public transport would seem the best commuting option as it is more affordable for Q2 renters than private transport and is likely to become more necessary as cities grow and intensify. This, in turn, requires new transport investment, particularly in middle and outer suburban areas. Ideally this would involve high capacity cross-town links, such as the Sydney Metro that has recently opened to positive patronage response. Concomitant consideration might be given to reducing public transport fares to reduce commuting costs. As with infrastructure investment, such a strategy requires funding.
5. Further research would be merited to evaluate which of these four options might be preferred.

There is a need for further research across both the academic and policy sectors to better define what is meant by urban productivity. Basic definitions of productivity are based on hours worked or capital advanced in relation to outputs generated. But we lack good data at the metropolitan level on either hours worked, capital advanced or outputs generated. Consequently, various proxy indicators, such as wages earned per unit area, jobs density, travel time costs, employment accessibility, to name but a few, are offered. One common measure decomposes national productivity measures to the metropolitan level by apportioning aggregate industry GDP to the equivalent metropolitan industry based on its proportional share of industry activity (BEA 2015). However, this method is used only occasionally in the literature and in Australia is not applied by either researchers or policy agencies, with the private sector filling this gap (Rawnsley 2018). Where the Australian policy literature attempts to measure productivity there is little consistency and limited effort to offer definitions. Following the observations by Maclennan et al. (2019) about deficits in Australian urban and housing economics capability, if Australian urban research and policy is to better understand how various factors affect the productivity of the nation's cities then further effort is needed to develop a systematic set of urban-level definitions, measures and data for this task.

References

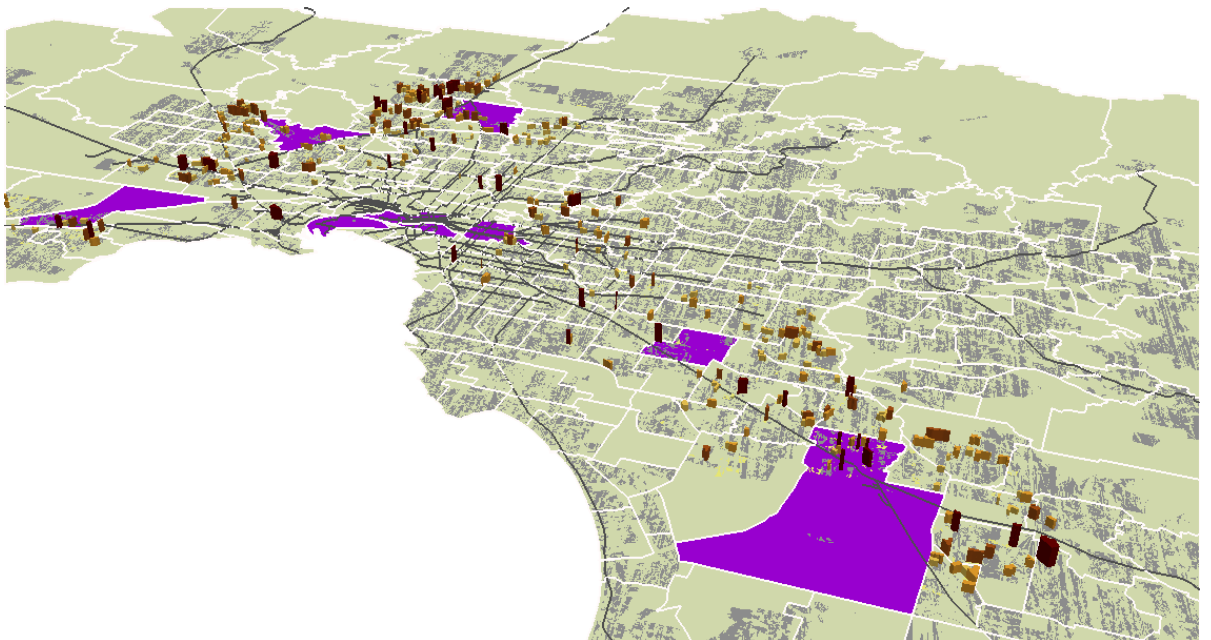
- Albouy, D. (2016) 'What Are Cities Worth? Land Rents, Local Productivity, and the Total Value of Amenities', *Review of Economics and Statistics*, vol. 98, no. 3: 477–487. https://doi.org/10.1162/REST_a_00550.
- Brueckner, J. and Zenou, Y. (2003) 'Space and Unemployment: The Labor-Market Effects of Spatial Mismatch', *Journal of Labor Economics*, vol. 21, no. 1: 242–266. <https://doi.org/10.1086/344129>.
- Bureau of Economic Analysis (BEA) (2015) *GDP by Metropolitan Area Methodology*, accessed 8 June 2019, <https://www.bea.gov/sites/default/files/methodologies/GDPMetro2015.pdf>.
- Buxton, M. and Taylor, E. (2011) 'Urban Land Supply, Governance and the Pricing of Land', *Urban Policy and Research*, vol. 29, no. 1: 5–22. <https://doi.org/10.1080/08111146.2011.537605>.
- Chatman, D.G. and Noland, R.B. (2011) 'Do Public Transport Improvements Increase Agglomeration Economies? A Review of Literature and an Agenda for Research', *Transport Reviews*, vol. 31, no. 6: 725–742. <https://doi.org/10.1080/01441647.2011.587908>.
- Chatman, D.G. and Noland, R.B. (2014) 'Transit Service, Physical Agglomeration and Productivity in US Metropolitan Areas', *Urban Studies*, vol. 51, no. 5: 917–937. <https://doi.org/10.1177/0042098013494426>.
- Ciccone, A. (2002) 'Agglomeration Effects in Europe', *European Economic Review*, vol. 46, no. 2: 213–227. [https://doi.org/10.1016/S0014-2921\(00\)00099-4](https://doi.org/10.1016/S0014-2921(00)00099-4).
- Department of Infrastructure Regional Development and Cities (2018) *Western Sydney City Deal*, accessed 5 July 2019, https://citydeals.infrastructure.gov.au/sites/default/files/2018-06/western_sydney_city_deal_pdf.pdf.
- Department of Environment, Land, Water and Planning (DELWP) (2017) *Plan Melbourne 2017*; Melbourne, Victorian Government.
- Dodson, J., and Berry, M. (2005) Is there a Spatial Mismatch between Housing Affordability and Employment Opportunity in Melbourne? (No. 192094169X), Australian Housing and Urban Research Institute, Melbourne.
- Eriksson, R., Lindgren, U. and Malmberg, G. (2008) 'Agglomeration Mobility: Effects of Localisation, Urbanisation, and Scale on Job Changes', *Environment and Planning A: Economy and Space*, vol. 40, no. 10: 2419–2434. <https://doi.org/10.1068/a39312>.
- Gipps, P., Brotchie, J., Henshaw, D., Newton, P. and O'Connor, K.B. (1997) *The Journey to Work Employment and the Changing Structure of Australian Cities*, accessed 15 July 2019, <https://research.monash.edu/en/publications/the-journey-to-work-employment-and-the-changing-structure-of-aust>.
- Glaeser, E.L., Gyourko, J. and Saks, R.E. (2006) 'Urban Growth and Housing Supply', *Journal of Economic Geography*, vol. 6, no. 1: 71–89. <https://doi.org/10.1093/jeg/lbi003>.
- Greater Sydney Commission (GSC) (2018) *Greater Sydney Region Plan: Metropolis of Three Cities* [Metropolitan Plan]; Sydney, New South Wales Government.
- Gurran, N. and Phibbs, P. (2013) 'Housing Supply and Urban Planning Reform: The Recent Australian Experience, 2003–2012', *International Journal of Housing Policy*, vol. 13, no. 4: 381–407. <https://doi.org/10.1080/14616718.2013.840110>.
- Gurran, N. and Phibbs, P. (2016) 'Boulevard of Broken Dreams: Planning, Housing Supply and Affordability in Urban Australia', *Built Environment*, vol. 42, no. 1: 55–71. <https://doi.org/10.2148/benv.42.1.55>.

- Gurran, N., Phibbs, P., Yates, J., Gilbert, C., Whitehead, C., Norris, M., Goodman, R. (2015) Housing Markets, Economic Productivity, and Risk: International Evidence and Policy Implications for Australia, AHURI Final Report No. 254, Australian Housing and Urban Research Institute, Melbourne, <http://www.ahuri.edu.au/research/final-reports/254>.
- Harris, T. F. and Ioannides, Y. M. (2000) *Productivity and Metropolitan Density* (No. 0016), <https://ideas.repec.org/p/tuf/tuftec/0016.html>.
- Healy, E. and O'Connor, K. (2001) 'Jobs and Housing Location in Melbourne, 1986-1996', *Australian Planner*, vol. 38, no. 1: 9–15. <https://doi.org/10.1080/07293682.2001.9657925>.
- Holzer, H.J. (1991) 'The Spatial Mismatch Hypothesis: What has the Evidence Shown?', *Urban Studies*, vol. 28, no. 1: 105–122. <https://doi.org/10.1080/00420989120080071>.
- 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. 9, no. 4: 849–892. <https://doi.org/10.1080/10511482.1998.9521321>.
- Infrastructure Australia (IA) (2018) *Future Cities: Planning for Our Growing Population*; Sydney, Department of Infrastructure and Regional Development.
- Kain, J. (1968) 'Housing Segregation, Negro Employment and Metropolitan Decentralization', *Quarterly Journal of Economics*, vol. 82, no. 2: 175–192. <https://doi.org/10.2307/1885893>.
- Kelly, J.F. and Mares, P. (2013) *Productive Cities: Opportunity in a Changing Economy*, Grattan Institute, Melbourne.
- Kim, J.H. (2011) 'Linking Land Use Planning and Regulation to Economic Development: A Literature Review', *Journal of Planning Literature*, vol. 26, no. 1: 35–47. <https://doi.org/10.1177/0885412210382985>.
- Knaap, G.J. (1985) 'The Price Effects of Urban Growth Boundaries in Metropolitan Portland, Oregon', *Land Economics*, vol. 61, no. 1: 26–35. <https://doi.org/10.2307/3146137>.
- Li, T., Dodson, J. and Sipe, N. (2015) 'Differentiating Metropolitan Transport Disadvantage by Mode: Household Expenditure on Private Vehicle Fuel and Public Transport Fares in Brisbane, Australia', *Journal of Transport Geography*, vol. 49: 16–25. <https://doi.org/10.1016/j.jtrangeo.2015.10.001>.
- Li, T., Dodson, J. and Sipe, N. (2018) 'Examining Household Relocation Pressures from Rising Transport and Housing Costs—An Australian Case Study', *Transport Policy*, vol. 65: 106–113.
- MacLennan, D., Randolph, B., Crommelin, L., Witte, E., Klestov, P., Scealy, B. and Brown, S. (2019) *Strengthening Economic Cases for Housing Policies* (p. 70), UNSW City Futures Research Centre, SGS Economics and Planning and Cadence Economics, Sydney.
- Major Cities Unit (MCU) (2012) *State of Australian Cities 201*, Department of Infrastructure and Transport, Canberra.
- Manning, I. (1978). *The Journey to Work*, Allen & Unwin, Sydney.
- McCann, P. and van Oort, F. (2009) 'Theories of Agglomeration and Regional Economic Growth: A Historical Review', *Handbook of Regional Growth and Development Theories*, 19–32.
- Mitchell, W., and Watts, M. (2010) 'Identifying Functional Regions in Australia Using Hierarchical Aggregation Techniques', *Geographical Research*, vol. 48, no. 1: 24–41. <https://doi.org/10.1111/j.1745-5871.2009.00631.x>.
- Moran, A. (2007) 'Land Regulations, Housing Prices and Productivity', *Agenda: A Journal of Policy Analysis and Reform*, vol. 14, no. 1: 35.
- Mori, T. and Turrini, A. (2005) 'Skills, Agglomeration and Segmentation', *European Economic Review*, vol. 49, no. 1: 201–225. [https://doi.org/10.1016/S0014-2921\(03\)00018-7](https://doi.org/10.1016/S0014-2921(03)00018-7).
- NRMA. (2019) Real cost of buying a car, accessed [Accessed 18 July 2019], <https://thehub.nrma.com.au/drive/real-cost-buying-car>.
- Ong, R., Dalton, T., Gurran, N., Phelps, C., Rowley, S. and Wood, G. (2017) Housing Supply Responsiveness in Australia: Distribution, Drivers and Institutional Settings; AHURI Final Report, Australian Housing and Urban Research Institute, doi:10.18408/ahuri-8107301.
- Partridge, M.D. and Rickman, D.S. (2008) 'Distance from Urban Agglomeration Economics and Rural Poverty', *Journal of Regional Science*, vol. 48, no. 2: 285–310. <https://doi.org/10.1111/j.1467-9787.2008.00552.x>.

- Productivity Commission (2017) *Shifting the Dial: Five-year Productivity Review*, accessed [Accessed 21 June 2019], <https://www.pc.gov.au/inquiries/completed/productivity-review/report/productivity-review.pdf>.
- Quigley, J.M. and Rosenthal, L.A. (2005) 'The Effects of Land Use Regulation on the Price of Housing: What Do We Know? What Can We Learn?', *Cityscape*, vol. 8, no. 1: 69–137.
- RACV. (2019), Driving your dollars 2019, accessed [Accessed 19 July 2019], <https://www.racv.com.au/on-the-road/buying-a-car/car-running-costs.html>.
- Rawnsley, T. (2018) *Economic Performance of Australia's Cities and Regions*, accessed [Accessed 8 June 2019], https://www.sgsep.com.au/download_file/view_inline/1803.
- Rice, P., Venables, A.J. and Patacchini, E. (2006) 'Spatial Determinants of Productivity: Analysis for the Regions of Great Britain', *Regional Science and Urban Economics*, vol. 36, no. 6: 727–752. <https://doi.org/10.1016/j.regsciurbeco.2006.03.006>.
- Rosenthal, S.S. and Strange, W.C. (2001) 'The Determinants of Agglomeration', *Journal of Urban Economics*, vol. 50, no. 2: 191–229. <https://doi.org/10.1006/juec.2001.2230>.
- Saberi, M., Wu, H., Amoh-Gyimah, R., Smith, J. and Arunachalam, D. (2017) 'Measuring Housing and Transportation Affordability: A Case Study of Melbourne, Australia' *Journal of Transport Geography*, vol. 65: 134–146. <https://doi.org/10.1016/j.jtrangeo.2017.10.007>.
- Venables, A.J. (2007) 'Evaluating Urban Transport Improvements', *Journal of Transport Economics and Policy*, vol. 41: 16.
- Venables, A.J. (2011) 'Productivity in Cities: Self-selection and Sorting', *Journal of Economic Geography*, vol. 11, no. 2: 241–251. <https://doi.org/10.1093/jeg/lbq040>.
- Vickrey, W.S. (1977) 'The City as a Firm' in M.S. Feldstein and R.P. Inman (eds), *The Economics of Public Service*, Macmillan, New York: 334–343.
- Weisbrod, G., Vary, D. and Treyz, G. (2003) 'Measuring Economic Costs of Urban Traffic Congestion to Business', *Transportation Research Record: Journal of the Transportation Research Board*, 1839: 98–106. <https://doi.org/10.3141/1839-10>.

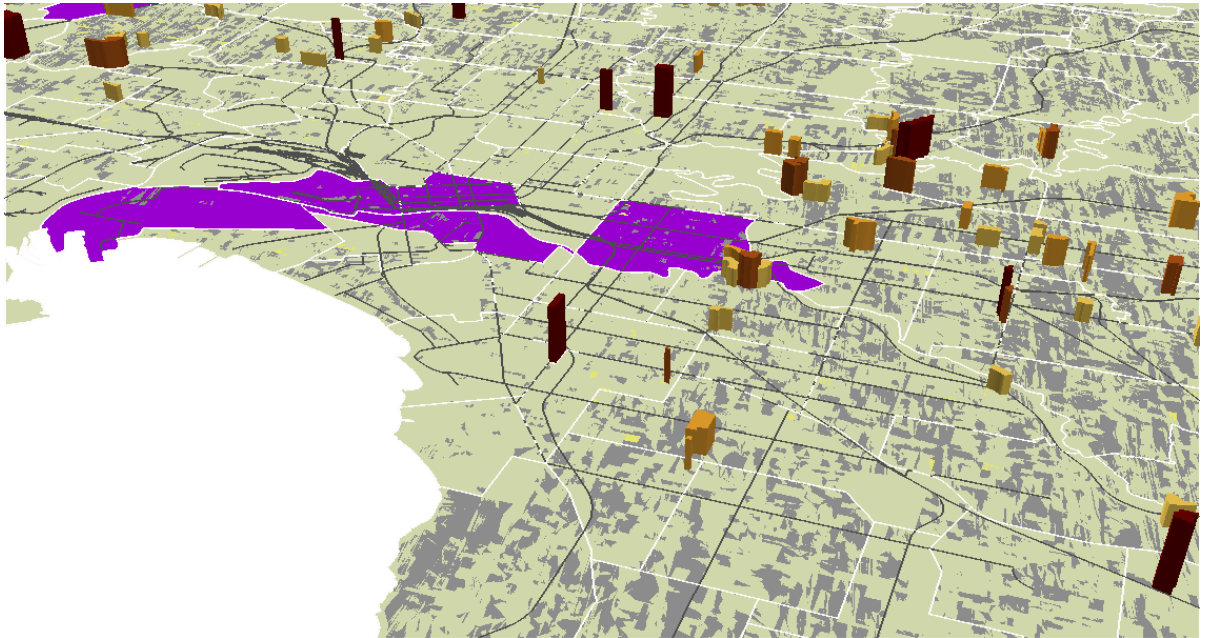
Appendix 1: Land capacity for affordable rental houses for Q2 renters in Melbourne

Figure 28: Land capacity around top 10 employment centers for Q2 workers in Melbourne



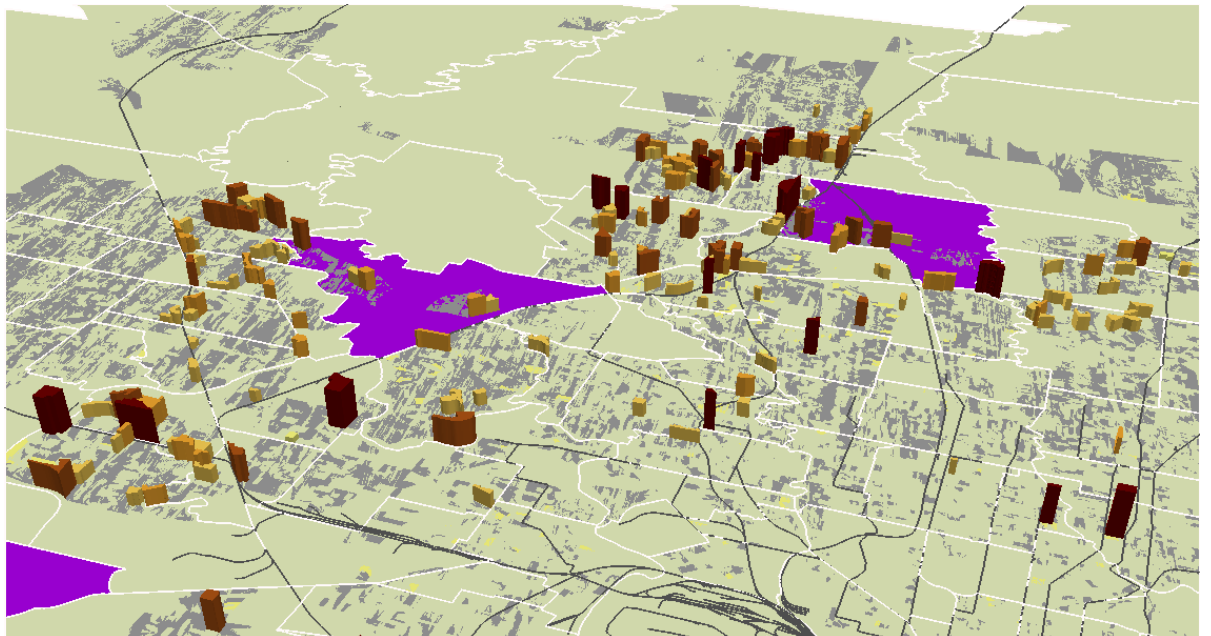
Source: Authors, derived from ABS Census data.

Figure 29: Land capacity at suitable locations for affordable rental houses around the CBD, Richmond, Port Melbourne, Southbank and Docklands



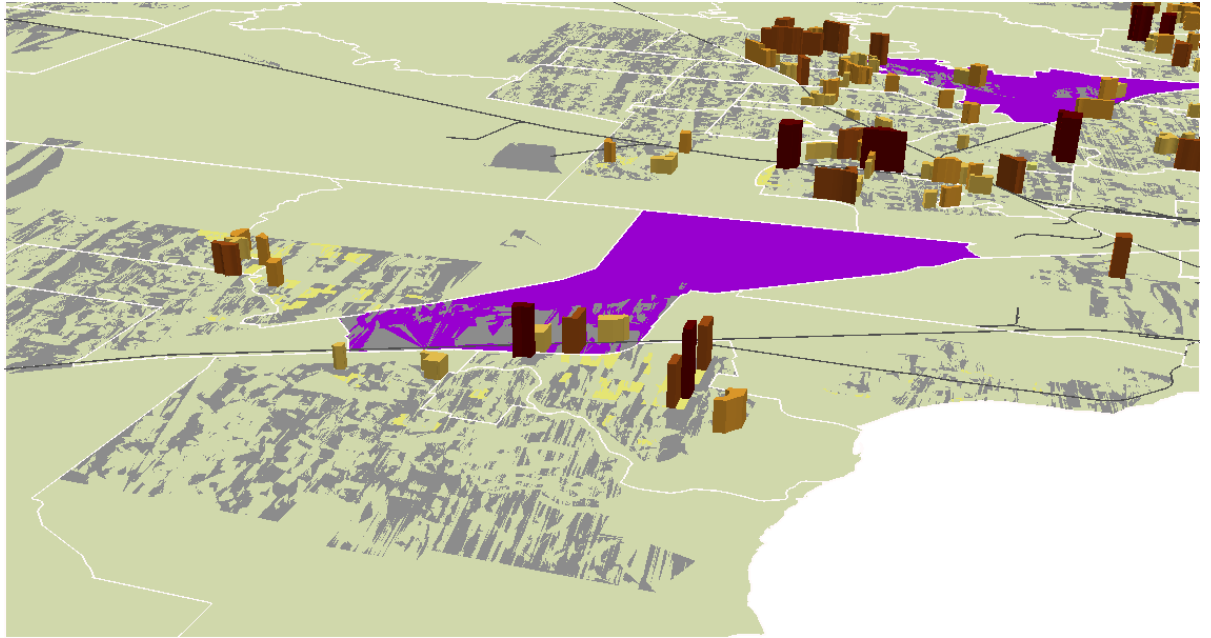
Source: Authors, derived from ABS Census data.

Figure 30: Land capacity at suitable locations for affordable rental houses around Keilor and Campbellfield



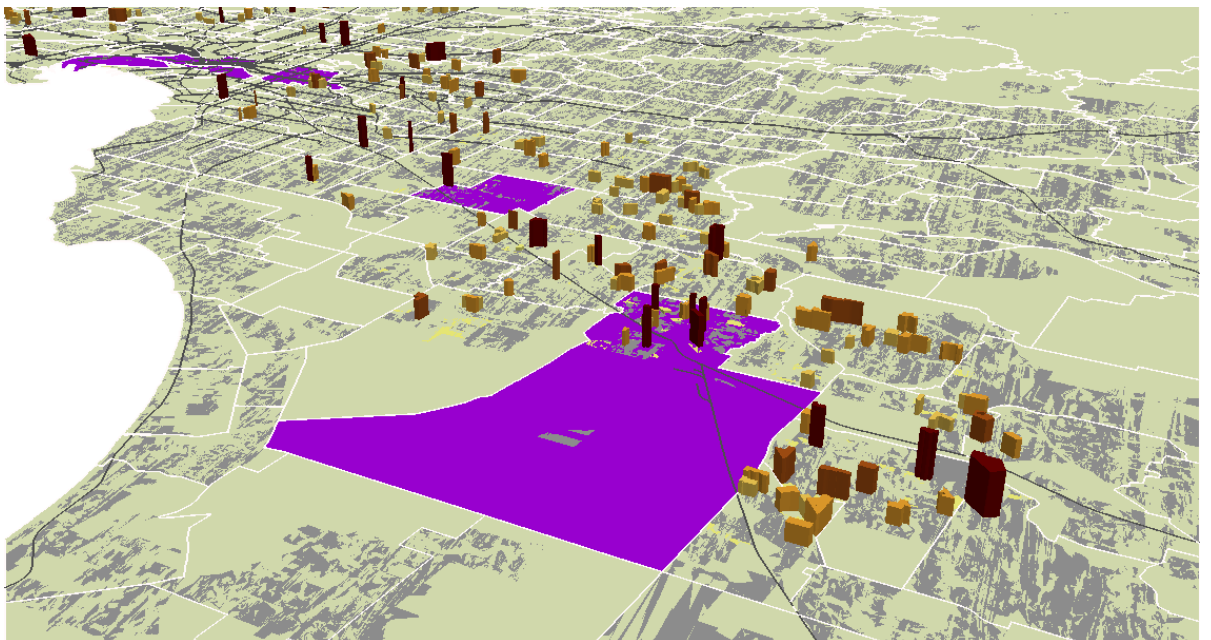
Source: Authors, derived from ABS Census data.

Figure 31: Land capacity at suitable locations for affordable rental houses around Laverton



Source: Authors, derived from ABS Census data.

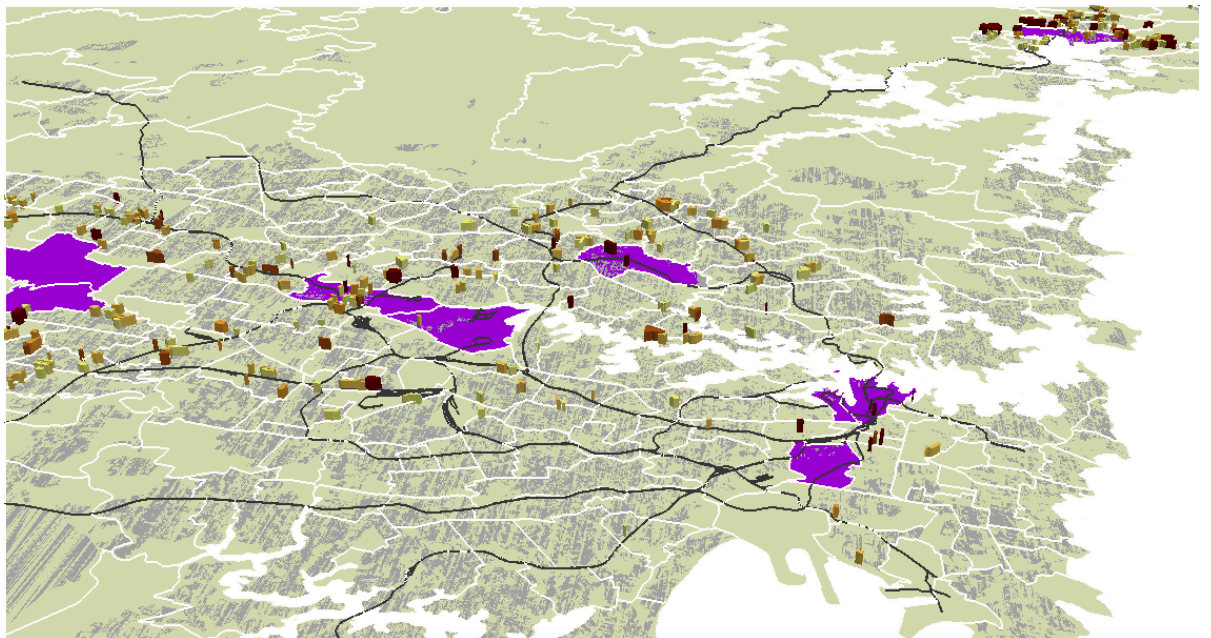
Figure 32: Land capacity at suitable locations for affordable rental houses around Dandenong and Clayton



Source: Authors, derived from ABS Census data.

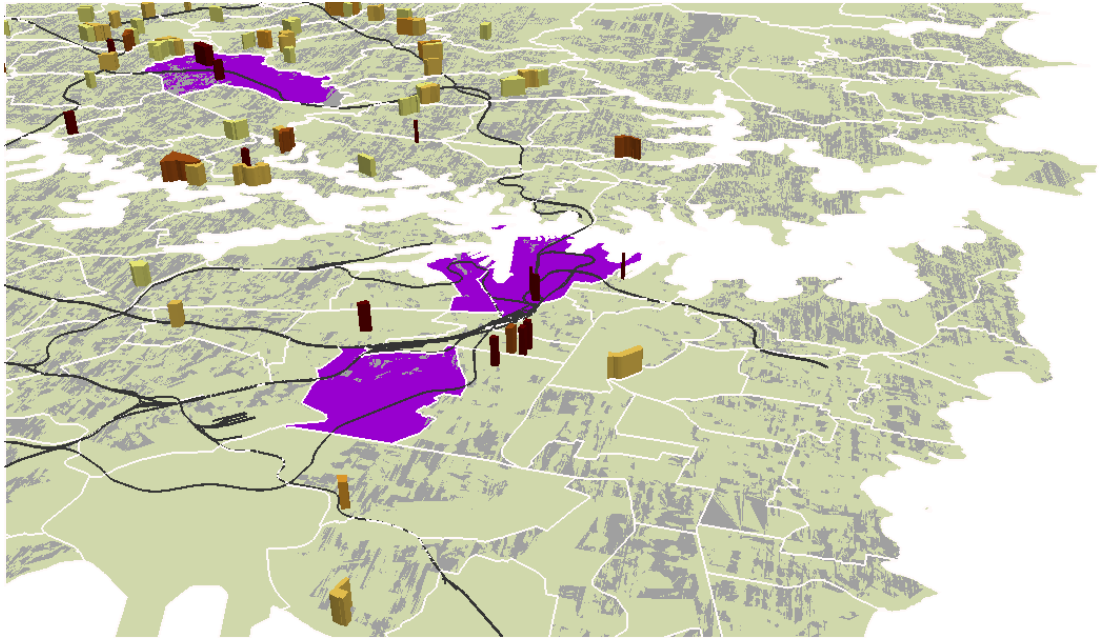
Appendix 2: Land capacity for affordable rental houses for Q2 renters in Sydney

Figure 33: Land capacity around top-10 employment centers for Q2 workers in Melbourne



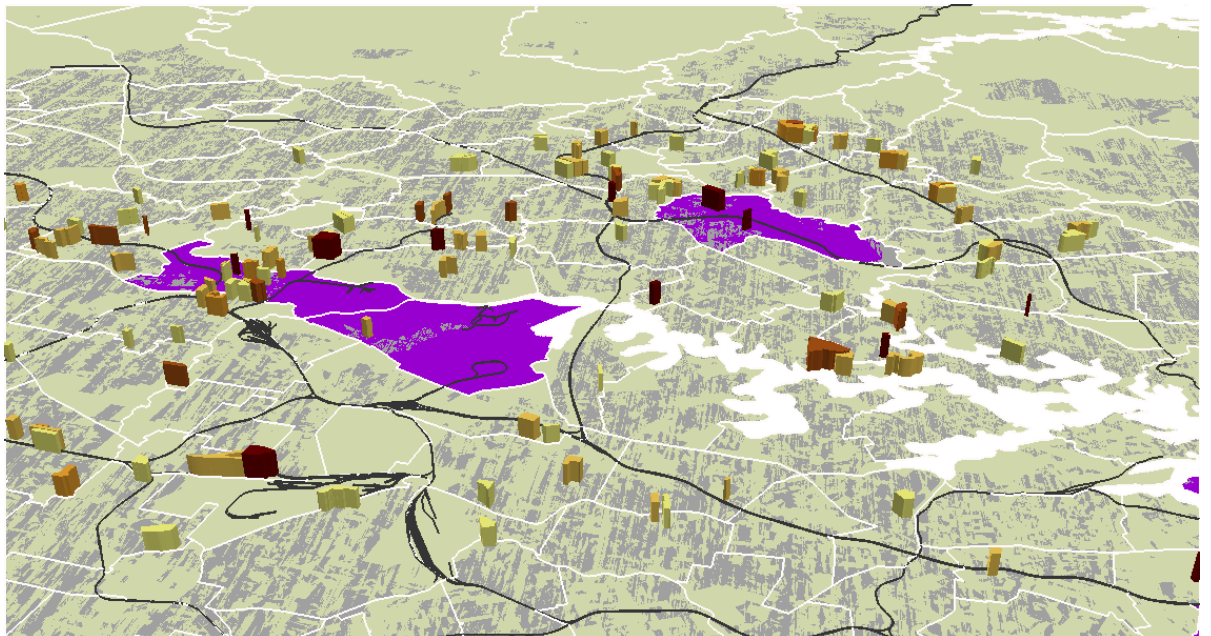
Source: Authors, derived from ABS Census data.

Figure 34: Land capacity at suitable locations for affordable rental houses around Sydney CBD and Alexandria



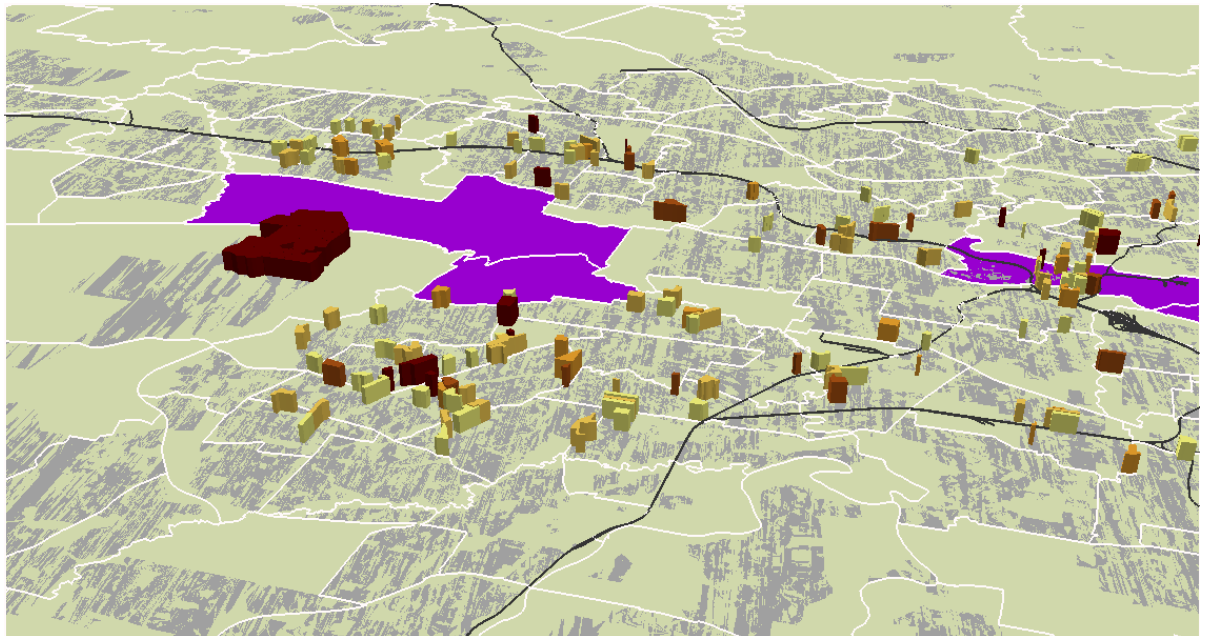
Source: Authors, derived from ABS Census data.

Figure 35: Land capacity at suitable locations for affordable rental houses around Macquarie Park and Silverwater



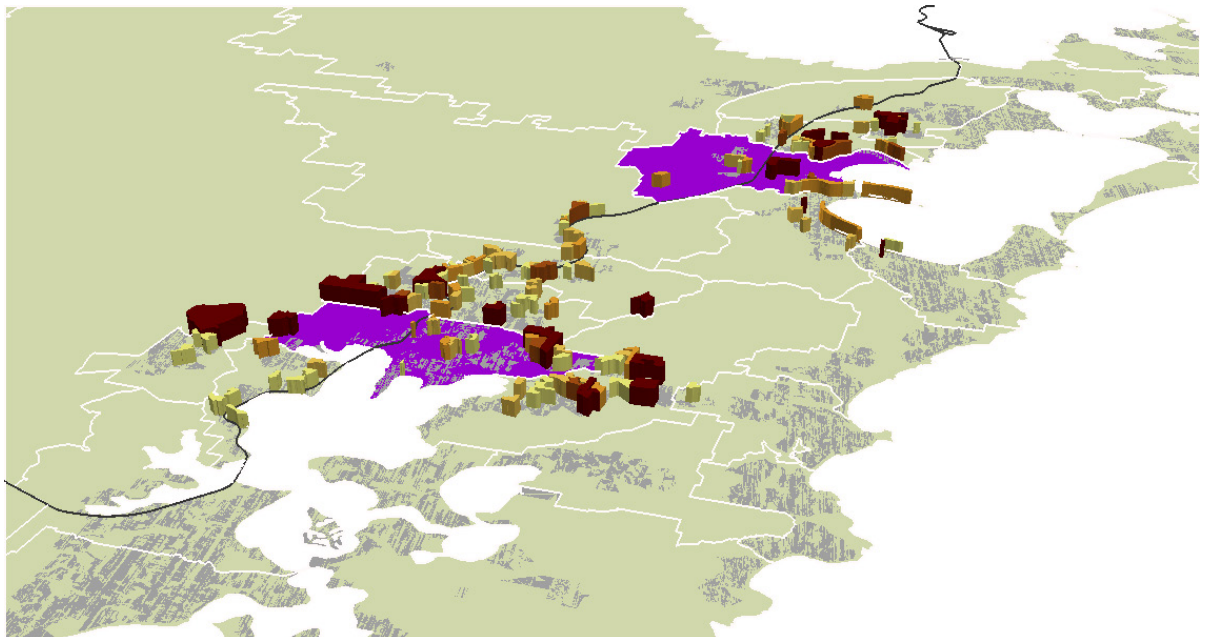
Source: Authors, derived from ABS Census data.

Figure 36: Land capacity at suitable locations for affordable rental houses around Wetherill Park Industrial and Prospect Reservoir



Source: Authors, derived from ABS Census data.

Figure 37: Land capacity at suitable locations for affordable rental houses around Springfield (Gosford) and Kangy Angy (Tuggerah)



Source: Authors, derived from ABS Census data.



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