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Relationships between metropolitan, satellite and regional city size, spatial context and economic productivity

From the AHURI Inquiry: Inquiry into population growth, migration and agglomeration

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Acronyms and abbreviations used in this report

ABS	Australian Bureau of Statistics
ACS	American Community Survey
AHURI	Australian Housing and Urban Research Institute
ANZSIC	Australian and New Zealand Standard Industrial Classification
CBD	Central Business District
CO2	Carbon dioxide
EU	European Union
GDP	Gross Domestic Product
GFC	Global Financial Crisis
GSE	General Spatial Equilibrium model
GMM	Generalised Method of Moments
UK	United Kingdom
MCU	Major Cities Unit
NUTS	Nomenclature of Territorial Units
NZ	New Zealand
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
RQ	Research Question
SA2	Statistical Area Level 2
SUA	Significant Urban Area
US	United States
USA	United States of America

Qualifying statement

The research referred to in this final report was designed and commissioned before the onset of the COVID-19 pandemic. Datasets were collected prior to the pandemic, and the quantitative work largely completed around the middle of 2020. This report is part of the Inquiry into population growth, migration and agglomeration - other reports from the Inquiry consider the impacts of COVID-19.

Executive summary

Key points

- Based on international evidence, there is a prima facie case that the economic productivity gains arising from city scale are being eroded by negative factors, including congestion and adverse housing outcomes—such as unaffordability.
- International and internal migrants have begun to disperse from metropolitan areas and migrate directly to new smaller areas, particularly in North America and Europe. The major metropolitan areas are losing the largest share of net domestic migrants, while domestic migration is accelerating suburbanisation within metropolitan areas.
- Empirical results suggest that, for US cities, a city of 1 million people would imply a wage rate 7.6 per cent higher than a city of 500,000 population.
- For Australian cities, the evidence of a productivity gain from higher city scale is weaker, and the estimates are smaller than for US cities. The results are inconclusive, probably reflecting the short time series of data available to the project, but there are indications that agglomeration economies might appear at smaller city scales in Australia compared to the USA and the EU.
- Population is positively associated with higher wage rates in Australian cities. There are also positive impacts on the number of businesses and total jobs. The results suggest that having larger cities could therefore yield a productivity dividend.

- **Industrial agglomeration, or increased industry employment shares, is also positively linked to incomes and the number of businesses in Australian cities—particularly for employment in those economic sectors that are already associated with high employment shares.**

- **The relationships between city size and economic productivity are complex and nonlinear. There are suggestions that improvements to productivity are greater at lower levels of city population, but tail off as population grows.**

Key findings

The research questions addressed by this study are:

- **RQ1:** At what city scales do agglomeration economies (and diseconomies) arise? And how does this vary over time, by Australian geography and by international context?
- **RQ2:** What are the relative importances of accessibility, housing and commercial real estate user costs, population density, environmental factors, skills, interstate and international migration to growth in jobs, businesses and city-scale economic output?
- **RQ3:** What does the international evidence base suggest about the relationship between international migration, housing costs and economic output?

The research combined a number of research approaches, including:

- a review of international literature, evidence and statistics
- econometric analysis of US, EU and Australian data on the economic performance of cities.

The international review revealed a number of insights that are relevant to housing and urban policy in the Australian context. For example, we found that there appears to be broad support for the notion that housing outcomes—including affordability and congestion caused by commuting—may be beginning to erode the potential economic productivity gains that arise through city scale. There are also knock-on impacts within the urban economy, including impacts on the composition and skill levels and mix of labour markets. There are also other complex interactions at work because there is evidence, internationally and from Australia, that patterns of migration are changing. These interactions suggest that the relative desirability of metropolitan, smaller cities and regional markets are changing for international migrants, and for migrants within countries.

The econometric analyses showed that agglomeration economies—or the combined benefits of a range of advantages arising from city scale and concentration—appear at all levels of population within a range of city sizes examined in the US and Australian data. Estimated threshold effects do not imply any diseconomies of scale over the range of city sizes and, if anything, that agglomeration economies strengthen in the larger cities, rather than weaken. The positive coefficients for cities below the lowest thresholds examined suggest that agglomeration economies occur even for very small cities.

A set of models based on US cities, which included interaction effects, suggested that agglomeration economies strengthen with city size. Although the results for Australia were often not statistically significant, the coefficients were consistent with the results for the USA. The weaker levels of statistical significance found for Australian cities probably reflects the shorter time series of data and the smaller number of cities in Australia rather than any systematic difference.

The European data did not indicate agglomeration economies or diseconomies, nor any pattern of strengthening or weakening. It may be that structural factors in Europe mean that agglomeration economies are less of a factor for predicting average city incomes in Europe. This could be due to 'borrowed size', industrial structure or migration.

The analysis of Australian data focusses only on the period 2011–16, which reflects the poor availability of time series data for cities. Our simple linear estimation results show that population is positively associated with higher wage rates, creation of businesses and total jobs. We also found that industry agglomeration—that is, increasing industry employment shares—is positively linked with income and business. In particular, increasing the employment shares from the five largest economic sectors—Health, Retail Trade, Construction, Manufacturing and Education—would in theory lead to a higher level of real wages. Meanwhile, population density seems to play a minor role in determining wage rates, but is an important determinant of business growth in Australia.

In a different set of nonlinear (parametric) estimations, we found that the positive relationship between population and income is conditional on city population levels. In other words, the effect of population on income is heterogenous, and only the cities with low population levels are positively related to income. A set of semiparametric estimations shows that the relationship between income and population is nonlinear. Overall, these results suggest that higher levels of population increase wage rates for smaller cities rather than much larger cities.

Policy development options

An important feature of local housing outcomes is that they reflect levels and interactions of factors:

- **local factors**—residential structures, neighbourhood qualities, physically limited developable land
- **metropolitan factors**—agglomeration economies and amenities
- **subnational influences**.

The policy approaches and instruments that are reflected in the choices of households and developers reflect a variety of instruments controlled from different levels of government. These measures are not always well coordinated—and some measures may even run counter to each other. Managing the metropolitan housing system requires a real grasp of policy impacts and interactions in achieving metropolitan goals.

The assignment of policy responsibilities and functions within a geographically large federal system such as Australia must take into account the functional nature of systems. With a strong local dimension to housing systems, it could be expected that state and metropolitan scales would have significant housing policy roles. However, housing outcomes from local actions may spillover into other jurisdictions, and across the nation as a whole. So it is important to have a federal view on good or desirable housing outcomes for Australians.

The Australian Government has previously reported that the contribution of major cities to national economic growth has declined over time. Our more recent results suggest that this decline may have continued. However, we also find evidence to suggest that smaller Australian cities stand to make a higher contribution to economic productivity, if permitted to scale up.

However, there are some key aspects of public policies for housing—apart from their framing—that need to change if the gap between achieved and potential metropolitan economic potential is to be reduced or removed. This involves rethinking the structures and settings for housing policies in major metropolitan areas, and so it will be essential:

- to manage the real housing system to facilitate faster supply responses
- to better connect housing and other areas of policy activity
- to deal with market failures
- to avoid demand stimuli that needlessly raise prices or underutilise existing residential spaces.

A first step will be to reconceive housing policies as being, in part, concerned with real economic infrastructure to facilitate economic development. A second step is to move away from a narrow focus on homelessness and the poorest households and to set their concerns within a broader housing-systems framework that considers all housing outcomes in metropolitan areas—and in the nation.

Two important policy changes are required to deal with 'multi-order' issues.

First, multi-order cooperation in housing policy needs to be incentivised. This may require federal/state/provincial governments to develop performance-conditional housing deals with metropolitan governments.

Second, key housing policy decisions increasingly rest at the metropolitan scale. Given their important role in national economic development, there is a strong case to refocus the leadership roles in housing policy strategy and delivery down from federal/state/provincial levels and up from municipal scales to metropolitan scales.

Metropolitan boundaries are rarely well aligned with daily functional system boundaries. Although around half of the metropolitan areas in the OECD have now evolved some form of metropolitan governance, fewer than one in six have any resource or fiscal powers. So, the best geographic and fiscal structures to take forward more effective metropolitan housing powers may currently be missing.

Similar remarks can be made in relation to the assignment of fiscal powers to different orders of government. In a functional metropolitan area, the problem is that costs—such as affordable housing, traffic congestion and green space requirements—all rise with economic growth, as do tax revenues. So while the problems remain in the functional city, the tax revenues required to address them accrue to other orders of government. There is no automatic flowback of locally generated resources to pressured localities so they can take action to reduce negative growth consequences.

Given the vast scale of the housing shortages current in all of Australia's major growth localities, a serious attempt to reduce house price growth for the future might have to include radical options such as:

- compulsory purchase of land
- requirements for inclusionary zoning.

In other words, housing policy should be a key element in 'place-making' policy at both metropolitan and neighbourhood scales. This also requires that related infrastructure and services—as well as transport links to jobs and services—are built into the proposal beforehand (ex ante), and that infrastructure and planning gains are taken to the greatest extent possible by metropolitan governments.

The study

The research summarised in this Final Report forms part of a wider AHURI *Inquiry into population growth, migration and agglomeration*. This project focusses on two of the four overarching inquiry level research questions:

- **RQ2:** At what population and geographic scales do agglomeration economies begin to alter the economic productivity of cities, and at what stage do these advantages begin to slacken off or give rise to diseconomies?
- **RQ4:** How can the benefits of agglomeration economies be quantified in the Australian context? This includes evaluation of housing market effects, employment density, market potential, traffic congestion/commuting times/pollution and wellbeing, and differences between household types and/or socio-economic groups.

The emphasis in this report is on addressing RQ2, but the empirical findings give some insights into RQ4.

The AHURI inquiry is motivated by the fact that the goal of raising economic productivity is rising in importance nationally and internationally. There are many reasons for this, but this report focusses mainly on the relationship between city scale and productivity, and on interactions between housing outcomes and productivity outcomes.

Commonly cited barriers to the improvement of economic productivity in Australia include:

- high housing costs—which reduce the opportunities to match productive workers to affordable housing
- diseconomies associated with urban agglomeration—that is, the big cities have become too big (Maclennan, Crommelin et al. 2015; van den Nouwelant, Crommelin et al. 2016; Hulse, Reynolds et al. 2015).

Migration is also a hotly contested topic, particularly international migration. Many commentators argue that migration drives up housing costs and contributes to housing unaffordability, with a feedback effect of reducing economic productivity. Others point out that international migrants make a positive contribution to economic output and productivity. The balance of the affordability vs productivity impact argument is unclear at present, with relatively little empirical evidence to inform policy development.

In the past, AHURI funded a number of research projects examining linkages between housing and productivity, and so the evidence base is beginning to build up. However, agglomeration economies are inherently complex in terms of how they interact with city size, regional and spatial issues, and change over time, and may be subject to threshold and nonlinear effects. There are numerous econometric and identification issues to be overcome, and existing data sources are barely sufficient for the purpose. The empirical work shown in this report brings together data on US and EU cities, as well as Australian cities. We examine the relationships in these three broad geographic contexts to determine whether there are relationships affecting cities in general—irrespective of their location internationally—and whether there is evidence that such relationships also exist in Australia.

The overarching inquiry is motivated by the idea that harnessing 'agglomeration economies' may provide the basis for designing policy solutions that boost economic productivity without seriously harming housing system outcomes.

The term 'agglomeration economies' is taken to mean the net aggregate impact of a range of internal and external economies, or advantages vs disadvantages, that accrue when firms and individuals locate in urban areas. This includes:

- economies of scale that arise when firms access larger markets
- internal advantages when firms can access higher quality labour supply
- cost advantages associated with accessing established supply chains.

This report is designed to contribute to the empirical evidence about the existence and scale of agglomeration economies, and the conditions under which they might exist and apply to Australian cities. As Glaeser and Gottlieb (2009) pointed out, agglomeration economies are difficult to estimate, and may be subject to nonlinear and threshold effects. The case for making policy interventions in an attempt to realise agglomeration economy dividends is far from having been made empirically. Thus, this project makes an important contribution to the evidence base to be considered by the overarching inquiry.

1. Population, city size and economic productivity: the research questions

- **Most of the published evidence on the relationship between city scale and productivity is from North America—particularly the United States. There is a broad consensus that doubling population density increases wages by between 4 per cent and 13 per cent.**
- **There is evidence of heterogeneity with respect to city size and industry / economic sector, which suggests that an econometric estimation strategy must account for these complexities.**
- **There is currently little or no evidence about agglomeration effects on productivity for Australian cities.**
- **There is evidence in Australia and internationally that the relative performance of metropolitan cities—in terms of contribution to national productivity—is declining or reverting to average levels of performance.**
- **There is emerging support for the argument that adverse housing outcomes—including affordability and longer commuting—play a role in eroding the economic productivity gains through agglomeration.**

1.1 Policy context

The concept of agglomeration economies has been becoming increasingly important to Australian public policy debate for a number of reasons, but particularly because of the apparent slowing down of economic growth and productivity in Australia's largest capital cities, as mentioned earlier. There is also growing concern over levels of poverty and inequality. Meanwhile, Australia's labour productivity, although marginally improved since the global financial crisis (GFC; Campbell and Withers 2017), is still below the rate required to maintain Australia's historic per capita income growth rate of 2.5 per cent, and is driven by capital deepening—that is, more capital per worker—rather than multifactor productivity (Campbell and Withers 2017).

Previous AHURI-funded research has emphasised the potential role to be played by housing in helping to shape economic productivity. Gurran, Phibbs et al. (2015) summarised the four main impacts of housing as:

- labour market mobility
- labour market participation and employment
- urban congestion
- indirect costs—such as the pressure that high housing costs exert on wage demands.

Gurran, Phibbs et al. (2015) also noted growing disparity between housing markets that offer accessibility to capital city employment markets, and outer metropolitan and regional areas that do not offer the same accessibility.

Whelan and Parkinson (2017) found that unemployed people, underemployed people and private renters have higher mobility and lower reservation wages—the lowest wages they are prepared to work for—than homeowners and employed people. Van den Nouwelant, Crommelin et al. (2016) noted escalating commuting times and a growing mismatch between low-income employment and low-income housing opportunities, with a knock-on impact to economic productivity.

Labour productivity is driven by numerous factors, including agglomeration economies, which suggest that the spatial organisation of labour and housing markets is key to Australia's future prosperity. There is mounting empirical evidence to show not only that agglomeration economies exist, but that they matter in terms of the determination of economic productivity. Glaeser and Gottlieb (2009) pointed out that human capital spillovers suggest that attracting workers to an area will boost local productivity. It has also been shown that low-income workers, and households with benefit recipients, tend to gravitate towards areas with stronger employment opportunities (Glaeser and Gottlieb 2009).

Agglomeration economies include three distinct categories put forward by Marshall (1890/1920):

- labour pooling
- shared input markets
- technological spillovers.
- Other reasons put forward in the literature for the existence of positive agglomeration economies are that:
- positive (non-zero) transportation costs mean that denser areas offer an advantage or reduced relative transport costs
- very dense areas of economic activity offer opportunities for a higher degree of specialisation—division of labour.

In terms of the policy implications, some commentators (for example Chatterji, Glaeser et al. 2013) argue that some policies have many apparent positive aspects and few negative aspects. They include allowing more skilled immigration, strengthening education systems and eliminating unwise regulations in this category of policy intervention. They argue that there is not enough evidence to show that policies designed to cluster entrepreneurship are effective.

Productivity increases in cities and regions will have differing impacts on incomes, jobs and housing prices because of the variations in housing supply elasticity between locations. Elasticity, in turn, depends on the availability of land and the extent to which planning controls permit housing development. While planning and infrastructure responses attempt to accommodate further population growth in Australia's hottest cities, it is logical to question whether an alternative population and urban growth strategy might result in superior outcomes in terms of economic growth and wellbeing. This argument is driven by the notion that regional areas and satellite cities could begin to harness the advantages of agglomeration economies if they were permitted (or encouraged) to grow. The argument is that population growth redirected to regions and satellite cities would have an economic productivity dividend, with much lower negative impacts (or diseconomies) such as congestion, noise, overcrowding, housing stress and pollution. These are the diseconomies associated with cities having grown too large, and in which the negative consequences begin to approach the magnitude of the positives associated with city size.

There is a related question of which regions and satellite cities chosen as alternative locations for population growth might offer the greatest dividend. Those near larger metropolitan areas might be expected to have greater existing productivity advantages such that greater gains are available elsewhere.

Yet, Glaeser and Gottlieb (2009) caution that in relation to policies designed to subsidise the movement of firms or people, the simple existence of agglomeration economies does not necessarily imply that policy intervention should facilitate this, nor what form those interventions should take. They also note that 'the existence of agglomeration economies does not imply that the winning area will win more than losing areas loses' (Glaeser and Gottlieb 2009:1014).

The empirical evidence that already exists in relation to agglomeration economies is largely confined to the US experience and, to a lesser extent, European cities. It is also important to note that there are very significant differences in productivity between countries—as well as differences between cities within countries. The evidence from US research is becoming something of a consensus. For example, Ciccone and Hall (1996) found that a doubling of employment density for US states increased labour productivity by 6 per cent. Carlino, Chatterjee et al. (2007) showed that patent intensity is positively related to employment density in highly urbanised areas. Bruelhart and Mathys (2008) found that the elasticity of productivity to density is around 13 per cent, which is higher than that reported by other studies. They also found that this elasticity has been rising over time—that is, the importance of agglomeration economies is rising over time. They found that urbanisation economies—or cross-sectoral economies—are generally positive but that localisation economies—own sector economies—are mostly negative. This, they argued, suggests congestion diseconomies.

More recently, Ahlfeldt and Pietrostefani (2019) employed synthesis and meta-analysis methods to examine the effect of population density on a broad range of economic outcomes from wage, innovation, rents, different amenities, the cost of providing public services, and transport-related and environment-related costs. This study showed that an increase in population density results in:

- higher wages
- higher rent
- greater pollution concentration
- higher patent activity
- higher consumption

- greater preservation of green spaces
- higher construction costs
- higher skill wage gaps
- greater mortality risk.

However, the increase in population density also leads to:

- reduced average vehicle mileage
- reduced car use
- reduced average speed
- reduced energy consumption
- reduced crime
- reduced costs of providing local public services
- increased self-reported wellbeing.

Duranton and Puga (2020) reinforced these findings through a literature review, which emphasised that the associated benefits and costs from population and employment density include enhanced productivity and innovation and reduced pollution. However, they also find that population and employment density can drive up the land and housing prices and increase transportation costs.

Based on Canadian data, Baldwin, Beckstead et al. (2007) found that buyer–supplier networks, labour market pooling and knowledge spillovers are all significant determinants of productivity, but that the effects are not uniform between industry types. They found that knowledge spillovers are bounded, and extend no more than 10 kilometres from an individual plant.

Wheeler (2001) focussed on the argument that city scale better facilitates the firm–worker matching process —a form of agglomeration economy that lowers a firm's search costs and then gives rise to productivity gains. Wheeler estimated that a doubling of metropolitan area population leads to a 4 per cent increase in wages, and a 2 per cent increase in the population with a bachelor's degree or higher. He put forward three propositions that are supported by empirical evidence from US cities: larger markets have great productivity per worker, higher wage inequality and higher returns to level of skill.

Localisation economies are agglomeration economies that arise from spatial concentration within a given industry. Rosenthal and Strange (2003:385) found that localisation economies accumulate much more rapidly in the 'first few miles', and then slowly thereafter. They speculate that this reflects the way that information spillovers probably dissipate over a short distance as walking opportunities diminish, but that the benefits of labour market pooling and shared inputs dissipate over greater distances. Rosenthal and Strange (2008) found that the elasticity of wages with respect to the number of workers within five miles (8 kilometres) is approximately 4.5 per cent. They argue that the productivity gain is largely due to the presence of human capital, as proximity to college-educated workers enhances wages, while the opposite is true for proximity to workers with lower qualifications. Rosenthal and Strange also found that these effects fall very sharply with distance.

Based on analysis of Japanese firm-level data for 10 personal service industries, Morikawa (2011) found that a doubling of population density at municipality level gave rise to an increase in productivity of between 7 per cent and 15 per cent, and concluded that these industries benefit from significant economies of scale and density.

Foster and Stehrer (2009) examined 255 regions in 26 European countries, including Central and East European countries. Perhaps their most interesting finding is of a difference in the scale of agglomeration economies between 'new' and 'old' Europe, both at aggregate and at sectoral level, and argue that prospects for productivity

growth are higher in denser regions in new Europe. They speculate that this may reflect the more uneven nature of transport and business infrastructure in new Europe than in old Europe. Also focussing on the EU, Combes and Gobillon (2014) examined log of density on log of wages as a proxy for workers' productivity, and attempted to separate out the role of local labour skills, defined as being unrelated to location but inherited from parents or through education. They also noted that it is possible that highly skilled workers generate local externalities, or that they are over-represented in cities because they value these amenities. Finally, they argue that there are both static and dynamic effects at work, because the link between productivity and wages probably involves rapid adjustment, but the link between local amenities and productivity probably does not.

However, to date there is relatively little existing empirical evidence to suggest that agglomeration economies are as important to Australian cities, or to demonstrate the scale of the effects. In fact, very little is known about the size that cities, and potentially their hinterlands, must be before agglomeration economies occur. Yet it is likely that agglomeration is important, and perhaps even more important to Australia cities than elsewhere, as they are isolated from the rest of the world and from each other.

This Inquiry Research Project Final Report addresses overarching inquiry RQ2:

- **RQ2:** At what population and geographic scales do agglomeration economics begin to alter the economic productivity of cities, and at what stage do these advantages begin to slacken off or give rise to diseconomies?

The following project-specific research questions were designed to provide the detailed evidence with which the Inquiry can answer that question:

- **RQ1:** At what city scales do agglomeration economies (and diseconomies) arise? And how does this vary over time, by Australian geography and by international context?
- **RQ2:** What are the relative importances of accessibility, housing and commercial real estate user costs, population density, environmental factors, skill and interstate migration to growth in jobs, businesses and city-scale economic output?
- **RQ3:** What does the international evidence base suggest about the relationship between international migration, housing costs and economic output?

1.2 Existing research

Economists and economic geographers have long recognised the complexity and significance of agglomeration effects on the productivity and competitiveness of cities (Marshall 1890/1920). Agglomeration effects were linked with the locational choices of firms by both Weber (1897/1929) and Losch (1927/1954) but as ex post, empirically driven adaptations to their core theoretical models. However, three decades ago Paul Krugman 'endogenised' increasing returns to the scale of places in spatial economic modelling (Krugman 1991), which unleashed a new range of thinking focussed on the relationships between city size, growth and productivity.

The last three decades have seen a wide range of studies, both establishing the empirical significance of agglomeration economies (Strange 2019) and developing the theorisation of spatial economic growth models involving agglomeration effects. The most widely used approach, and the most influential in terms of policies, has been the 'general spatial equilibrium' (GSE) model attributable to Glaeser (2008).

The GSE model lies at the heart of much contemporary urban economic thinking. Wide claims have been made for the importance of agglomeration economies in promoting city economic development policies—although often without much evidence, which is an omission that Glaeser (2008) carefully notes, and with little regard to how housing systems influence the processes and outcomes observed. Importantly, there are few discussions of the nature and importance of agglomeration economies in housing research and policy debates. That deficit in understanding within the housing sector needs to be addressed in making better cases for housing programs and policies (Maclennan, Crommelin et al. 2018).

Agglomeration economies have been widely offered as an explanation for the higher productivity performance of larger cities. GSE models have been used to explain:

- why economic activities have increasingly clustered, or localised, in larger metropolitan areas at the same time as global flows of goods, labour and finance have increased
- why incomes and employment rates do not completely converge across cities and regions in national economic systems
- why some cities have had protracted performance as what has been labelled—arguably incorrectly—as superstar cities (Glaeser and Gyourko 2018).

However, there has been a growing concern, particularly following the GFC, that larger cities that had led national productivity growth are now reverting to average national performance. For instance, there have been claims in Sydney and Melbourne that creative cultural clusters and other skilled households and firms are being diverted by high costs and congestion in major metropolitan cores to smaller, lower-cost locations. Maclennan, Ong and Wood (2015) noted published evidence of such effects in North America, and noted that lower-cost new locations do not always best serve long-term innovation and productivity growth for the nation. The New Zealand Government has recently been concerned that productivity in Auckland, which led the NZ economy through the 1990s, has now fallen to below the national average. A number of recent reports on commuting patterns within metropolitan areas, migration patterns from metropolitan areas to smaller cities and towns (see for example ABS 2019), and on the productivity effects of metropolitan housing shortages (Hsieh and Moretti 2019) have all suggested a worrying possibility that housing-system outcomes are driving sub-optimal productivity outcomes.

Alain Bertaud (2016) emphasised that in metropolitan economic policy-making, agglomeration economies can only be seen as a potential gain and that metropolitan systems—including infrastructure and housing—need to be well managed so that they do not consume the gains of 'agglomeration' economies through shortages and rising prices. With housing and infrastructure as spatially fixed capital, and embedded in land, there is a potential for rising scarcity rents to transfer the gains from innovation and skill-related productivity increases to the 'rentier' gains of land and property owners.

Where such effects prevail, the potential for agglomeration gains to drive a competitive productive economy is lost. Rentier gains and accumulation play increasing roles in the economic system, and growth drives increasing inequalities of both income and wealth through pressures on rents and increases in house prices (Maclennan and Miao 2017).

Defining agglomeration economies

Agglomeration economics is particularly concerned with how concentration or clustering of activities, largely firms, become associated with higher returns to scale, or higher productivity. When larger cities are identified as having higher productivity, this can arise because of the following factors.

1. Individual firms in larger places may themselves become larger—for example, by serving larger local markets. Where internal economies of scale prevail, this will also imply higher productivity in that place.
2. A larger scale of place allows more diverse firms of different sizes, specialisations and sectors located in a place to buy required and specialised inputs. Similar arguments can be applied to mixes and scales of available labour inputs, which allow the firms to produce more efficiently, thus raising productivity.
3. Larger places may have scale economies in the provision of key facilities—or may provide a facility that has some minimum scale of operation—which allows users to consume services that may not be available in smaller cities or, if available, may be unduly costly.

The first effect does not necessarily create or reflect agglomeration economies, and it is not considered further here. The second and third effects are often labelled 'external economies' and they are at the core of agglomeration effects.

Alfred Marshall first referred to the importance of 'atmosphere' and knowledge spillovers that drove creativity in English cities during the Victorian era. Subsequent research has explored the development of 'knowledge spillovers'. These spillovers arise in two different ways.

First, a great deal of knowledge is tacit rather than codified and disseminated, and it is usually exchanged through personal interactions, or face-to-face contacts in the course of work and business. These exchanges of tacit information are often important in service provision and consumption, and in developing trust between 'traders' when contracts are incomplete or cannot be specified. They are important in service industries and in innovation processes (where cross-firm trust can be important).

Second, knowledge spillovers arise when individuals in informal social and leisure settings exchange information and build trust.

It is argued that developing these relationships of trust leads to a higher generation rate of new ideas and their faster transmission into innovations—that is, they raise the volume and speed of information flow in the urban economy. This is argued to have significance where strategy and fast change is required in the metropolitan economy. (However, giving this idea empirical importance contradicts the assumption of firms and households acting with perfect knowledge).

The role of 'non-traded-inputs' that raise productivity in larger cities arises from the provision of infrastructures or services that can only be provided in cities with a high minimum threshold scale. For instance, the role played by:

- skilled finance lawyers in the City of London
- special high-fibre optic cables in financial districts
- specialist equipment testers in the manufacturing districts of Munich
- rehearsal pianists on Broadway.

These structures and services are only available to those located in the largest places.

A particularly important application of agglomeration economics has been to the functioning of urban labour markets—and it has changed the ways that urban labour markets are now addressed in urban economics.

Large pools of labour with a diverse range of skills reduce the hiring costs of firms, as they can access the range of skills they require directly from the local market—and if labour demands change, they can rapidly restructure the size and mix of the labour force. Further, firms can adjust labour supply without incurring training costs. Workers also benefit from being close to large concentrations of employment. They can change jobs without moving homes, and this will be particularly important for two-earner households. They can also make moves to better jobs, plan career moves, and move from failing to growing firms.

In summary, large 'thick' labour markets reduce hiring and training costs for firms, and offer workers easier organisation of higher permanent-income careers.

These firm and labour market effects have been usefully explored and summarised by Duranton and Puga (2004) as 'learning', 'sharing' and 'matching' effects. The arguments are well established, and evidenced in multiple settings—although not all. However, there has been relatively little thinking about how housing systems play into the formation of agglomeration effects. Typically, the interest has been in how agglomeration effects in innovation and labour markets drives growth in incomes and labour demand, and which raise the demand for housing—with some potentially adverse effects that may attenuate subsequent growth. But do housing systems, even without growth congestion effects, affect any of the agglomeration economy-creating mechanisms articulated earlier? Are there housing outcomes of policies that are more likely to create a competitive metropolitan economy?

In relation to the development and capture of knowledge spillovers, the informal contacts that individuals make arise within their household or individual space–time activity patterns. This leads, in Putnam's (2000) terms, to different frequencies and intensities of social contact that generate different levels of willingness to exchange information and develop trust. The home and its neighbourhood are at the core of the household activity pattern —and home and neighbourhood are jointly purchased in the housing market. Thus, the quality and variety of housing and the mix of households within a neighbourhood will be important to interaction, knowledge exchange and creativity. Florida has emphasised the importance of tolerant, bohemian neighbourhoods as being important in attracting particular kinds of skill groups and age groups. High quality residential suburbs, and their social and sports amenities, may be the terrain for social exchange of a different business and professional grouping, and clusters of well-serviced neighbourhoods with access to common spaces for interactions may be dispersed across urban areas. Reuschke and Houston (2016) make clear how important neighbourhood and 'home' context is in entrepreneurial behaviours. Chatterji et al (2013) have also noted the significance of residential clusters in developing ethnic businesses.

Home and neighbourhood may matter in the formation of agglomeration effects. However, with particular reference to labour markets, spatial access to employment concentrations also matters. High-tech workers not only seek high quality interactive neighbourhoods, they also have a predisposition to walk or cycle to work —which means that they are sensitive to all the key characteristics of housing choices on offer. Has the housing supply-side of existing stock in metropolitan neighbourhoods been adequately refashioned to meet these new demands? This again raises questions of mix and variety of housing in relation to core nodes of employment, and their accessibility to different income and skills groups. The most obvious example in this scenario are public sector workers, who may lag behind in wage and house price booms in expanding cities, and increasingly find their homes are displaced away from employment cores, such as the CBD.

The 'key worker' problem is a widespread manifestation of the misalignment of labour and housing market systems in contemporary metropolitan areas. The problem is widespread, and the displacement of lower- and middle-income households further into the suburbs may reduce their lifetime earnings and productivity —primarily through their inability to capture knowledge spillover benefits rather than their inability to save on transport costs. From the housing standpoint, when workers are displaced away from employment cores, the solution is invariably seen as building new roads and transit systems. Insufficient attention is paid to how changes in housing mix and housing density closer to employment nodes might better resolve the issues in the long term (Maclennan, Crommelin et al. 2018).

These points emphasise that the housing supply offered within a metropolitan area—and in particular neighbourhoods —may be crucial in shaping the extent and power of agglomeration effects, but this is a largely ignored area of research and policy.

1.3 Research methods

1.3.1 Method and data

The specific research questions and datasets required for this project are as follows.

- **RQ1:** At what city scales do agglomeration economies (and diseconomies) arise? And how does this vary over time, by Australian geography and by international context?
- **RQ2:** What are the relative importances of accessibility, housing and commercial real estate user costs, population density, environmental factors, skills, interstate and international migration to growth in jobs, businesses and city-scale economic output?
- **RQ3:** What does the international evidence base suggest about the relationship between international migration, housing costs and economic output?

There are significant methodological challenges in addressing the research questions empirically. For example, as Glaeser and Gottlieb (2009) emphasise, analysis at subnational level must focus on explaining population growth in addition to changes in incomes and, ideally, housing prices. This is primarily because population responses to changes in income are expected to be large at subnational level, whereas population is relatively more fixed or stable at national level. Population and housing prices are endogenous to incomes, so there are serious identification problems in attempting to model the impact of agglomeration on productivity.

The overall aim of the project is to provide an evidence base to support policy development options in relation to harnessing agglomeration economies in Australia's cities and regions. RQ1 and RQ2 are addressed using spatial endogenous threshold models. Explaining agglomeration economies would usually require predetermining a function of either continuous city size or a variable where city size is arbitrarily split into various categories. It is not clear beforehand (ex ante) whether a linear or a nonlinear function is appropriate, how cut-offs for city size categories should be defined, or the causal direction of agglomeration and productivity. The endogenous sample-splitting estimator first proposed by Hansen (2000) and extended by Seo and Shin (2016) endogenously determines the functional form by estimating the optimal number of critical thresholds and their respective critical value from the data such that an arbitrarily chosen threshold level (of city scale or other relevant variables) or pre-imposed functional form are not required. The threshold defines the critical value(s) where the functional form changes —for example, where productivity increases. The advantage of this approach is that the change in the threshold variable is directly causal of changes in the functional form.

In the base model, output is a function of technology, capital and labour:

$$Y_t = A_t K_t^{\alpha} (h.L.X)_t^{\beta} \qquad (1)$$

where Y = output; A = technology; K = capital; X = annual hours worked; h = human capital; and L = raw labour. The model is linearised by log transformation. The coefficients α and β indicate the productivity of the respective inputs. Various measures of agglomeration such as population and density—and a combination of these measures—will be used to split regional data. A single threshold mode would be estimated according to:

$$\ln Y = M + \alpha_{pop<\gamma} \ln K_{pop<\gamma} + \beta_{pop<\gamma} \ln(h.L.X)_{pop<\gamma} + \alpha_{pop>\gamma} \ln K_{pop>\gamma} + \beta_{pop>\gamma} \ln(h.L.X)_{pop>\gamma} \qquad (2)$$

where γ indicates the threshold level of population where the productivity of those inputs changes. In such a model, an increase in the agglomeration measure above the threshold triggers an increase or decrease in the productivity due to the change in agglomeration. Additional thresholds are added until less variation can be explained by additional thresholds.

Several city-size thresholds may be found to be optimal, such that there might be several regimes of agglomeration economies and diseconomies of varying strength. By definition, any other split of the sample based on the same variable—measures of agglomeration—in an empirically reasonable range would result in explaining less of the variation in productivity. There is well-defined asymptotic theory available for endogenous threshold models, but they are not straightforward to implement, in particular p-values and confidence intervals require non-standard techniques.

In addition, a spatial autoregressive specification will be used to test and control for spatial spillover effects. The threshold variable(s) can also include spatially weighted agglomeration measures of neighbouring regions—for example, cities close to other larger agglomerations might benefit from such spatial externalities.

The methodology can be extended for RQ2, testing for thresholds in other variables such as accessibility, housing and commercial real estate user costs, environmental factors, skill and specialisation. In addition, the output function could be for any measure of economic activity, such as number of businesses or jobs. The proposed method would endogenously derive from the data:

- at which city-scale economies or diseconomies of agglomeration arise
- at which cities or areas fall into the different regimes of economies and diseconomies
- that account for spatial effects across cities, with the potential to test for other important characteristics—such as industry clustering.

RQ3 is addressed through a review of the international literature, including secondary data sources. Although expressed as the third research question, the evidence from the international literature is considered in the first empirical section, which follows on from this introductory section.

2. Unbundling agglomerations: the international evidence

- **Based on international evidence, there is a prima facie case that the economic productivity gains arising from city scale are being eroded by negative factors—for example, congestion and adverse housing outcomes, including unaffordability.**
- **Rising house prices may change the composition and skill mix of the population within metropolitan areas, which changes the skills of the local workforce, with knock-on consequences to industrial composition and the availability of 'key workers'.**
- **International and internal migrants have begun to disperse from metropolitan areas, and to migrate directly to new smaller areas, particularly in North America and Europe. The major metropolitan areas are losing the largest share of net domestic migrants, while within metropolitan areas domestic migration is accelerating suburbanisation.**
- **The risks of being affected by future pandemics in dense, large-scale cities reliant on mass-transit commuting will accelerate such shifts, as will new trends in working from home.**

2.1 Setting the scene

Section 2 is based on a desktop review of literature and statistics, and addresses RQ3:

- **RQ3:** What does the international evidence base suggest about the relationship between international migration, housing costs and economic output?

We begin by asking whether there is broad evidence in support of the idea that city scale affects productivity, before moving on to consider whether there is evidence of change in that relationship over time. In particular, we note that it has been well established (see Glaeser and Gyourko 2018; Maclennan and Miao 2017) that major metropolitan areas in most of the advanced economies have experienced sustained periods of house price increases that run ahead of national average house prices and inflation rates. We ask whether there is any evidence that—similarly and without implying causation—larger cities in advanced economies are also now reverting to mean national rates of productivity growth, or that their productivity or GDP growth rates—relative to national averages—have fallen over recent decades? An important aspect of this section is the review of evidence to suggest that city scale, economic productivity and housing outcomes are interdependent. In particular, we ask whether housing outcomes—including impacts on affordability and urban disamenities such as congestion—influence the potential productivity gains that come with city scale.

The analysis also has an explicit focus on migration as an outcome—and potential causal factor—of changes to metropolitan economic productivity. We examine the relocation of individuals and their households, and the relocation of firms and businesses. Trends in migration are clearly complex, and break down into:

- overseas and domestic components
- highly skilled versus less skilled categories.

There is an ongoing debate about the scale of the contributions of each to urban economic productivity. Therefore the discussion and principles set out in this section flow on to the design and method of the empirical analysis in subsequent sections.

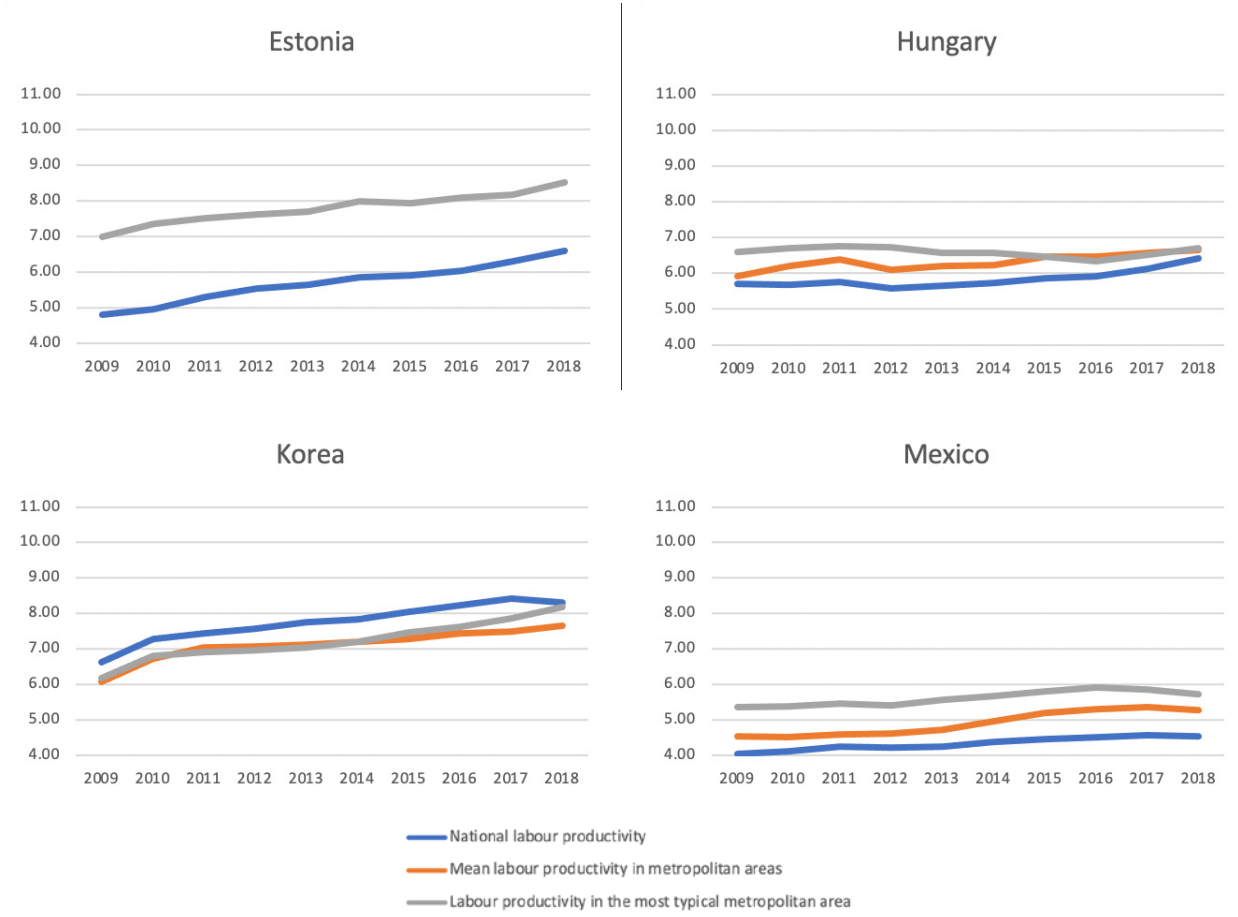
2.2 Are metropolitan areas falling back to national averages?

As noted earlier, it has been widely accepted that agglomeration economies appear to have, by the start of this millennium, positioned larger cities as the major motors of economic growth. Thus, compared with smaller cities, metropolitan areas in the advanced economies have higher productivity.

However, in recent years more diverse patterns have been identified. For instance, since 2009, national labour productivity has been higher than the mean labour productivity in metropolitan areas of Korea, Canada, Denmark, Germany, Japan, the UK, Luxembourg, Norway and the USA. It has been argued that large city productivity effects were primarily confined to the USA, Japan, Korea, Canada and Australia (Dijkstra, Garcilazo and McCann 2013), and some urban trends appear to have changed in these typical countries. In the UK, Fothergill and Houston (2016) suggested that other places performed better than big provincial cities—with London a high productivity world city. Frick and Rodríguez-Pose (2017) also questioned the city size and productivity/growth relationship and concluded that 'in contrast to the prevailing view that large cities are growth-inducing, for a majority of countries relatively small cities of up to 3 million inhabitants are more conducive to economic growth.' (They assessed 113 countries, although we note that a city of 3 million would be regarded as a large city in many advanced economies.) Frick and Rodríguez-Pose (2017:20) concluded that 'it becomes evident that the benefits of increasing city size are not without limits and for many countries, smaller cities seem to offer a better balance'.

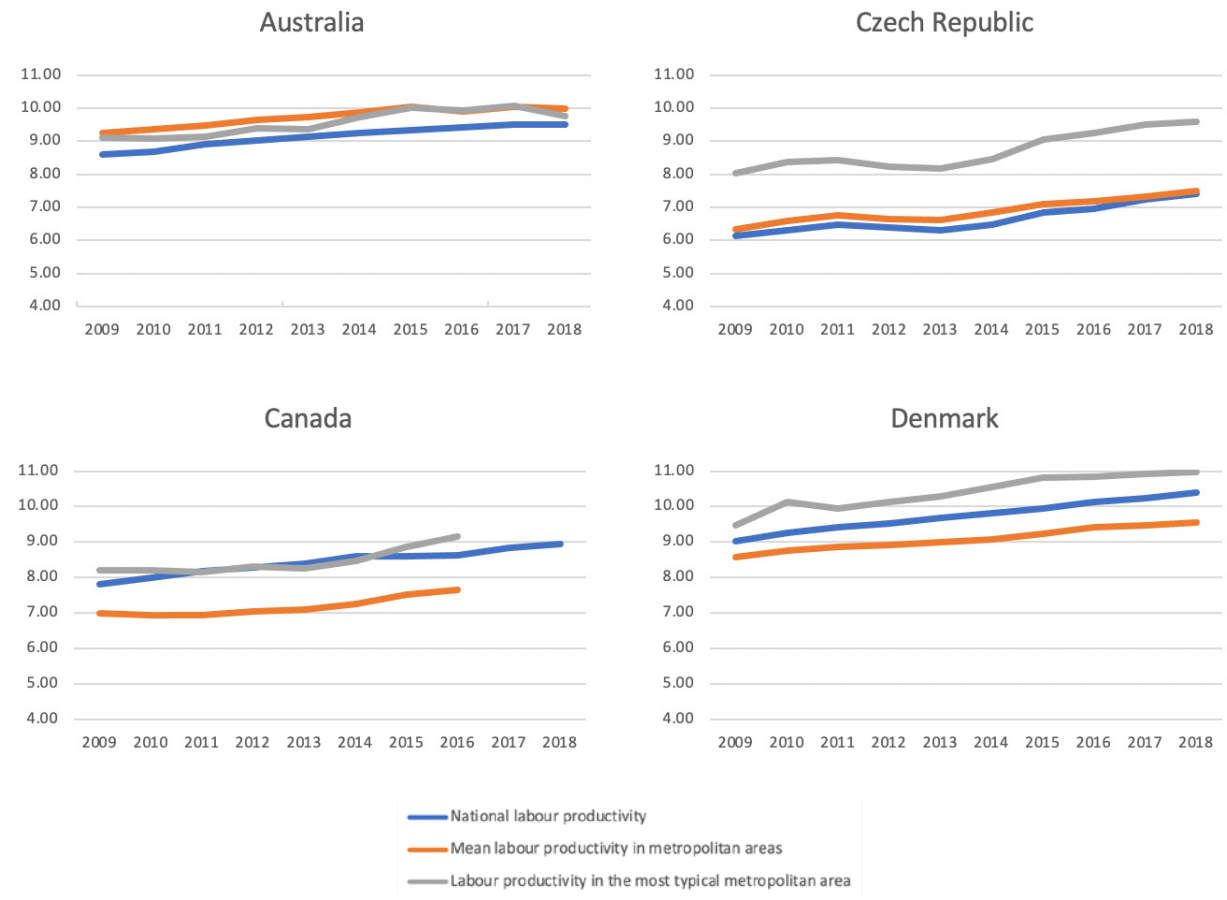
The claim of a trend of clear agglomeration gains for very large cities is further undermined by examining growth rates of labour productivity since 2009, as depicted in Figures 1 through 3. There seem to be no advantages in the growth rates of labour productivity in metropolitan areas, compared with national rates of productivity growth. Most larger cities are now reverting to mean national rates of productivity growth. In some advanced countries, such as the USA, the UK, Finland and Denmark, the growth rates in metropolises have been lower than the national growth rates throughout this period (2010–2018).

Figure 1: Labour productivity in selected OECD countries with productivity below 8



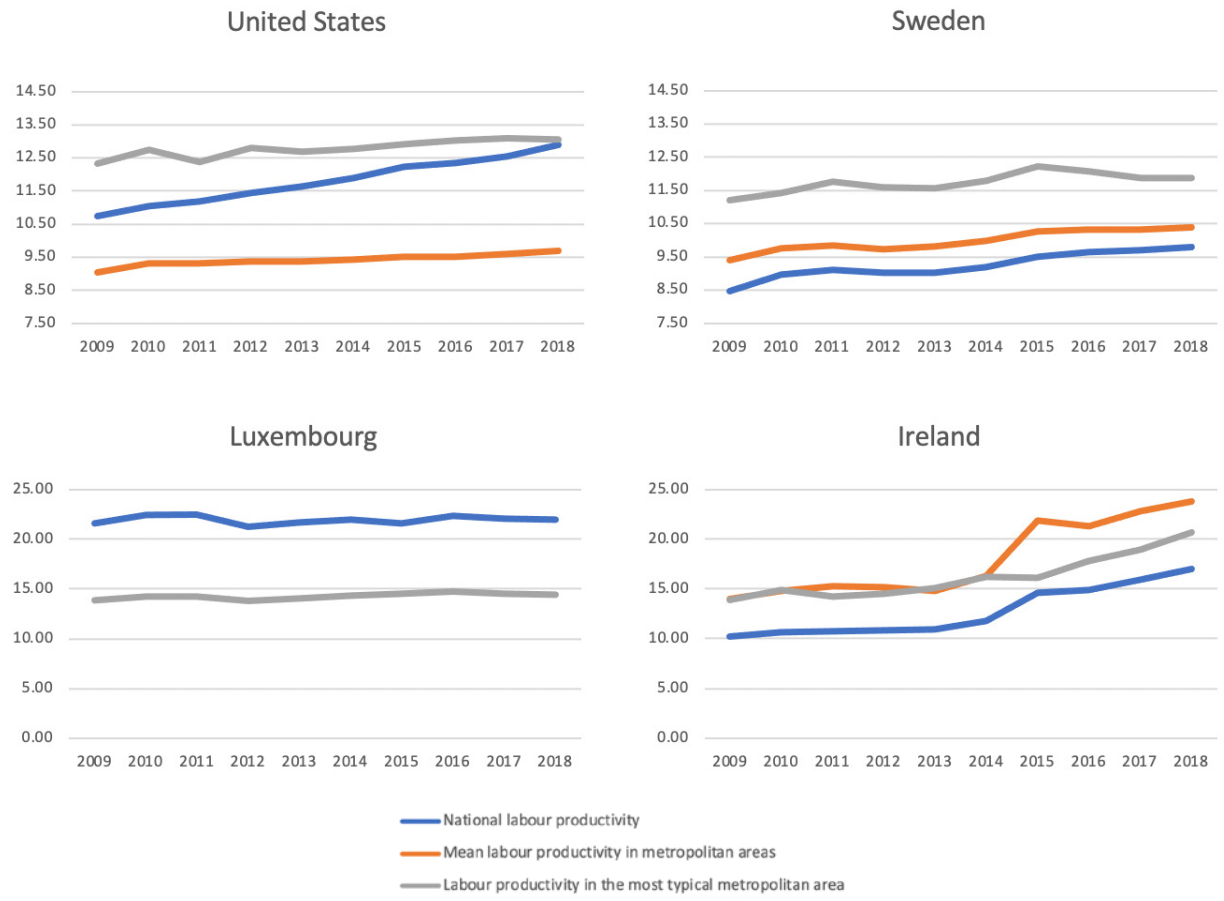
Source: OECD Statistics.

Figure 2: Labour productivity in selected OECD countries with productivity 8 and 11



Source: OECD Statistics.

Figure 3: Labour productivity in selected OECD countries with productivity above 11

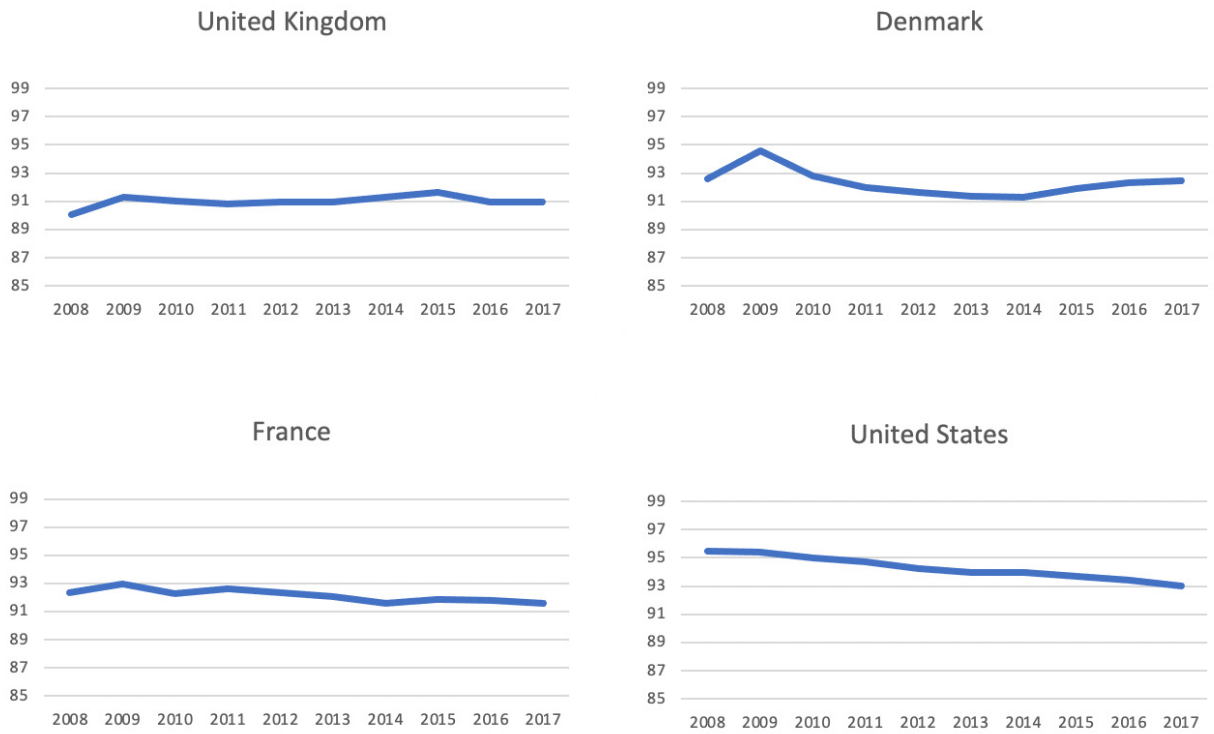


Source: OECD Statistics.

Note: Labour productivity (GDP per worker in USD, constant prices, constant PPP, base year 2015).

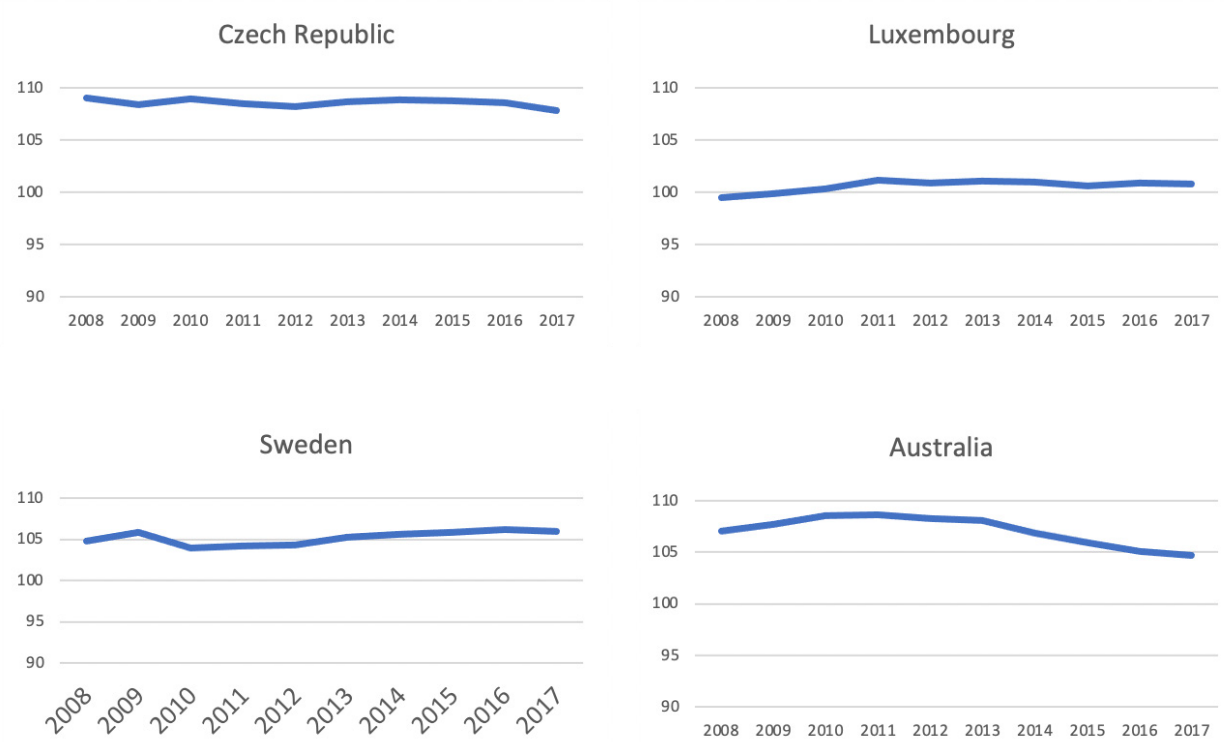
From the perspective of GDP per capita, the share of metropolitan areas in national GDP has been declining, as shown in Figures 4 through 6. It is worth noting that the mean GDP per capita in the metropolitan areas was even lower than the national GDP per capita in Canada, Denmark, Estonia, France, Germany, Japan, Lithuania, Norway, the UK and the USA in the period 2008–2017.

Figure 4: GDP per capita as a share of the national value in selected OECD countries with a share below 110%



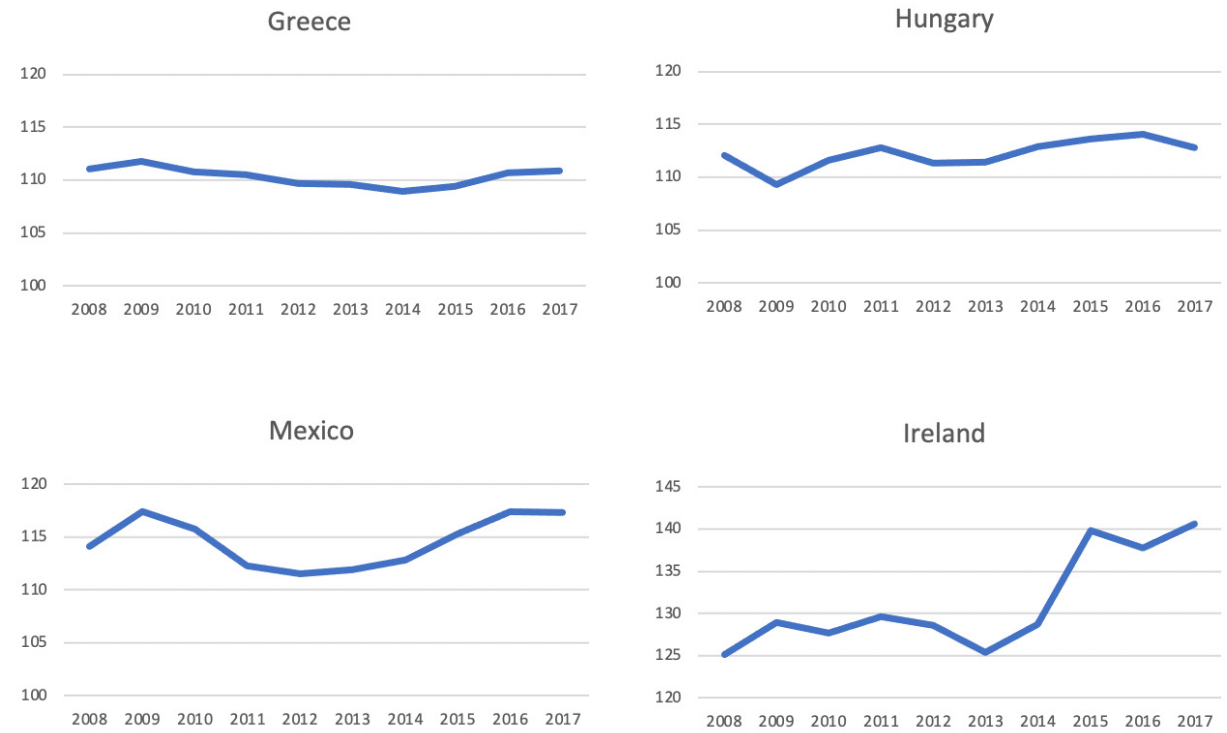
Source. OECD Statistics.

Figure 5: GDP per capita as a share of the national value in selected OECD countries with a share between 100-110%



Source. OECD Statistics.

Figure 6: GDP per capita as a share of the national value in selected OECD countries with a share over 110%



Source. OECD Statistics.

Although there are falling growth rates of labour productivity and GDP per capita in metropolitan areas relative to their national levels, this does not necessarily mean that large and densely populated cities are no longer the major motors of economic activity. In terms of scale, large cities are still the largest economic aggregates in the nation, and agglomeration economies in metropolitan areas may still be a major source of innovation and productivity. The figures reported are consistent with the argument made earlier that congestion costs may be 'eating-up' agglomeration gains, and that metropolitan growth is now being constrained by housing and infrastructure shortages and their knock-on effects for labour supply flexibility and diversity. This is a possibility rather than a certainty—but it does mean that housing effects on the growth and productivity performance of the economy need to be addressed as an economic policy question in the major cities of the advanced economies.

However, regardless of the market or policy or planning causes, a prima facie case exists in the spatial and temporal patterns of the figures presented in Figures 1 through 6: the economic growth rates of metropolitan areas are being diminished by housing market outcomes that are reflected in rising housing costs and shortages of housing. There is extensive evidence that a range of housing outcomes may have effects on health and education that impact the growth driver of human capital quality and supply. These outcomes include the:

- quality of space
- socio-economic nature of the neighbourhood outcomes
- frequency of mobility of households with young children
- level of residual incomes after housing costs
- location relative to jobs.

See Maclennan, Ong and Wood (2015) and Maclennan, Crommelin et al. (2018) for a review of some key effects.

2.2.1 Relationships between housing outcomes and productivity

Housing outcomes clearly impact the formation and utilisation of human capital. However, this fragmented evidence has not been augmented by carefully designed, longitudinal studies of housing outcomes impacting household characteristics that influence economic growth. Rising housing costs and shortages of housing that impact housing choices, with recursive effects on economic growth, could constrain metropolitan economic growth as they make certain residential locations too expensive in relation to incomes. This then impacts on:

- labour market choices (within and between different cities)
- labour productivity
- location choices of some enterprises.

The bullet points above are consistent with the predictions of GSE and other models.

Empirically, Szumilo (2019) found that London had the highest increase in the affordability ratio where productivity was the lowest in the period 2002–2016, compared with other cities in England. Maclennan et al. (2018) established how housing costs forced middle-income households away from major job concentrations and rendered them less productive—not just because of increases in time lost in travelling, but by thinning their labour market choices and potential career earnings. Hsieh and Moretti (2019) used a GSE framework and found that the spatial misallocation of labour—which they argued was caused by stringent restrictions on new housing supply—lowered aggregate US growth by 36 per cent in the period 1964–2009. Glaeser and Gyourko (2018) agree with the Hsieh and Moretti 'cause' of lowered productivity, but suggested a much lower effect of around 4 per cent. Regardless of the scale —or the causes—it is clear that housing outcomes are reducing productivity.

There is a fundamental mechanism involved: as rising housing costs are imposed on workers as a result of metropolitan growth, households may not be able to move into an area that would offer them the potential to earn a higher wage. This then means that potential benefits from agglomeration accrue neither to firms nor their employees, but to those who own the scarce factors of production in the metropolitan economy—namely the owners of land and properties. Some firms are then unable to expand employment and output because workers' housing is simply too expensive. Both firms and households face the choice of relocating within or away from their present metropolitan home.

Rising house prices may change the composition and skill mix of the population within these metropolitan areas, which means the skills of the local workforce will change—which then alters the industrial composition of local firms (Saks 2008). For example, key public-service workers are often not highly paid, and they become excluded from access to the core population and employment localities where they are most needed. At the level of the metropolitan area as a whole, these effects may raise quit rates from the most pressured metropolitan areas —and there is growing statistical evidence that such processes are already impacting cities such as Sydney, London, Toronto and Los Angeles. In these cities, there have been upward shifts in the rate of 25–40-year-old workers leaving the metropolitan areas for smaller cities and towns because of their frustrated demands for housing tenures and housing sizes or qualities consistent with their expectations and life-cycle stage.

There must now be a concern that the risks of being affected by future pandemics in dense, large-scale cities where commuting on mass transit will accelerate such shifts, reinforced by new possibilities for working from home, will influence the mobility and diversity of labour markets, which are beneficial to labour productivity and city productivity (Glaeser 2011; Hsieh and Moretti 2019; Kolko 2010). It is argued that unaffordable housing limits local productivity growth by influencing labour supply (Szumilo 2019). Muellbauer and Murphy (1997) noted that overinflated house prices lead to regional labour mismatches, which cause losses in efficiency.

Housing shortages may reduce economic productivity in other ways. Hulse, Reynolds et al. (2015) estimated a shortfall of 52,600 affordable private rental dwellings in Sydney for households with annual incomes below $30,000, and a further shortfall of 40,500 dwellings for those with incomes between $30,000 and $56,000. Housing shortages that prevent people or businesses from locating in the neighbourhood they prefer can result in lower productivity and other deadweight losses. Maclennan et al. (2018) also noted that for middle-income and lower-income renters in Sydney, more than half of households paid more than 30 per cent of their incomes—a widely used guide to 'affordability' for renters—with an average excess payment of $6,500 per annum. Aside from the distributional consequences, with landlords gaining at the cost of tenants, such 'excess' rents on patterns of consumption, savings and investment are likely to have substantial effects.

It has been argued that housing shortages are closely associated with strict restrictions in metropolitan areas (Jackson 2016). There is mixed evidence of the major influences on inelastic housing supply in metropolitan areas, which include:

- development planning
- strategic planning
- infrastructure deficits
- shortages of materials, labour and development finance.

In addition, the strategies of construction development firms may involve profit-seeking behaviours from landholding as well as building homes and, as a result, they may hold output constant as their stocks of land rise in value. Regardless of their causes, constraints on housing supply in a city inhibit the growth and diversity that is essential to productivity (Been, Ellen and O'Regan 2019). Ganong and Shoag (2017) found that reduced mobility resulted from the constrained supply of housing. That reduced mobility is harmful to cities and individual workers —and also to national productivity. Workers living with tighter restrictions on housing supply are more likely to be locationally mismatched and have to commute further—which implies longer commutes (Cheshire, Hilber and Koster 2018).

In summary, if agglomeration economies do drive growth because the metropolitan area is of significant scale, then it is precisely in these localities where supply constraints will be most pronounced. Housing is economic infrastructure that needs to be configured to serve metropolitan aims. So rather than large metropolitan housing markets washing their hands of policy responsibility and leaving housing market outcomes to 'a well functioning housing system', they need to be carefully monitored and strategically managed if Berthaud's 'potential' gains are to be captured and maintained.

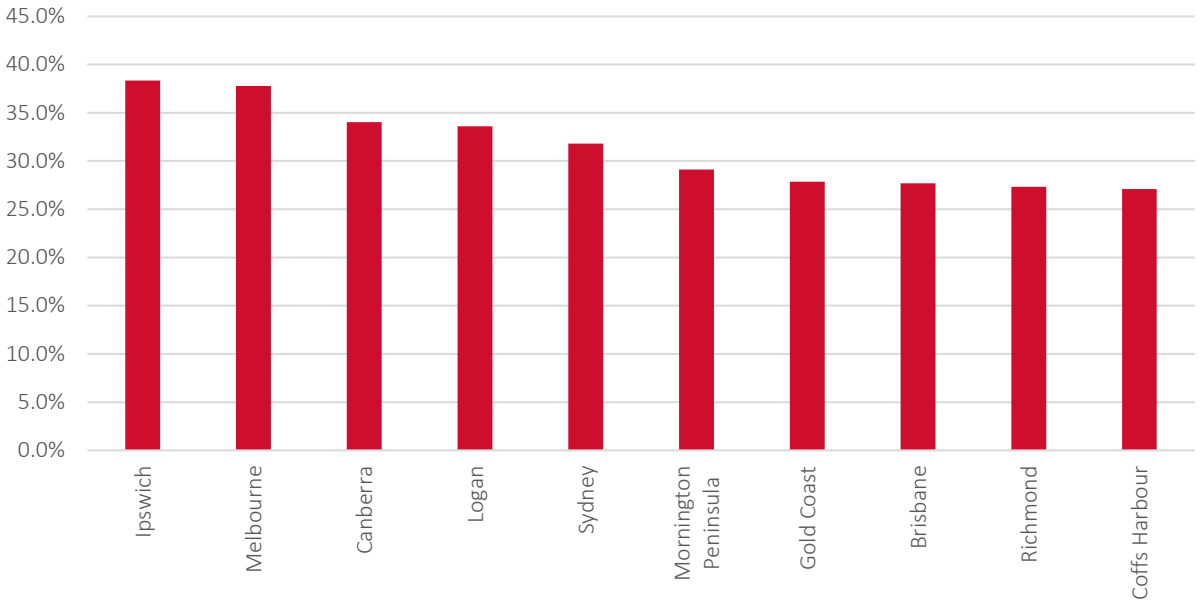
There are other co-located influences that may also diminish productivity. For instance, there is some evidence that traffic congestion impedes metropolitan economic growth. However, the relationship between metropolitan economic activity and traffic congestion is complex and unclear (Taylor 2002). Using panel data for 88 US metropolitan statistical areas, Sweet (2014) suggested that congestion slows job growth, and higher levels of congestion appear to be associated with slower productivity growth per worker. Also, Jin and Rafferty (2017) found that traffic congestion growth negatively affected income growth and employment growth in 86 US metropolitan areas. Consequently, severe traffic congestion has negative effects on metropolitan economies. By contrast, Marshall and Dumbaugh's (2020) results showed that economic productivity is not significantly negatively impacted by high levels of traffic congestion in metropolitan statistical areas. They assert that traffic congestion could be positively associated with economic outcomes, rather than the limiting factor it is often considered to be.

2.2.2 Evidence on firm relocation/formation and migration

The potential for firm relocations and household mobilities was noted earlier, as were population shifts. In relation to firms, there is a high concentration of companies in metropolitan areas. It has been argued that not only do new establishments choose to locate within metropolitan areas (Florida and King 2018), but firm relocations typically happen within or among metropolitan areas, rather than move to municipalities outside metropolitan areas where production costs are lower (Rossi and Dej 2019).

Nevertheless, there is emerging evidence that rural counties have increasingly attracted some businesses from urban counties in some metropolitan areas (Rupasingha and Marre 2020). New establishments tend to avoid environments with longer commuting times and congested traffic conditions (Chin 2020). For example, in Australia, some smaller areas experienced similar or even faster growth in new firm formation in the period 2015–2018 than the capital cities, as shown in Figure 7.

Figure 7: Top 10 cities/areas in growth rate of business entries in Australia, 2015–2018



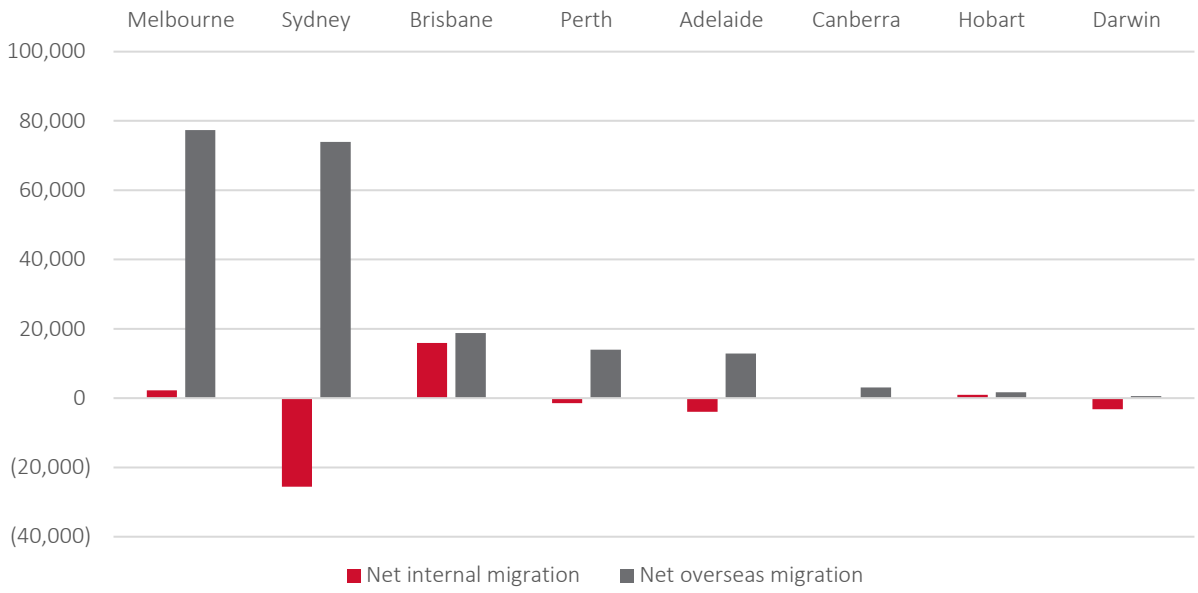
Source: Australia Bureau of Statistics.

It has become apparent that both internal and international movers have begun to disperse from metropolitan areas, as well as to migrate directly to new smaller areas, particularly in North America and Europe (Esipova, Pugliese and Ray 2013; Hempstead 2007). New immigrants may settle directly in smaller micropolitan cities. A growing number of foreign-born households may also migrate from metropolises to smaller cities (Painter and Yu 2010). Generally, international migrants tend to be particularly concentrated in global cities—which are usually the largest metropolitan areas—while internal migrants are starting to settle in smaller cities in advanced economies. The major metropolitan areas are losing the largest share of net domestic migrants (Cox 2018). Within metropolitan areas, domestic migration also continues to accelerate to the suburbs of the major metropolitan areas.

In the USA, the largest increase in internal migration in 2012–2013 was to secondary cities, while the three largest metropolitan cities—New York, Los Angeles and Chicago—experienced a net outflow of residents in the same period (World Migration Report 2015). In 2016–2017, metropolitan areas with between 1.0 and 2.5 million population gained the most domestic migrants relative to their 2016 population (0.33 per cent), while the super metropolitan areas with over 10 million population had an enormous 0.95 per cent net domestic migration *loss* (Cox 2018). There was also a substantial increase of international migrants in the secondary cities of Atlanta, Charlotte and Nashville (Price 2014). In Canada, the geographic concentration of immigrants in Toronto, Montreal and Vancouver has fallen in recent years, from 72 per cent in 2005 to 57 per cent in 2014 (Brown 2017).

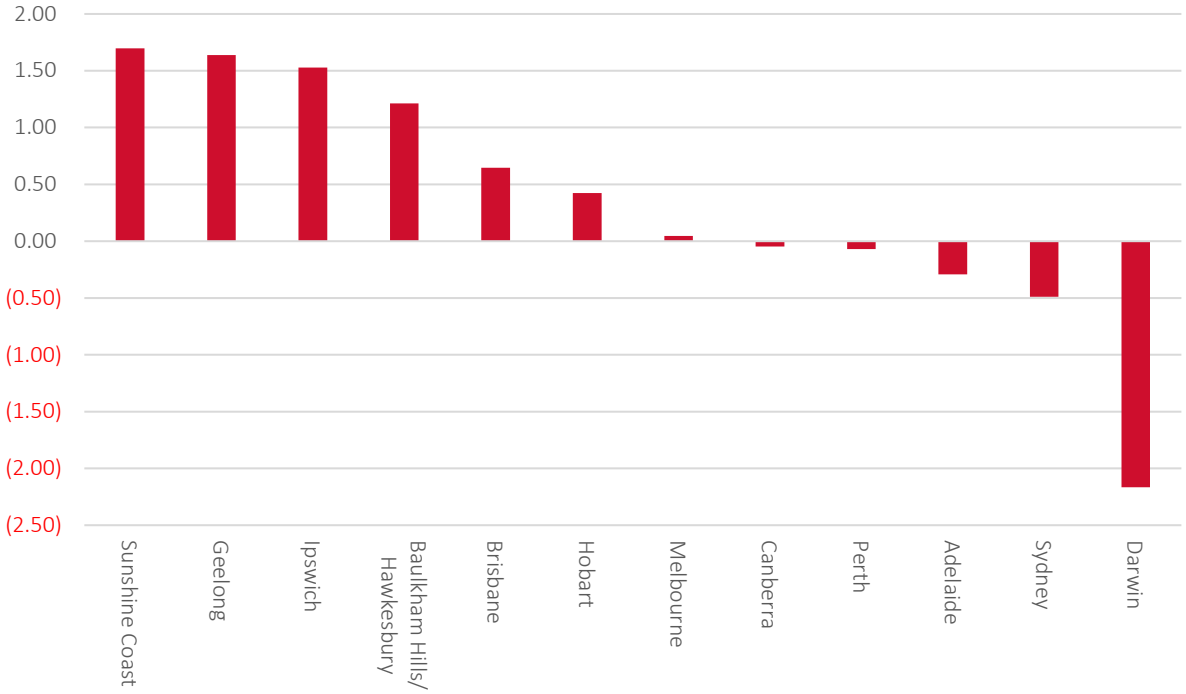
The same trend is also emerging in Australia. Five of the Australian capital cities had negative growth rate of net internal migration in 2018–2019, apart from Melbourne, Hobart and Brisbane, as shown in Figure 8. The highest growth rate of net internal migration happened in some smaller areas, as shown in Figure 9. However, most of these big capital cities are still the most favourite places for international migration, enjoying the biggest growth rate of net international migration in 2018–2019, as shown in Figure 10.

Figure 8: Migration to capital cities in Australia, 2019



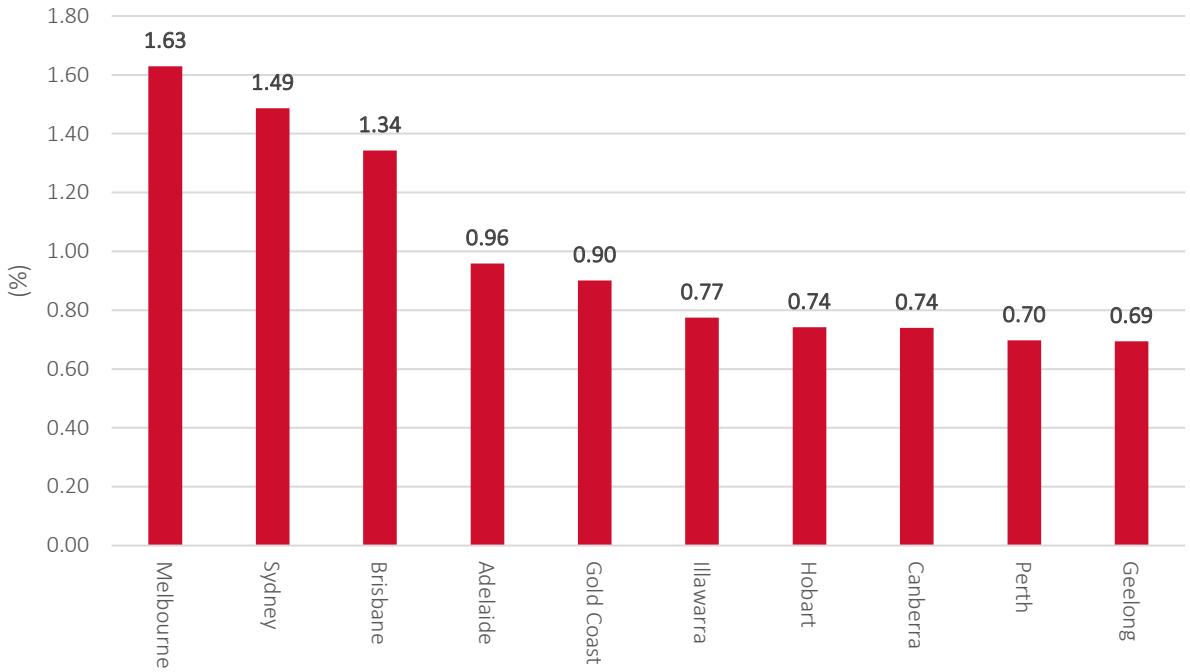
Source: Australia Bureau of Statistics.

Figure 9: Comparison between capital city and Top 5 cities/areas in growth rate of net internal migration in Australia, 2018–2019



Source: Australia Bureau of Statistics.

Figure 10: Top 10 cities/areas in growth rate of net international migration in Australia, 2018–2019



Source: Australia Bureau of Statistics.

Such reductions in migration to the largest metropolitan areas, and increases in exits from them, are consistent with the declining affordability and availability of housing. And they will have a direct effect in reducing and undiversifying the supply of labour. These effects will differ from country to country as skills and education requirements for entry permissions vary considerably—for instance, Canada, Australia and the UK select immigrants more on economic potential than family ties. A significant spillover agglomeration benefit for firms in larger cities is the ability to select the right skills quickly and avoid training costs, which means that diverting skilled immigrants to smaller places will reduce productivity potentials. In effect, there is a market failure in the supply of training that is revealed and exacerbated by declining immigration.

There is a counter-stream of households leaving metropolitan areas (Aner 2016; Hansen and Aner 2017). Historic patterns have tended to suggest that younger households—and often skilled households—migrate from provincial cities, towns and rural areas to shape careers in major metropolitan economies, often upon leaving higher education or further education. Most progress through their career and life cycle of housing choices until leaving the metropolis when their children leave home or retirement beckons. Now, however, families with young children and a high level of education are part of the migration stream out of metropolitan areas in Sweden to medium-sized or small Swedish towns (Hansen and Aner 2017; Sandow and Lundholm 2019). Regarding demographic variations among migrants within metropolitan areas, Walker (2017) emphasised that younger, single, educated and white-collar internal migrants are more likely to move to the core, whereas migrants who are blue-collar, less educated, older and with families remain more suburban.

There are many reasons that attract inter-regional and international immigrants to settle in smaller cities. Among them are:

- workers crowded out of metropolitan areas by lack of job opportunities and the fundamental changes in economic geography (Rodríguez-Pose and Storper 2020)
- immigrants moving to non-traditional receiving areas to pursue better labour opportunities (Hernandez-Leon and Zuniga 2000)
- government policies in Canada that have increasingly encouraged immigrants to settle in second-tier cities and smaller urban areas (Simone and Newbold 2014)
- immigrants have been crowded out of mid-size metropolitan areas by the high cost of living in the metropolis. For example, metropolitan areas with higher costs of living such as coastal California—especially Los Angeles, San Francisco, San Diego and San Jose—have experienced a significant deterioration in net domestic migration (Cox 2018).

It could be particularly important for growing families to acquire a desirable lifestyle in another geographical context, where opportunities such as job and housing match their preferences. Housing costs are a main component of living costs, and rising housing costs in metropolises in the early 2000s may have diverted many immigrants to mid-size metropolitan areas where housing is more affordable (Sandow and Lundholm 2019).

Housing prices may represent complex push and pull factors for mobility (Haas and Osland 2014). Rising housing costs and housing shortages in metropolises crowd out certain types of workers. Housing poverty and unaffordability are becoming acute problems for low-skilled and low-wage migrants in metropolitan cities. Low-skilled migrants are engaged in the lower-end industries, and their income level and housing affordability are therefore below the average income levels of permanent residents and high-skilled migrants (Grogger and Hanson 2011). Rising housing prices in high-income areas deter low-skill migration, which have eroded the gains from migration. High-skill workers move to high-income places and low-skill workers leave (Ganong and Shoag 2017).

Although Rodríguez-Pose and Storper (2020) emphasised that the only people that are crowded out from metropolitan areas are low-skilled workers, and that highly educated individuals still generally prefer 'superstar' cities, the attractiveness of superstar cities has declined over time as housing becomes increasingly unaffordable (Chen, Hu and Lin 2019). The next-tier alternative cities become increasingly attractive to workers who have a masters degree or above. This result confirms that there is a crowding-out effect on the skilled class in superstar cities because of housing unaffordability.

On the other hand, Hamalainen and Bockerman (2004) found that an increase in housing prices reduces in-migration, whereas outmigration remains more or less unaffected. Local-level housing and transport services are becoming impediments for global cities, such as Sydney, making it harder for them to attract mobile capital and labour—including international students, tourists and young skilled workers (Nasreen and Ruming 2019). And this is a view that the business organisations in Australia's two major cities have espoused, notably the Committee for Sydney; it was also emphasised by Jennifer Westmacott, Chief Executive of Australia's peak business body, at a UNSW seminar in March 2018. Business leaders believe that housing outcomes are damaging labour supply and growth in Australia's major cities.

2.3 Policy development implications

The analysis in this chapter is based on a review of international literature and evidence, including secondary data. As such, the main implications are on the design of research methods intended to address the empirical research questions RQ1 and RQ2. However, the review of international evidence yields a number of interesting insights that are of relevance to housing and urban policy in the Australian context. For example, we have found that there appears to be broad support for the notion that housing outcomes—including affordability and congestion caused by commuting—may be beginning to erode the potential economic productivity gains that arise through city scale.

There are knock-on impacts within the urban economy, including impacts on the composition and skill levels and mix of labour markets. There are other complex interactions at work too, as there is also evidence internationally and domestically that patterns of migration are changing. These trends are explored elsewhere in more depth in the overall Inquiry, but there are suggestions that the relative desirability of metropolitan, smaller cities, and regional markets are changing for international migrants, and for migrants within countries.

The analysis reveals a number of additional questions that are relevant to overall economic outcomes:

- How are migration patterns changing within Australia?
- What are the impacts on the availability of skills in each tier of Australian cities?
- How do the changes to migration and skill levels impact on economic productivity?
- How do housing outcomes impact on productivity?
- How can housing and urban policies reflect the potential for influencing future change in economic productivity through housing and planning interventions?

3. City scale and agglomeration economics: empirical evidence

- **Empirical results suggest that, for US cities, a city of 1 million people would imply a wage rate 7.6 per cent higher than a city of 500,000 population.**
- **Agglomeration economies occur above and below all estimated threshold populations, and this implies that there are no diseconomies of scale with respect to population.**
- **The evidence of a productivity gain from higher city scale is weaker for Australian cities, and the estimates are smaller than for US cities. The results are inconclusive, probably reflecting the short time series of data available to the project, although there are indications that agglomeration economies might appear at smaller city scales in Australia compared to the USA and the EU.**
- **EU data do not show convincing patterns that suggest either agglomeration economies or diseconomies, but there are clear differences within the dataset. Notably, German cities show some evidence of higher productivity, which may be the result of a 'borrowed size' effect, but further research would be needed to confirm this.**

3.1 City scale and agglomeration economies

Section 3 focusses on RQ1:

- **RQ1:** At what city scales do agglomeration economies (and diseconomies) arise? And how does this vary over time, by Australian geography and by international context?

To examine this question, we conducted a regression of average per capita wages by city explained by local labour market characteristics and population with city fixed effects. City fixed effects describe the productivity differences that cannot be explained by standard labour market characteristics. Population is added as an explanatory variable to explain some of the variation in these fixed effects as a result of agglomeration economies (+) or diseconomies (–). We then estimate a threshold to search for turning points where these productivity differences indicate the initiation of economies or diseconomies at particular city population levels. We conducted analysis for separate models for the USA, Australia and the EU. The EU analysis also includes country fixed effects. In standard economic models, output is a function of technology, capital and labour. In per capita terms it is:

$$y_{it} = A_t {k_{it}}^{\alpha} {h_{it}}^{\beta} \qquad (3)$$

where lower-case variables represent per capita characteristics of a person in city i:[1] y is per capita output or earnings, A is technology, k is physical capital per capita and h is average human capital. The function is linearised by log transformation:

$$\ln(y_{it}) = M_i + yr_t + \alpha \ln(k_{it}) + \beta \ln(h_{it}) \qquad (4)$$

The coefficients α and β indicate the elasticity of each input with respect to output, while M describes the productivity differential between cities that is not explained by the local labour market characteristics in the initial regression. yr describes the annual productivity improvements that are common to all cities. We did not have data on capital, so used industry shares to control for capitalisation differences between industries.

Agglomeration economies imply that productivity increases with city scale. Based on Ahrend, Lembcke et al. (2017), this implies a model of these productivity differentials as a function of city population and other city-specific characteristics.

$$(M_i + yr_t) = yr_t + f(pop_{it}, ch_{it}, x_t, z_i) \qquad (5)$$

Where ch_{it} and z_i represent time-varying and non-time-varying city characteristics, while represents time-varying characteristics that affect all cities. For simplicity, we start with the functional form used by Ahrend, Lembcke et al. (2017).

$$M_i + yr_t = yr_t + a \ \ln(pop_{it}) + \sum_j b_j ch_{ijt} + \ z_i \qquad (6)$$

Where j indexes the type of city characteristics that may vary over time can be treated as a time-fixed effect without being observed, while z_i is the city-specific productivity differential that is not explained by the other explanatory variables. Since we start with a city fixed effects regression, this can be substituted into (6) in order to yield:

$$\ln(y_{it}) = yr_t + a \ \ln(pop_{it}) + \sum_j b_j ch_{ijt} + x_t + \ z_i \ + \beta \ln(h_{it}) \qquad (7)$$

1 i can be an individual, business, region, city, country or any other unit of people.

In this function, the coefficient describes the *strength* of agglomeration economies. Agglomeration economies imply that this coefficient is positive. Agglomeration diseconomies imply that productivity eventually decreases at very high levels of city population, as factors that affect production, such as congestion costs or rent, increase with city size, to the extent that this coefficient would be negative if the regression contained only cities at this very high population level.

This project is not focussed on the *strength* of these agglomeration effects, but the city scales at which agglomeration effects change. A threshold model can be used to find turning points in a function where the coefficients change at some particular threshold—in this case, population. A single population threshold model implies:

$$\ln(y_{it}) = yr_t + a_{pop<\gamma}\ \ln\left(pop_{it,pop<\gamma}\right) + a_{pop>\gamma}\ \ln\left(pop_{it,pop>\gamma}\right) + \sum_j b_j ch_{ijt} + \ z_i + \beta \ln(h_{it}) \qquad (8)$$

Where $a_{pop<\gamma}$ describes the productivity benefit (cost) per capita of additional population for cities that are smaller than a particular threshold, γ, which is also estimated from the data. If it is insignificant, then it does not imply agglomeration economies for these small cities. If $a_{pop>\gamma}$ is greater than $a_{pop<\gamma}$ it implies an increase in agglomeration economies at the threshold γ. A double threshold model implies:

$$\ln(y_{it}) = yr_t + a_{pop<\gamma 1}\ \ln\left(pop_{it,pop<\gamma 1}\right) + a_{\gamma 1<pop<\gamma 2}\ \ln\left(pop_{it,\gamma 1<pop<\gamma 2}\right) + a_{pop>\gamma 2}\ \ln\left(pop_{it,pop>\gamma 2}\right) + \sum_j b_j ch_{ijt} + z_i + \beta \ln(h_{it}) \qquad (9)$$

If $a_{pop<\gamma 2}$ is negative, the equation implies agglomeration diseconomies for cities larger than the population threshold $\gamma 2$, while if it is positive, but less than $a_{\gamma 1<pop<\gamma 2}$, it still implies agglomeration economies, but with diminishing strength. If it increases, then it implies that agglomeration economies strengthen above the population threshold $\gamma 2$.

We do not assume that a threshold model describes the actual empirical relationship between population and these city productivity differences. Instead, *the threshold approach is used to find turning points that may represent a suitable target for city population that may be useful for policy-makers*. The actual relationship is likely to be some continuous function with interaction effects and a nonlinear population variable, such as population squared, but estimating such a model tells us more about the strength of these effects rather than turning points in city scales. If the number of thresholds is extended to infinity, it becomes equivalent to the model with log(population) squared, so the threshold exercise is consistent with the approach of finding the true empirical model, but offers the advantage of useful targets for policy-makers that are estimated from the data where the change in coefficients is greatest.

Similarly, we do not assume that our results imply population growth is causal for productivity differences between cities. It is to be expected that higher-wage cities will grow faster than lower-wage cities. But it could also be expected that such urban growth would reduce real wage disparities. We do not believe there are any suitable instruments to resolve between the different causes of population growth that also affect wages or GDP. Similarly, most natural experiments will be associated with impacts on GDP or wages. Instead, our analysis shows how population is associated with productivity differences between cities. This approach is standard in the literature. See, for example, Ahrend, Lembcke et al. (2017).

As data is not typically collected for city (or even country-level) capital stocks, the capital variable is embedded in the city-specific productivity differences. To the extent that capital stocks are a function of agglomeration economies, this does not affect the results. Otherwise, capital stocks are controlled for in the regression with city-level industry shares. This implicitly assumes that capital intensity is probably consistent within industries, but can vary between industries. Similarly, we control for economic effects by including the unemployment and employment or participation rates.

3.2 Estimation method

Per capita wage is estimated as a function of the human capital characteristics of cities in separate models in each of the USA, the EU and Australia, using city and year fixed effects regression. Per capita GDP is not readily available at the city level. The estimated city fixed effect constants describe productivity differentials of each city that are not explained by the explanatory variables. The regression is then estimated adding population as an explanatory variable representing city size and other city-specific labour market characteristics, such as employment or participation rate and the unemployment rate. Finally, regressions are estimated with population thresholds on the population variable to determine turning points that could indicate agglomeration economies and diseconomies at particular population levels if the coefficient on population becomes negative.

The first step is required to define how within-city variation in the average characteristics affect within-city variation in average wages. This determines a residual that is not explained by standard labour market characteristics. The second step is required to analyse the effect of variation in the scale of cities on wages—that is, the strength of agglomeration economies over the entire range of population levels included. The third step is required to consider if these agglomeration effects vary over particular city scales. The EU model also controls for country-specific fixed effects.

The threshold model is not intended to reflect the true empirical relationship, but provides data-driven specific targets for population levels where larger changes in productivity occur due to agglomeration. Separate models are estimated for the EU, the USA and Australia to allow for country characteristics that might affect where these thresholds occur, and to allow a greater number of variables, since these vary by region or country.

3.3 Data

Three datasets are included to answer RQ1 and RQ2 in this project, which covers the US, Australia and Europe. The first dataset is the US dataset. The sample period is 2010–2017, and the observational units are US cities or metropolitan areas (or Core-based statistical area). There are 51 variables associating with income, labour market, industry, education and population in this dataset.

US dataset

For example, our US dataset contains the variable of income per capita as the dependent variable and total population as the main independent variable in our estimation. Additionally, we include education and labour market variables, as outlined below.

Education includes the number of people:

- with less than 9th grade education
- with less than 12th grade education
- with high school education
- with a college degree
- with an associate degree
- with a bachelor degree
- with a postgraduate degree.

*Labour market variable*s include the number of:

- people in the labour force,
- employed people in the labour force,
- unemployed people in the labour force.

To investigate the impact of industry on household income in our regression, we consider the percentage of employed people working in these sectors:

- Agriculture
- Construction
- Manufacturing
- Wholesale trade
- Retail trade
- Transportation
- Information
- Finance
- Professional services
- Arts
- Service
- Public administration.

All the data for these listed variables were extracted from American Community Survey (ACS), and are at the county level. To construct the dataset at the city for our project, we first grouped the counties into their corresponding cities on the basis of geographical relatedness (refer to the list provided by the Office of Management and Budget).[2] Then, we summed up the data of the count variables at the county level to represent their corresponding cities.

For example, according to the Office of Management and Budget, there are four counties in the City of Montgomery: Autauga, Elmore, Lowndes and Montgomery County. To construct the number of people with less than 9th grade education for the City of Montgomery, we can simply sum up the number of people with less than 9th grade education in Autauga, Elmore, Lowndes and Montgomery County. For the labour participation rate at the City of Montgomery—a percentage variable—we first weighted the labour participation of Autauga, Elmore, Lowndes and Montgomery County by the yearly total population of the City of Montgomery. Next, we took the average of the weighted labour participation among Autauga, Elmore, Lowndes and Montgomery County to represent the City of Montgomery.

Australia dataset

The second dataset in this project is the Australia dataset. This dataset is from 2011 to 2016 and is extracted from the Regional Statistics at the Australian Bureau of Statistics (ABS). We started with the data at the Statistical Area Level 2 (SA2) and then constructed the data for the Significant Urban Area (SUA) or city level using the same method outlined earlier for constructing the US dataset. Specifically, we categorise the SA2s into their associated SUAs on the basis of the list provided by ABS.[3]

There are 34 variables in the Australian dataset. They are:

- working age population—that is, number of people aged 15–64 years
- total population
- population density (per square kilometre).

2 Please visit https://www.census.gov/geographies/reference-files/time-series/demo/metro-micro/delineation-files.html to see the categorisation of counties into cities.
3 To see the list, please visit https://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/1270.0.55.001July%202016?OpenDocument.

The Australian dataset also contains the industry variables. For instance, we included the proportion of employed persons in these sectors at the SUA level:

- Agriculture
- Forestry and fishing
- Mining
- Manufacturing
- Electricity
- Wholesale trade
- Retail trade
- Accommodation and food services
- Transport
- Postal and warehousing
- Information media
- Telecommunications
- Rental
- Hiring and real estate service
- Professional scientific and technical services
- Administrative and support services
- Public administration and safety
- Education and training
- Arts and recreation services
- Healthcare and social assistance
- Other services.

The unit of all these industry variables is percentage.

Moreover, we included variables that related to the Australian labour market. For example, our Australian dataset contains the total number of employed and unemployed people and people in the labour force, and employment, unemployment and labour participation rate at the SUA level. We next included income variables—that is, mean employee income—and education variables that showed the percentage of persons aged 15 years and over:

- with postgraduate degree
- with graduate diploma/graduate certificate
- with bachelor degree
- with advanced diploma or diploma
- with certificate IV
- with completed Year 12, or equivalent.

Europe dataset

The last dataset in this project is the Europe dataset, which spans 2000–2016. The data source for this dataset is Eurostat. There are 21 variables relating to income, education, population industry and employment. For example, we have the data of household income and total population from 15 to 64 years (or working age population) in the Europe dataset.

In addition, we included the number of employed persons in these sectors:

- Agriculture
- Forestry and fishing
- Arts, entertainment and recreation
- Construction, financial and insurance
- Industry (except the construction industry)
- Manufacturing
- Information and communication
- Public
- Professional
- Real estate
- Food and accommodation
- Wholesale.

The employment in the listed industries can capture the impacts of industry on household income. The income, population and industry variables mentioned are all at the metropolitan or city level.

Moreover, we included education variables in the Europe dataset. For instance, our Europe dataset contains the percentage of people aged 25–64 with:

- primary education
- lower secondary education
- upper secondary education
- tertiary education.

However, the data of these education variables at the city level are sparse. To solve this issue, we followed these steps to construct new education data at the city level.

- **Step 1:** We transformed the data of education variable mentioned above at the Nomenclature of Territorial Units (NUTS) 2 (or NUTS3) into NUTS3.
- **Step 2:** We grouped the NUTS3 data into their corresponding cities.[4]
- **Step 3:** We weighted the education data at NUTS3 by population from their corresponding cities and took the average of weighted education data at NUTS3 to represent the city level.

Here is an example of how we constructed the education data at the city level from the NUTS2 level. In the city of Wien in our Europe dataset, we have three NUTS2 that are coded as AT11, AT12 and AT13 by Eurostat. These three NUTS2 are made of four NUTS3 that are coded as AT112, AT125, AT126 and AT127. To construct the data of the education variables for the city of Wien, we weighted the education data at AT11, AT12 and AT13 by population from their corresponding NUTS3. Then, we can take the average of weighted education data at NUTS2 to represent NUTS3. Next, we can weigh the NUTS3 education data by their city population—in this case, the city of Wien—and take the average of weighted NUTS3 education data to represent the data of education variables at the city of Wien.

4 To see the categorization of NUTS3 into their corresponding cities, please follow this link: https://ec.europa.eu/eurostat/web/metropolitan-regions/background

3.4 Summary of results: United States

Initial regressions are fixed effects log regressions of income per capita against education rates (representing human capital) and industry shares. Subsequent regressions add employment and unemployment rates as city-specific labour market characteristics and population. The Hausman test confirmed that fixed effects were required, rather than random effects. Robust standard errors are in parentheses with tests confirming the presence of heteroskedasticity. Tests also confirm year fixed effects are required. Year fixed effects negate the need to deflate GDP per capita.[5] Several regression results are shown in Table 1.

Table 1: USA metropolitan area per capita income fixed effects regressions

Regression	Model 1 Fixed effects (FE)	Model 2 Year FE (YFE)	Model 3 YFE, employment and unemployment	Model 4 YFE, employment, unemployment, and population	Model2A Bachelor or graduate	Model 3A Bachelor or graduate	Model 4A Bachelor or graduate
Log population				0.076*			0.080*
				(0.042)			(0.042)
Log unemployment			−0.021**	−0.017*		−0.021**	−0.018*
			(0.010)	(0.009)		(0.010)	(0.009)
Log employment			0.545***	0.560***		0.548***	0.562***
			(0.090)	(0.085)		(0.090)	(0.085)
Log education Grade 9 to Grade 12	−0.062***	−0.018***	−0.013***	−0.011**			
	(0.008)	(0.005)	(0.005)	(0.005)			
Log high school graduate	−0.056**	−0.053***	−0.036**	−0.025*			
	(0.027)	(0.017)	(0.015)	(0.015)			
Log college no degree	−0.031	−0.038***	−0.027**	−0.018			
	(0.021)	(0.014)	(0.012)	(0.013)			
Log associate degree	0.065***	−0.011*	0.010*	−0.008			
	(0.010)	(0.006)	(0.005)	(0.005)			
Log bachelor degree	0.112***	−0.005	−0.002	0.001			
	(0.016)	(0.011)	(0.010)	(0.010)			
Log graduate degree	0.105***	0.001	0.001	0.003			
	(0.012)	(0.007)	(0.007)	(0.007)			
Log bachelor or graduate degree					0.035***	0.028**	0.026**
					(0.011)	(0.013)	(0.012)
Industry controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	No	Yes	Yes	Yes	Yes	Yes	Yes
R^2 within	0.556	0.872	0.894	0.896	0.870	0.894	0.895

*Notes: Robust standard errors are in parentheses. * 10% confidence level, **5% confidence level, ***1% confidence level.*

All regressions also use log industry shares with coefficients not reported (agriculture, construction, manufacturing, wholesale trade, retail trade, transport, information, finance, professional services, education, arts, other services and public administration).

Source: Authors' calculations.

5 Year fixed effects are also required when tests are run using real income per capita as the dependent variable.

All coefficients have expected signs and relative magnitudes:

- unemployment implies lower wages
- employment implies higher wages
- low levels of education imply lower wages
- higher levels of education imply higher wages.

A 1 per cent higher population implies approximately 0.08 per cent higher per capita income. This impact seems small, but it is cumulative. That is, a city of 1 million people would imply a wage that is 7.6 per cent higher than a comparable city of 500,000.

The preferred models are 4 or 4A. While population is not quite significant at the 95 per cent level in regression 4, this is probably due to multicollinearity with the education variables. Regression 4A resolves this issue by utilising the single composite human capital variable.

The preferred base regressions are repeated with population thresholds to determine the city scales at which agglomeration economies or diseconomies occurs. For completeness, we estimate thresholds for both regressions 4 and 4A, and also estimate models with one, two or three thresholds. These regressions are shown in Table 2.

Table 2: US metropolitan area per capita income regressions with population thresholds

Regression	4 (i) 1 threshold (1T)	4 (ii) 2 thresholds (2T)	4 (iii) 3 thresholds (3T)	4A (i) 1 threshold (1T)	4A (ii) 2 thresholds (2T)	4A (iii) 3 thresholds (3T)
Lower threshold (population)	99,725	99,725	99,725	99,725	99,725	99,725
Upper threshold (population)		108,945	108,945		108,945	108,945
Highest threshold (population)			153,972			153,972
Mean standard error	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004
Log population pop<LT	0.065* (0.039)	0.045 (0.041)	0.026 (0.042)	0.071* (0.039)	0.051 (0.041)	0.033 (0.042)
Log population LT<pop<UT	0.068* (0.039)	0.048 (0.041)	0.029 (0.042)	0.074* (0.039)	0.054 (0.041)	0.036 (0.042)
Log population UT<pop<HT		0.051 (0.041)	0.032 (0.042)		0.057 (0.041)	0.039 (0.042)
Log population pop>HT			0.034 (0.042)			0.041 (0.042)
Log unemployment	−0.018** (0.009)	−0.016** (0.008)	−0.017** (0.008)	−0.018** (0.009)	−0.017** (0.008)	−0.017** (0.008)
Log employment	0.568*** (0.076)	0.588*** (0.064)	0.585*** (0.064)	0.572*** (0.075)	0.591*** (0.064)	0.589*** (0.064)
Log education Grade 9 to Grade 12	−0.011** (0.005)	−0.011** (0.005)	−0.011** (0.009)			
Log high school graduate	−0.029* (0.015)	−0.029* (0.015)	−0.032** (0.014)			
Log college no degree	0.020 (0.012)	−0.021* (0.012)	−0.021* (0.012)			
Log associate degree	−0.009* (0.005)	−0.008 (0.005)	−0.009* (0.005)			

Regression	4 (i) 1 threshold (1T)	4 (ii) 2 thresholds (2T)	4 (iii) 3 thresholds (3T)	4A (i) 1 threshold (1T)	4A (ii) 2 thresholds (2T)	4A (iii) 3 thresholds (3T)
Log bachelor degree	0.000 (0.010)	−0.001 (0.009)	0.002 (0.009)			
Log graduate degree	0.01 (0.007)	0.000 (0.007)	0.000 (0.006)			
Log bachelor or graduate degree				0.026** (0.011)	0.023** (0.009)	0.023** (0.009)
Industry controls	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R2 within	0.897	0.898	0.899	0.897	0.898	0.899

*Notes: Robust standard errors are in parentheses; Bootstrapped mean standard errors for thresholds. * 10% confidence level, **5% confidence level, ***1% confidence level. UT = Upper Threshold. LT = Lower Threshold.*

Mean standard error is used to judge the optimal threshold. All regressions use log industry shares (agriculture, construction, manufacturing, wholesale trade, retail trade, transport, information, finance, professional services, education, arts, other services and public administration).

Source: Authors' calculations.

Agglomeration economies occur both above and below all of the estimated thresholds. Agglomeration economies strengthen with each threshold, although adding additional thresholds reduces the statistical significance of the estimated coefficients. That is, the regressions do not imply any indication of agglomeration diseconomies at any population level within the sample, and agglomeration economies appear to be strengthening at higher city scales.

Notably the coefficients are smaller in the threshold models than in the continuous model, indicating that there is probably some variation in city productivity that is due to population that is assigned to the fixed effects in the threshold models simply due to sample selection of thresholds. Therefore, the coefficients in the threshold model may underestimate the strength of agglomeration economies.

3.5 Summary of results: Australia

The same regressions were conducted for Significant Urban Areas (SUAs) in Australia. There are fewer SUAs in Australia than metropolitan urban areas in the USA, but this effect is mitigated because the definition of an SUA includes many smaller cities with much smaller populations. These regressions also add an additional control variable for the city's population density. This was required to avoid cross-sectional dependence. Industries in Australia are defined by the Australian and New Zealand Standard Industrial Classification (ANZSIC) standard, so some specific industry categories vary from the US regressions. The education variables differ slightly for Australia from the US. Unfortunately, the education data for Australia are only available in census years (2011 and 2016). Therefore, it is not expected that these should be strongly significant, nor should a great deal of emphasis be focussed on the signs or relative magnitudes of these variables. The only education variables that are significant are the proportion with a bachelor degree and the proportion who completed Year 12. On this basis in the regressions, with fewer human capital variables, we use these two variables only rather than the consolidated bachelor degree or above variable used in the US regressions (see regressions 2A–4A in Table 3).

Table 3: Australia significant urban area per capita income fixed effects regressions

Regression	Model 1 Fixed effects (FE)	Model 2 Year FE (YFE)	Model 3 YFE, employment and unemployment	Model 4 YFE, employment, unemployment, and population	Model 2A Bachelor and Year 12	Model 3A Bachelor and Year 12	Model 4A Bachelor and Year 12
Log population				0.063 (0.053)			0.061 (0.050)
Log unemployment			−0.010 (0.012)	−0.015 (0.013)		−0.011 (0.012)	−0.017 (0.013)
Log participation			0.230** (0.096)	0.223** (0.099)		0.236** (0.092)	0.223** (0.096)
Log Year 12	0.085 (0.165)	−0.053 (0.082)	−0.152* (0.083)	−0.161* (0.086)	−0.097 (0.069)	−0.165** (0.065)	−0.155** (0.068)
Log certificate	0.154 (0.107)	−0.001 (0.049)	0.009 (0.046)	0.037 (0.053)			
Log advanced diploma	−0.017 (0.053)	−0.048 (0.031)	−0.033 (0.027)	−0.029 (0.027)			
Log bachelor degree	0.157** (0.071)	0.126*** (0.004)	0.093** (0.046)	0.087* (0.048)	0.113*** (0.039)	0.095** (0.042)	0.084* (0.044)
Log graduate diploma	0.037 (0.027)	−0.006 (0.017)	−0.002 (0.017)	−0.002 (0.017)			
Log postgraduate degree	0.015 (0.026)	0.009 (0.014)	0.014 (0.015)	0.013 (0.016)			
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	No	Yes	Yes	Yes	Yes	Yes	Yes
R2 within	0.339	0.913	0.913	0.914	0.912	0.913	0.913

*Notes: Robust standard errors are in parentheses. * 10% confidence level, **5% confidence level, ***1% confidence level. All regressions also use log industry shares with coefficients not reported (agriculture, mining, construction, manufacturing, electricity, wholesale trade, retail trade, accommodation, transport, information, finance, rental, professional services, administrative, public administration, education, health, arts, and other services).*

Source: Authors' calculations.

A 1 per cent higher population implies approximately 0.06 per cent higher per capita income, but the estimate is not statistically significant. Given the lack of significance, it cannot be concluded that agglomeration economies are any weaker in Australia or that they are non-existent—the data simply do not provide enough information.

Even so, the strength of the point estimate of agglomeration impacts seems small, but it is cumulative. That is, a city of 1 million people would imply a wage that is 6.3 per cent higher than a comparable city of 500,000. This is weaker than the US estimate of the strength of agglomeration economies. The difference could be a result of including smaller cities in the regression, but may also be due to structural differences between the two economies, or simply a result of the data used in Australia.

The preferred models are 4 or 4A. Unfortunately, population is not significant at the 95 per cent level in either regression. We do not believe that this implies no agglomeration economies—it is most likely a result of poor data reducing confidence in the estimates. The main issue is that the education data is only from the 2011 and 2016 censuses. For 2012–2015, we therefore used the 2011 observations. If we use an extrapolation for 2012–2015, coefficients are much more comparable to the US results.

The above regressions also include an additional control variable for the city's population density. This was required to avoid cross-sectional dependence. The regressions are repeated in table 4 without density as a control variable. These regressions require Driscoll and Kraay standard errors. These results are comparable with the regressions that include density as a control variable with robust standard errors.

Table 4: Australia significant urban area per capita income fixed effects regressions with Driscoll and Kraay standard errors

Regression	2 Year FE (YFE)	3 YFE, employment and unemployment	4 YFE, employment, unemployment and population	2A Bachelor and Year 12	3A Bachelor and Year 12	4A Bachelor and Year 12
Log population			0.079 (0.047)			0.073 (0.044)
Log unemployment		−0.004 (0.008)	−0.012 (0.010)		−0.006 (0.009)	−0.013 (0.011)
Log participation		0.236* (0.094)	0.225* (0.088)		0.240** (0.089)	0.221** (0.078)
Log Year 12	−0.048 (0.060)	−0.155** (0.047)	−0.170** (0.044)	−0.090* (0.039)	−0.162*** (0.035)	−0.150*** (0.036)
Log certificate	0.016 (0.037)	0.028 (0.042)	0.069 (0.064)			
Log advanced diploma	−0.053 (0.032)	−0.039 (0.027)	−0.033 (0.023)			
Log bachelor degree	0.139*** (.029)	0.111*** (0.027)	0.105*** (0.023)	0.140*** (0.022)	0.110*** (0.019)	0.097*** (0.016)
Log graduate diploma	−0.006 (0.019)	−0.001 (0.020)	−0.001 (0.020)			
Log postgraduate degree	0.008 (0.005)	0.015** (0.005)	0.013** (0.005)			
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R2 within	0.910	0.9102	0.911	0.909	0.910	0.911

*Notes: Driscoll and Kraay standard errors standard errors are in parentheses. * 10% confidence level, **5% confidence level, ***1% confidence level. All regressions also use log industry shares with coefficients not reported (agriculture, mining, construction, manufacturing, electricity, wholesale trade, retail trade, accommodation, transport, information, finance, rental, professional services, administrative, public administration, education, health, arts, and other services).*

Source: Authors' calculations.

The preferred base regressions are repeated with population thresholds to determine the city scales at which agglomeration economies or diseconomies occur. For completeness, we estimated thresholds for both regressions 4 and 4A, and also estimated models with one, two or three thresholds. These regressions are shown in Table 5.

Table 5: Australian significant urban area per capita income regressions with population thresholds

Regression	4 (i) 1 threshold (1T)	4 (ii) 2 thresholds (2T)	4 (iii) 3 thresholds (3T)	4A (i) 1 threshold (1T)	4A (ii) 2 thresholds (2T)	4A (iii) 3 thresholds (3T)
Lower threshold (population)	15,192	15,192	15,192	15,192	15,192	15,192
Upper threshold (population)		43,166	43,166		43,166	43,166
Highest threshold (population)			123,820			123,820
Mean standard error	0.0003	0.0003	0.0002	0.0003	0.0003	0.0003
Log population pop<LT	0.073* (0.042)	0.063 (0.041)	0.058 (0.041)	0.069* (0.039)	0.061 (0.038)	0.056 (0.038)

Regression	4 (i) 1 threshold (1T)	4 (ii) 2 thresholds (2T)	4 (iii) 3 thresholds (3T)	4A (i) 1 threshold (1T)	4A (ii) 2 thresholds (2T)	4A (iii) 3 thresholds (3T)
Log population LT<pop<UT	0.083* (0.043)	0.073* (0.042)	0.068 (0.042)	0.079** (0.040)	0.070* (0.038)	0.066* (0.038)
Log population UT<pop<HT		0.086** (0.042)	0.081* (0.041)		0.084** (0.038)	0.079** (0.038)
Log population pop>HT			0.086** (0.041)			0.084** (0.038)
Log unemployment	−0.004 (0.020)	−0.008 (0.020)	−0.011 (0.020)	−0.004 (0.022)	−0.008 (0.022)	−0.011 (0.022)
Log participation	0.225** (0.110)	0.215* (0.110)	0.193* (0.108)	0.238** (0.108)	0.227** (*0.107)	0.202** (0.103)
Log Year 12	−0.215* (0.122)	−0.211 (0.122)	−0.224* (0.119)	−0.214* (0.117)	−0.214* (0.118)	−0.224* (0.117)
Log certificate	0.059 (0.058)	0.043 (0.058)	0.038 (0.058)			
Log advanced diploma	−0.026 (0.121)	−0.023 (0.042)	−0.014 (0.042)			
Log bachelor degree	0.137* (0.070)	0.118* (0.067)	0.115* (0.066)	0.129* (0.066)	0.112* (0.064)	0.111* (0.064)
Log graduate diploma	−0.022 (0.044)	−0.021 (0.044)	−0.024 (0.044)			
Log postgraduate degree	0.005 (0.023)	0.006 (0.023)	0.007 (0.023)			
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R^2 within	0.921	0.929	0.931	0.921	0.928	0.930

*Notes: Robust standard errors are in parentheses; bootstrapped mean standard errors for thresholds. * 10% confidence level, **5% confidence level, ***1% confidence level. UT = Upper Threshold. LT = Lower Threshold. Mean standard error is used to judge the optimal threshold. All regressions use log industry shares (agriculture, mining, construction, manufacturing, electricity, wholesale trade, retail trade, accommodation, transport, information, finance, rental, professional services, administrative, public administration, education, health, arts, and other services).*

Source: Authors' calculations.

Agglomeration economies occur both above and below all of the estimated thresholds—although the coefficients are not statistically significant for the smaller thresholds. We do not believe that this means agglomeration economies are not occurring, only that there are too few cities below the very low threshold that is estimated. Agglomeration economies strengthen with each threshold, and strengthen in statistical significance. In other words, the regressions do not imply any indication of agglomeration diseconomies at any population level within the sample.

Notably the coefficients are higher in the threshold models than in the continuous model, which indicates that the threshold models possibly fit the data better than the original linear models.

3.6 Summary of results: European Union

Data for the EU is not organised by metropolitan area. Instead, metropolitan data were calculated as the sum or weighted averages of data for the NUTS3 regions that make up a metro area. We are confident that these measures are representative of the economic situation in EU cities because the explanatory variables are often statistically significant.

Using household income, the log-linear fixed effects regressions estimate positive coefficients for population, indicating agglomeration economies, although the coefficients are not statistically significant. We do not believe that this is evidence that there are no agglomeration economies. Instead, there may be agglomeration economies, but it is not estimated with statistical significance, possibly due to how the data is recorded. The linear regressions are shown in Table 6.

Table 6: EU metropolitan area per capita income fixed effects regressions

Regression	1. Fixed effects (FE)	2 Year FE (YFE)	3 YFE, employment and unemployment	4 YFE, employment, unemployment and population	2A Secondary and tertiary	3A Secondary and tertiary	4A Secondary and tertiary
Log population				0.144 (0.128)			0.143 (0.128)
Log unemployment			−0.072*** (0.021)	−0.067*** (0.021)		−0.072*** (0.021)	−0.067*** (0.021)
Log less than lower secondary (levels 0–2)	−0.082** (0.031)	−0.043 (0.045)	−0.009 (0.042)	0.001 (0.040)			
Log upper secondary and post-secondary non-tertiary (Levels 3–4)	−0.450* (0.217)	−0.68*** (0.103)	0.579*** (0.093)	−0.583*** (0.088)	−0.641*** (0.113)	−0.870*** (0.093)	−0.583*** (0.084)
Log tertiary (Levels 5–8)	0.513*** (0.101)	0.489*** (0.102)	0.513*** (0.103)	0.515*** (0.101)	0.497*** (0.010)	0.515*** (0.101)	0.515*** (0.099)
Industry controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	No	Yes	Yes	Yes	Yes	Yes	Yes
R^2 within	0.574	0.654	0.638	0.639	0.623	0.638	0.639

*Notes: Driscoll and Kraay standard errors are in parentheses, and are required due to cross-sectional dependence * 10% confidence level, **5% confidence level, ***1% confidence level. All regressions also use log industry shares for industries where there is complete data with coefficients not reported (agriculture, construction, industry, manufacturing, entertainment, and information and communications).*

Source: Authors' calculations.

Threshold estimates are shown in Table 7. As coefficients are not statistically significant in the linear regressions, the threshold models also estimate coefficients that are not statistically significant. The estimates are all in similar magnitude, above and below estimated thresholds, so there is no indication that agglomeration is strengthening or weakening. Notably, none of the estimates are negative, which would have indicated agglomeration diseconomies.

Table 7: EU metropolitan area per capita income regressions with population thresholds

Regression	4 (i) 1 threshold (1T)	4 (ii) 2 thresholds (2T)	4 (iii) 3 thresholds (3T)	4A (i) 1 threshold (1T)	4A (ii) 2 thresholds (2T)	4A (iii) 3 thresholds (3T)
Lower threshold (population)	736,500	480,100	480,100	736,500	480,100	480,100
Upper threshold (population)		527,400	527,400		527,400	527,400
Highest threshold (population)			736,500			736,500
Mean standard error	0.0066	0.0066	0.0065	0.0066	0.0066	0.0065
Log population pop<LT	0.165 (0.176)	0.144 (0.184)	0.173 (0.182)	0.166 (0.166)	0.142 (0.173)	0.171 (0.171)
Log population LT<pop<UT	0.159 (0.176)	0.138 (0.184)	0.167 (0.182)	0.159 (0.166)	0.136 (0.173)	0.165 (0.171)
Log population UT<pop<HT		0.144 (0.183)	0.172 (0.182)		0.142 (0.172)	0.171 (0.170)
Log population pop>HT			0.166 (0.182)			0.164 (0.170)
Log unemployment	−0.068*** (0.022)	0.067*** (0.023)	−0.067*** (0.023)	−0.068*** (0.022)	−0.066*** (0.022)	−0.067*** (0.022)
Log less than lower secondary (levels 0–2)	−0.000 (0.162)	0.007 (0.160)	0.008 (0.161)			
Log upper secondary and post-secondary non-tertiary (levels 3–4)	0.581* (0.334)	−0.574*** (0.333)	−0.569* (0.334)	−0.581* (0.300)	−0.581** (0.294)	−0.576* (0.294)
Log tertiary (levels 5–8)	0.522*** (0.169)	0.501*** (0.169)	0.507*** (0.170)	0.522*** (0.159)	0.499 (0.160)	0.506*** (0.161)
Industry controls	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R^2 within	0.642	0.646	0.649	0.642	0.646	0.649

*Notes: Robust standard errors are in parentheses, Driscoll and Kraay standard errors are not possible with the threshold estimator; bootstrapped mean standard errors for thresholds. * 10% confidence level, **5% confidence level, ***1% confidence level. UT = Upper Threshold. LT = Lower Threshold. Mean standard error is used to judge the optimal threshold.*

Education variables are for the NUTS2 region associated with the NUTS3 regions that make up the metropolitan area. If NUTS2 education variables are not available, national education measures are used. All regressions also use log industry shares for industries where there is complete data with coefficients not reported (agriculture, construction, industry, manufacturing, entertainment, and information and communications). Initial analyses predicted a threshold within 5 per cent of the top of the range, thresholds that are corner solutions such as this are excluded.

Source: Authors' calculations.

3.7 Summary

Agglomeration economies appear at all levels of population within range of city sizes examined in the US and Australian data. Thresholds do not imply any diseconomies over the range of city sizes, and if anything, that agglomeration economies strengthen in the larger cities, rather than weaken. The positive coefficients for cities below the lowest thresholds imply that agglomeration economies occur even for very small cities, although these results are not statistically significant.

Regressions with interaction effects suggest that agglomeration economies strengthen over the range of city sizes examined. Although the results for Australia were often not statistically significant, the coefficients were consistent with the results for the USA. Lower significance is likely to be a result of the data and there being fewer cities in Australia, rather than any difference in the behaviour of agglomeration economies in Australia.

The thresholds estimated for the USA and Australia are at the lower end of the population range of the city scales examined. We expect that the differences between the estimated thresholds in the USA and Australia are likely to be due to the range of sizes of cities included in each dataset. The Australian cities included much smaller urban areas, leading to a smaller estimated threshold. We do not believe that this implies a lower threshold for agglomeration economies in Australia—it is simply a result of the different definitions used for significant urban areas in Australia compared to the metropolitan area sizes in the EU or the USA. In other words, if the US data included cities with fewer people, these regressions are likely to have also estimated lower thresholds.

The European data did not indicate agglomeration economies or diseconomies or any pattern of strengthening or weakening. It may be that structural factors in Europe mean that agglomeration economies are less of a factor for predicting average city incomes in Europe. This could be due to borrowed size, industrial structure or migration patterns, but further research would be required to draw any conclusions. The result may also be due to the quality of the data.

4. City scale, urban amenities and output

- **Simple OLS estimations show that population is positively associated with higher wage rates in Australian cities. There are also positive impacts on the number of businesses and total jobs. The results suggest that having larger cities could therefore yield a productivity dividend.**
- **Industrial agglomeration, or increased industry employment share, is also positively linked to incomes and the number of businesses in Australian cities—particularly for employment in those economic sectors that are already associated with high employment shares.**
- **Population density does not appear to increase wages or jobs, but is a determinant of business growth.**
- **The relationships between city size and economic productivity are complex and nonlinear. There are suggestions that improvements to productivity are greater at lower levels of city population, but tail off as population grows.**

4.1 City scale and agglomeration economies

Section 4 focusses on RQ2:

- **RQ2:** What are the relative importances of accessibility, housing and commercial real estate user costs, population density, environmental factors, skill and interstate migration to growth in jobs, businesses and city-scale economic output?

In RQ2, we aim to examine the determinants of growth in jobs and business and city economic output in Australia. Specifically, we investigate if the following factors play active roles in determining the job and business growth and economic output in Australia:

- accessibility—commuting time and distance between centroids of Australian cities and the centroid of the nearest capital city
- housing costs—house price
- population density
- environmental factors—total CO_2 emission to air
- skill/education—percentage of the population with specific educational qualification
- labour mobility—interstate migration.

Therefore, RQ2 can be demonstrated in the following estimation equation or the two-way fixed-effect panel model:

$$y_{it}=b_1 * X_{it} + b_2 * Z_{it} + a_i + u_t + e_{it} \qquad (10)$$

Where y_{it} represents the dependent variables that include income and the number of employed people and business in city i and year t.[6] X_{it} is the vector that contains the first set of independent variables, which are log population, participation rate and employment share from different industries in city i and year t. Z_{it} is another vector of independent variables that are important to answer RQ2, which are accessibility (i.e. log commuting time and log distance between centroids of Australian cities and the centroid of the nearest capital city), house price, population density, environmental factor (i.e. total CO_2 emission to air), the percentage of population with specific educational qualification, and the number of interstate migrants. a_i and u_t are the city and year fixed effects. e_{it} is the error term. The coefficients of interest are b_1 and b_2, which summarise the impact of the independent variables mentioned on our dependent variables.

Our estimation results are presented in the following sections. In the baseline results, we include our key variable, log population, along with other control variables—such as participation rate and the industry employment shares—that are used not only in the baseline but also the non-baseline results. In the non-baseline results, we add other key independent variables that are important to answer RQ2 to the baseline regression: log commuting time and log distance between centroids of Australian cities and the centroid of the nearest capital city, log house price, log population density, log total CO_2 emission to air, the percentage of population with specific educational qualification and the number of interstate migrants. To test whether the estimates of the effect of population on our dependent variables were sensitive to these key independent variables, we first added them individually, and then as a block to the baseline regression.

6 The income level in this study refers to mean employee income in the city. We prefer GDP at the city level over employee income. However, the GDP data at the city level are not available. We have to choose a variable that can closely represent the city productivity, and the data of the selected variable we choose must be available. Hence, mean employee income at the city level is selected.

4.1.1 The effects of city population on income, businesses and jobs in Australia

In this section, we continue our analysis of RQ1 by extending our investigation to the impact of city population on the number of businesses and jobs. In the baseline results (see Table 8), we started our estimation without any control variables. As we can see in Table 8, the simple regression indicates that population in a city is positively associated with income level, and the number of businesses and jobs. Specifically, the elasticities of income, businesses and jobs with respect to city population size are 0.082, 0.897, and 0.786 individually (see Column 1, Column 2 and Column 3 of Table 8). This implies that a 1 per cent increase in the city population results in 0.082 per cent, 0.897 per cent and 0.786 per cent increases in income, the number of businesses and number of employments on average. These estimates are strongly statistically significant. For example, the estimates for the number of business and employments are statistically significant at 1 per cent (see Column 2 and Column 3 of Table 8). One exception is the estimate for income, which is only statistically significant at 10%.

Table 8: The effect of city population on income, business and jobs in Australia (baseline estimation without control variables)

Regression	Log(income)	Log(business)	Log (job)
Log population	0.082* (0.048)	0.897*** (0.166)	0.786*** (0.076)
City fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
R^2 within	0.902	0.113	0.497
R^2 between	0.032	0.966	0.993
R^2 overall	0.087	0.965	0.993
Number of cities	101	101	101
Number of observations	606	558	606

*Notes: Robust standard errors are in parentheses and clustered at the city level. * 10% confidence level, **5% confidence level, ***1% confidence level.*

Source: Authors' calculations.

Table 9: The effect of city population on income in Australia (baseline estimation with control variables)

Regression	Log(income)	Log(income)	Log(income)
Log population	0.0763* (0.046)	0.085* (0.048)	0.082* (0.076)
Participation rate	0.001 (0.002)	0.001 (0.002)	0.002 (0.002)
Total employment share from Top 5 industry	0.003** (0.001)		0.002 (0.001)
Total employment share from Bottom 5 industry		−0.009*** (0.003)	−0.008** (0.003)
City fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
R^2 within	0.904	0.904	0.905
R^2 between	0.017	0.061	0.032
R^2 overall	0.066	0.124	0.089
Number of cities	101	101	101
Number of observations	606	606	606

*Notes: Robust standard errors are in parentheses and clustered at the city level. * 10% confidence level, **5% confidence level, ***1% confidence level. Top 5 industries are health, retail trade, construction, manufacturing and education sector; Bottom 5 industries are finance, electricity, rental, arts and information sector.*

Source: Authors' calculations.

Table 10: The effect of city population on business in Australia (baseline estimation with control variables)

Regression	Log(business)	Log(business)	Log(business)
Log population	0.879*** (0.159)	0.841*** (0.165)	0.842*** (0.161)
Participation rate	0.011* (0.006)	0.011* (0.006)	0.011* (0.006)
Total employment share from Top 5 industry	−0.001 (0.010)		0.003 (0.010)
Total employment share from Bottom 5 industry		0.027** (0.014)	0.030** (0.012)
City fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
R^2 within	0.119	0.127	0.128
R^2 between	0.966	0.966	0.967
R^2 overall	0.966	0.966	0.967
Number of cities	101	101	101
Number of observations	558	558	558

*Notes: Robust standard errors are in parentheses and clustered at the city level. * 10% confidence level, **5% confidence level, ***1% confidence level. Top 5 industries are health, retail trade, construction, manufacturing and education sector; Bottom 5 industries are finance, electricity, rental, arts and information sector.*

Source: Authors' calculations.

Table 11: The effect of city population on jobs in Australia (baseline estimation with control variables)

Regression	Log(job)	Log(job)	Log(job)
Log population	0.739*** (0.039)	0.747*** (0.045)	0.739*** (0.041)
Participation rate	0.019*** (0.005)	0.019*** (0.005)	0.019*** (0.005)
Total employment share from Top 5 industry	0.006** (0.003)		0.006** (0.003)
Total employment share from Bottom 5 industry		−0.005 (0.008)	0.001 (0.007)
City fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
R^2 within	0.614	0.604	0.614
R^2 between	0.998	0.997	0.998
R^2 overall	0.998	0.997	0.998
Number of cities	101	101	101
Number of observations	606	606	606

*Notes: Robust standard errors are in parentheses and clustered at the city level. * 10% confidence level, **5% confidence level, ***1% confidence level. Top 5 industries are health, retail trade, construction, manufacturing and education sector; Bottom 5 industries are finance, electricity, rental, arts and information sector.*

Source: Authors' calculations.

The positive association between city population and income, or the number of businesses or jobs, continues to be demonstrated after adding the control variables—that is, participation and industry employment shares—in the baseline estimation. For instance, in the case of log income as the dependent variable (see Table 9), the elasticity of income with respect to city population varies between 0.076 and 0.085. In addition, looking at Table 10 and Table 11, the number of businesses and jobs or employments would be enhanced by approximately 0.8 per cent or 0.7 per cent, respectively, from a 1 per cent increase in city population after the control variables—participation and industry employment shares—are included. If we compare the case of estimation without and with these control variables—that is, Table 8 versus tables 9, 10 or 11—the magnitude of the estimates and the statistically significant levels do not change notably. This implies that adding the control variables—participation rate and industry employment shares—does not affect the estimates of the effect of city population on income and the number of businesses and jobs.

The roles of our selected control variables are not trivial in the estimation. For example, labour participation rate is positively related to the number of businesses and jobs (refer to the second row of Table 10 and Table 11). The reason for that could be that the labour participation rate is a good indicator for the local economic conditions. As the local economy is strengthened with an increase in the labour participation rate, the number of businesses and employments may also rise. However, the positive association between labour participation and income is rather weak (see second row of Table 9). This indicates that getting more people to enter the labour market does not necessarily contribute to higher incomes.

4.1.2 Industry agglomeration effect on income, and the number of businesses and employments in Australia

Many studies claim that industry agglomeration is positively linked to productivity. For example, Cingano and Shivardi (2004) and Andersson and Loof (2011) provided evidence to show that larger employment sizes resulted in higher productivity in the manufacturing sector. Additionally, Melo, Graham and Noland (2009) conducted a meta-analysis and demonstrated a positive association between employment size and productivity in the service sector. Ciccone (2002) argued that the positive relationship between employment sizes and productivity occurred in all the non-agriculture sectors in Europe. As industry agglomeration can generate substantial external benefits and spillover effects to other industries through sharing labour and suppliers (Giuliano, Kang and Yuan 2019), we can understand that industry agglomeration—larger employment sizes—is potentially beneficial to economic development.

To investigate how the industry employment sizes (or agglomeration) affect economic development such as income, and the number of businesses and employments in Australia, we first selected some large and small industries in terms of their employment shares, and then we included their employment shares as control variables in our baseline regression.

As we can see in Table 12, the Top 5 industries in terms of employment shares are the Health, Retail, Construction, Manufacturing and Education sectors. The employment shares from the Top 5 industries together are more than 50 per cent. Conversely, the Bottom 5 industries are Financial, Electricity, Rental, Arts and Information technology sectors, and their total employment shares are less than 8 per cent in Australia between 2011 and 2016. Hence, we generate two control variables. The first control variable is '*Total employment share from Top 5 industry*' and the second control variable is '*Total employment share from Bottom 5 industry*'.

Table 12: Industry employment share in Australia, average 2011–2016

Sector	Employment share (%)
Health	14
Retail trade	13
Construction	9
Manufacturing	8
Education	8
Accommodation	8
Public administration	7
Transport	5
Professional	4
Other service	4
Mining	4
Administrative	3
Wholesale trade	3
Agriculture	2
Financial	2
Electricity	2
Rental	2
Arts	1
Information technology	1

Source: Data extracted from Regional Statistics, Australian Bureau of Statistics from 2011–2016.

As we can see in Table 13, there is a positive and statistically significant coefficient (or elasticity) between population and the wage rate, the number of businesses, and the number of jobs in Australian cities. The labour market participation rate also positively influences the wage rate and number of jobs—but not number of businesses. The employment share variables also show some interesting influences. Concentration of employment in the Top 5 industries increases the wage rate, but has no influence on the number of businesses or jobs. Conversely, concentration of employment in the Bottom 5 industries reduces both the wage rate and the number of jobs. Therefore, this is also supportive of the notion of scale economics positively affecting productivity, as revealed through wage rates.

As noted earlier, Table 13 also controls for a number of urban amenity and disamenity effects. The average commuting time is statistically significant and reduces the number of jobs, but appears to have no impact either on the wage rate or on the number of businesses. Air pollution, as measured by CO_2 emission to air, is a statistically significant partial determinant of the wage rate and number of jobs. Housing prices have a strong positive influence on the wage rate, but weakly significant negative impacts on businesses and jobs. The results also show strong influences of education variables—particularly a strong and positive relationship between bachelors-level qualifications and wages, businesses and total jobs.

Table 13: The effect of city population on income, business and jobs in Australia

Regression	Log(income)	Log(business)	Log (Job)
Log population	0.026**	0.927**	0.987***
	(0.012)	(0.024)	(0.004)
Participation rate	0.004**	0.004	0.014**
	(0.002)	(0.007)	(0.001)
Total employment share from Top 5 industry	0.013***	0.006	0.001
	(0.001)	(0.008)	(0.001)
Total employment share from Bottom 5 industry	−0.020***	0.020*	−0.005**
	(0.006)	(0.012)	(0.002)
Log commuting time	0.001	−0.002	−0.004***
	(0.001)	(0.005)	(0.001)
Log distance	0.014	−0.0150	−0.004
	(0.001)	(0.029)	(0.006)
Log house price	0.126***	0.152*	−0.031*
	(0.026)	(0.087)	(0.019)
Log CO_2 emission to air	0.005**	−0.004	0.002**
	(0.001)	(0.003)	(0.001)
Log interstate migrant	−0.001	−0.001	−0.001
	(−0.001)	(0.001)	(0.001)
Bachelor degree above	0.026***	0.017**	0.009***
	(0.002)	(0.007)	(0.001)
Post-high school	0.014***	−0.010	0.002*
	(0.003)	(0.011)	(0.001)
City fixed effects	No	No	No
Year fixed effects	Yes	Yes	Yes
R^2 within	0.538	0.069	0.497
R^2 between	0.522	0.973	0.993
R^2 overall	0.515	0.972	0.993
Number of cities	91	91	101
Number of observations	523	483	606

*Notes: Robust standard errors are in parentheses and clustered at the city level. * 10% confidence level, **5% confidence level, ***1% confidence level. Top 5 industries are health, retail trade, construction, manufacturing and education sector; Bottom 5 industries are finance, electricity, rental, arts and information sector.*

'Bachelor degree above' includes postgraduate, graduate diploma and bachelor degree; 'Post-high school' includes advanced diploma and certificate.

Source: Authors' calculations.

4.1.3 The non-linearity effect of city population on income (parametric estimation)

From our simple OLS regression results in sections 4.1.1 and 4.1.2, we can see that all the estimates of the effect of city population on income are positive. Additionally, most of these estimates are statistically significant at 5 per cent or 10 per cent. According to the Williamson hypothesis, the positive impact of agglomeration on economic growth is true only to a certain level of economic development (Brülhart and Sbergami 2009). In other words, the effect of city population on income should be nonlinear and the positive relationship between them disappears after the 'optimum' population level is reached. More importantly, the Williamson hypothesis suggests that the effect of city population on income is heterogenous among different population levels. If the relationship between population and income is nonlinear and heterogenous according to this hypothesis, then our empirical models above are likely to be mis-specified.

To capture the heterogenous effect of city population on income, we therefore modified our OLS estimation as follows. First, we split our city samples into four groups based on their population levels. Specifically, we divided the distribution of population data into 10 quantiles—or 10 different locations of the distribution of the population data—as shown in Table 14.

Table 14: Population groups and quantiles (or locations) of population distribution

Group	Quantile
Low population	1–4
Medium population	5
High population	6–8
Very population	9–10

Source: Authors' calculations.

As we can see from Table 14, the locations (or quantiles) of the population distribution can be used to represent different city population size groups. We generated four new variables to capture these group effects, to allow us to understand the heterogenous effect of population on income. We then ran new regressions of income on these four new variables in our estimations.

The results from Table 15 and Table 16 confirm that the relationship between population and income in Australian cities is not homogenous. The positive association between population and income occurs only in the low population group as their population coefficients are positive and statistically significant at 1 per cent. Although the population coefficients are not statistically significant at any conventional level, the results suggest that expanding population size in the cities with very high population levels may relate to a reduction in income.

Table 15: The heterogenous effect of city population on income in Australia (parametric estimation without control variables)

Regression	Log(income)	Log(income)	Log(income)	Log(income)
Log low population	0.003*** (0.000)			
Log medium population		−0.001 (0.001)		
Log high population			0.135 (0.139)	
Log very high population				−0.001 (0.001)
City fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
R^2 within	0.903	0.902	0.497	0.902
R^2 between	0.001	0.017	0.993	0.030
R^2 overall	0.089	0.10	0.993	0.094
Number of cities	101	101	101	101
Number of observations	606	606	606	606

*Notes: Robust standard errors are in parentheses and clustered at the city level. * 10% confidence level, **5% confidence level, ***1% confidence level.*

Source: Authors' calculations.

Table 16: The heterogenous effect of city population on income in Australia (parametric estimation with control variables)

Regression	Log(income)	Log(income)	Log(income)	Log(income)
Log low population	0.003*** (0.000)			
Log medium population		−0.001 (0.001)		
Log high population			0.164 (0.136)	
Log very high population				−0.001 (0.001)
Participation rate	0.002 (0.002)	0.002 (0.002)	0.007* (0.004)	0.002 (0.002)
Total employment share in the top 5 industries	0.002 (0.001)	0.002 (0.001)	0.002 (0.002)	0.002 (0.001)
Total employment share from Bottom 5 industry	−0.007** (0.003)	−0.007** (0.003)	−0.005 (0.004)	−0.007** (0.003)
City fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
R2 within	0.904	0.902	0.918	0.904
R2 between	0.001	0.017	0.165	0.001
R2 overall	0.067	0.10	0.316	0.085
Number of cities	101	101	33	101
Number of observations	606	606	182	606

*Notes: Robust standard errors are in parentheses and clustered at the city level. * 10% confidence level, **5% confidence level, ***1% confidence level.*

Source: Authors' calculations.

4.1.4 The non-linearity effect of city population and CO_2 emission to air on income (non-parametric estimation)

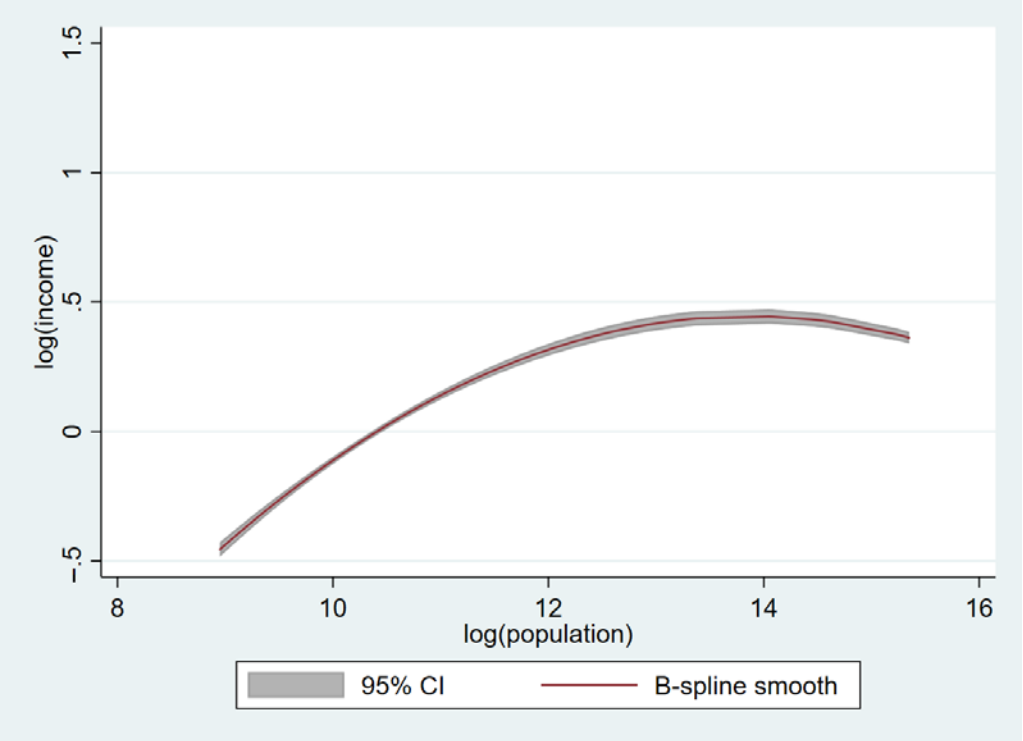
In the OLS estimations in Sections 4.1.1 and 4.1.2, an assumption is imposed that the relationship between the independent and outcome variables are linear. This assumption may not be appropriate in the case of the relationship between income and population. To explore this, we borrowed a methodology from the literature with an application on the relationship between CO_2 emission and population. To explore the nonlinear effect of CO_2 emission to air and population on income, we followed Baltagi and Li (2002), and conducted a semiparametric fixed-effects regression, thus:

$$y_{it}=\Omega k_{it}+f(v_{it})+ a_i+u_t+w_{it} \qquad (11)$$

Where y_{it} is our outcome variable, income in the log form in city i and year t, k_{it} is a vector of control variables that are used in the baseline estimation (i.e. participation and share of industries employment form in city i and year t), v_{it} is the variable of interest (i.e. population and CO_2 emission to air in log form in city i and year t), and are city and year fixed effects, and w_{it} is the error term. The semiparametric estimator here attempts to uncover the functional form, f, but without any predetermined knowledge between the income and population or CO_2 emission to air by employing the B-splines suggested in Baltagi and Li (2002). The results are presented in graphic form in Figures 11 and 12.

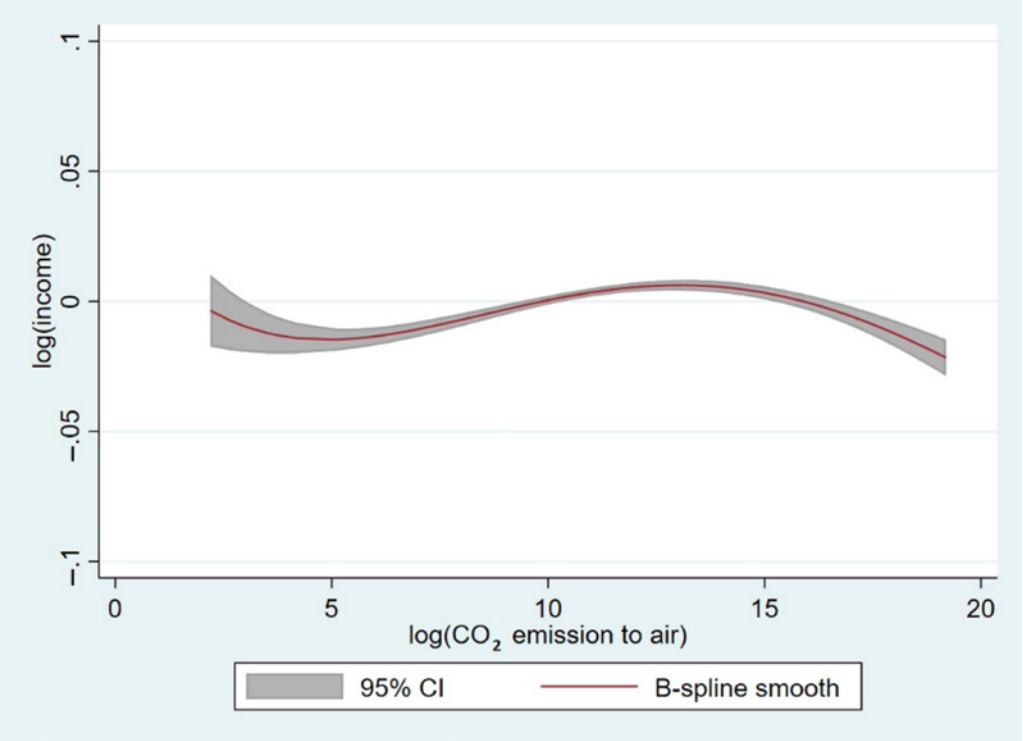
As we show in Figure 11, the relationship between population and income is nonlinear. Specifically, shown in Figure 11, after log (population) reaches 14 in the *x*-axis, the effect of population on income is decreasing. The implies that the positive relationship between population and income is much weaker in the cities with large population sizes. In the case of CO_2 emission to air, Figure 12 suggests that the cities with high CO_2 emission to air levels (i.e. log CO_2 emission to air reaches 15 in the *x*-axis) can reduce income level.

Figure 11: The non-linearity effect of log(population) on log(income)



Source: Authors.

Figure 12: The non-linearity effect of log (CO_2 emission to air) on log(income)



Source: Authors.

4.1.5 Summary of results

To answer RQ2, we employed the two-way fixed-effects model and semiparametric estimation to investigate the effect of population, accessibility, housing price, population density, CO_2 emission to air, education levels and labour mobility on income and the number of businesses and jobs in Australian cities between 2011–2016.

Our simple linear estimation showed that population is positively associated with income. Specifically, the elasticity of income with respect to population is from 0.0763–0.085. This may suggest that an 1 per cent increase in population in Australian cities can enhance income by 0.0763–0.085 per cent on average. The linear estimations continue to show that population can improve the number of businesses and jobs by 0.841–0.927 per cent and 0.739–0.987 per cent respectively, from a 1 per cent increase in Australian city population on average.

Industry agglomeration—that is, increasing industry employment shares—is positively linked with income and business. Particularly, increasing the employment shares from the Health, Retail Trade, Construction, Manufacturing or Education sectors may result in an income enhancement. Furthermore, the number of businesses may be expanded if the employment shares from the Financial, Electricity, Rental, Arts or Information technology sectors are increased. Population density plays a trivial role in improving income and creating jobs—however, it is an important determinant of business growth in Australia.

In our nonlinear (parametric) estimation designs, we found that the positive relationship between population and income is conditional on city population levels. In other words, the effect of population on income is heterogenous, and only the cities with low population levels are positively related to income. Our semiparametric estimations showed that the relationships between income and population or CO_2 emission to air are nonlinear. This means that enhancing population and CO_2 emission levels may be favourable to improve income **only** at their lower levels. But, this is not true when the population and CO_2 emission levels are very high.

It is important to note that the econometric results presented in this chapter may suffer from a number of possible estimation issues. For this reason, a diversity of estimation approaches has been employed, and various control variables designed and included in the estimations. But we should acknowledge the possibility that some issues remain. For example, omitted variable bias may be present. In our empirical models, we included an array of control variables—such as education, labour market conditions and industry variables—along with year and city fixed effects.

However, many variables could still jointly correlate with city population and our dependent variables. For example, city safety or urban amenities may positively affect population level and income. As our empirical models do not contain many of these variables, their omission will push any such effects into the error terms of our empirical models. In turn, given city population may be positively correlated with such amenities, the effect of city population on income may be overestimated.

Another potential issue is 'reverse causality'. Our estimations attempted to quantify the impact of city population on income. However, income could also affect city population. Specifically, Australian cities like Sydney and Melbourne with higher incomes are likely to attract more people to come to live and work. Consequently, the coefficient of interest—the effect of city population on income—may be overestimated.

A third possible problem could arise from potential measurement errors in the dataset. Our data for population, education and labour market variables are estimated data. It is likely that measurement errors exist in these estimated data. If the measurement errors induced by the estimated data in our dataset are classical measurement errors, the coefficients in our empirical models could be downward biased or be attenuated to 0 (Hyslop and Imbens 2004). However, as the extent of measurement errors in our datasets is unknown, we cannot determine the direction (i.e. positive or negative) of bias in our coefficients in our empirical models.

To overcome these issues in future work, researchers could employ the GMM[7] estimation to address the issue of omitted variable bias and reverse causality. However, such estimations require a long time series of data, and so their use was precluded by the short 2011–16 sample of data available to this study.

7 Instrumental Variable (IV) estimations are viewed as a special case of GMM estimation. The similarity is that both deploy instruments to overcome the endogeneity issue. The former uses external instruments, whereas the latter employs internal instruments. Specifically, the internal instruments in GMM estimation are the long lags of endogenous variables. For example, GMM uses the historical city populations as an instrument for the endogenous variable of current city populations in this study. The identification strategy in GMM estimation in our case is that historical city population levels are correlated with current city population levels, but historical city population levels do not affect city productivity directly.

5. Policy development options

5.1 Managing agglomeration gains

We return to Berthaud's (2014) observation that agglomeration gains are potential and are realised only where firms, workers and households can trade and exchange their goods, labour and ideas with minimal frictions of time and costs—and presumably secure housing at rents and prices that do not offset their gains from metropolitan labour market participation. This implies that metropolitan areas need to be managed for agglomeration gains net of congestion costs—which involves treating rising real house prices and rents as a form of congestion cost—to be captured by firms and households. Failure to manage them will reduce productivity and redistribute income and wealth away from the productive sector of the economy and the effort-led earnings of workers and instead reward the unearned gains of metropolitan property owners.

Unless efficient metropolitan supply-system responses to agglomeration-driven demands minimise non-essential and speculative demands, it can only impede metropolitan productivity growth, and exacerbate adverse distributional wealth and income outcomes.

An important feature of local housing outcomes is that they reflect levels and interactions of:

- **local factors**—residential structures, neighbourhood qualities, physically limited developable land
- **metropolitan factors**—agglomeration economies and amenities
- **subnational influences**.

The policy approaches and instruments that are reflected in the choices of households and developers reflect a variety of instruments controlled from different levels of government. Housing outcomes in all Australian localities are shaped by the roles played by:

- mortgage rates set by the Reserve Bank
- national tax structures
- state regulation in strategic and development planning
- state regulation in major infrastructure investments and housing subsidy measures
- local government planning, service and infrastructure provisions.

These measures are not always well coordinated—and some even may run counter to each other. Managing the metropolitan housing system requires a real grasp of policy impacts and interactions in achieving metropolitan goals.

How could metropolitan-scale policies for housing ensure that agglomeration gains become realised by workers and firms? Actions are required at national, state and metropolitan levels, as outlined in the next section.

5.1.1 Federal and state levels

The assignment of policy responsibilities and functions within a geographically large federal system such as Australia must have regard to the functional nature of systems, so that with a strong local dimension to housing systems it could be expected that state and metropolitan scales would have significant housing policy roles. However, housing outcomes from local actions may spillover into other jurisdictions and across the nation as a whole. So a federal view on good or desirable housing outcomes for Australians, which may not always coincide precisely with state level views, is important. At the moment, there is no evidence that the federal government has a clear vision for, or strategy to achieve, an effective housing system to boost productivity.

The prevalent federal view is that the housing market functions effectively, while the experience of major metropolitan areas suggests that this is an unreasonable assumption. There is no coherent national housing market modelling or macro to metro modelling that would suggest an informed interest in the performance of metropolitan housing markets. And although there is now macro-prudential policy concern about the debt-to-income positions of Australian households and policy measures to ensure prudential borrowing, there is no federal housing market strategy to ensure that housing pressures do not drive up house prices and household debts.

Within these considerations, although there is much federal concern about instability potentials and recognition of the affordability challenges that low- and middle-income households now face, there is no federal debate about the productivity effects of housing outcomes. The high and rising proportion of under 40s who are paying more than 30 per cent of their income on housing costs has not produced a federal policy response. The falling proportion of under 40s able to access home ownership has induced ad hoc first-buyer supports but not led to significant tax and subsidy reforms. The apparently endemic tendency of the major Australian metropolitan markets towards house price inflation has resulted in little analysis of impacts and no real policy responses. Now, with the major growth engines in the Australian economy with chronic housing affordability difficulties and falling relative productivity there is no recognition that housing affordability and productivity are related in multiple and significant ways.

In 2010, the Major Cities Unit, then located at the core of the Australian Government, reported (2010: 90) that:

> There are indications that the major cities may be losing their edge in contributing to economic growth … over a 33-year period from 1976 to 2009 the major cities recorded economic growth that was, on average, 0.201 per cent greater than the national average … However, over the past decade, the contribution of the major cities has resulted in an average economic growth only 0.037 per cent more than the national average.

The more recent analysis in this study suggests that the relativities may have worsened for metropolitan areas, which may now lag national averages. The Major Cities Unit (MCU) (Australian Government, 2010: 44) recognised the potential significance of growth congestion costs, noting that:

> contributing factors may have included increased inefficiencies and productivity losses arising from an infrastructure backlog, transport congestion, and increased costs associated with the movement of freight, and the provision of services such as water, power and sewerage associated with the growth of cities.

But until very recently, housing was not regarded as essential economic infrastructure, and this contrasts markedly with the views of economics and finance ministries about transport investment. Since 2015, there have been clear arguments made for housing as infrastructure (Maclennan et al. 2015) but both the housing sector and bureaucracies cut down the perspective to talk about 'social housing as infrastructure' or 'housing as social infrastructure'. Both these perspectives may be important and interesting but a system-wide view of all housing as economic infrastructure is required in order to get at the role of housing in the economy.

Without clarity on why housing might matter in impacting agglomeration economies and productivity, economic analysis of and arguments for disappear across the silos of government departments. A major interview study for AHURI across Victoria and Western Australia (Maclennan, Ong et al. 2015), supplemented by more recent interviews in New South Wales in 2017 (Maclennan, Crommelin et al. 2018), concluded that:

- ministries and agencies responsible for economic development and productivity growth in Australian states do not ask questions about housing effects on economic outcomes, and focus on issues concerned with skills and innovation
- housing ministries and agencies struggling to deal with needs queues well beyond their resource capacities focus only on the homeless and the worst-housed households, and have neither time to ask nor answer economic questions
- planning authorities neither model the economic drivers of metropolitan housing market change nor the likely consequences of planning decisions.

5.2 Policy structures and settings

There are some key aspects of public policies for housing—apart from framing—that need to change if the gap between achieved and potential metropolitan economic potential is to be reduced or removed. This involves rethinking the structures and settings for housing policies in major metropolitan areas, and so it will be essential to:

- manage the real housing system to facilitate faster supply responses
- better connect housing and other areas of policy activity
- deal with market failures
- avoid demand stimuli that needlessly raise prices or underutilise existing residential spaces.

A first step is to reconceive housing policies as being, in part, concerned with real economic infrastructure to facilitate economic development. A second step is to move away from a narrow focus on the poorest households and the homeless and to set their concerns within a broader housing-systems framework that has regard to all housing outcomes in the metropolitan area—and in the nation.

Such a 'housing-systems framework' has several other important dimensions:

- First, the connections between housing and the economic system must be clearly understood.
- Second, these system drivers and impacts may be local, national or global.
- Third, housing outcomes within a metropolitan area are influenced by policy actions by different orders of government, from federal to municipal. It is essential that housing policy influences emanating from different levels cohere at local–metropolitan level, even if they are potentially pursuing different kinds of interests.

Two important policy changes are required to deal with 'multi-order' issues:

First, multi-order cooperation in housing policy needs to be incentivised. This may be a matter for federal/state/provincial governments developing performance-conditional housing deals with metropolitan governments.

Second, given their important role in national economic development, there is a strong case to refocus the leadership roles in housing policy strategy and delivery down from federal / state / provincial levels and up from municipal scales, as key housing policy decisions increasingly rest at metropolitan scales.

Of course, there may be little point in placing metropolitan areas at the core of housing policies unless they are effectively structured to deliver change. Ahrend, Farchy et al. (2015) indicated how productivity increases with city size, but also highlighted three other important issues (Ahrend, Farchy et al. 2015; Katz 2015). Metropolitan boundaries are rarely well aligned with daily functional system boundaries. Although around half of metropolitan

areas in the OECD have now evolved some form of metropolitan governance, fewer than one in six have any resource or fiscal powers. So the best geographic and fiscal structures to take forward more effective metropolitan housing powers may currently be missing. Ahrend, Farchy et al. (2015) also highlighted that jurisdictional fragmentation within metropolitan areas diminishes productivity at quite potent rates. The inherited governance structures for housing within multi-municipality metropolitan areas may need radical change.

Similar remarks may be made in relation to the assignment of fiscal powers to different orders of government. In a functional metropolitan area, the problem is that costs—such as affordable housing, traffic congestion and green space requirements—all rise with economic growth, as do tax revenues. However, the problems remain in the functional city but the tax revenues to address them accrue to other orders of government. There is no automatic flowback of locally generated resources to pressured localities for action to reduce negative growth consequences. These issues have been extensively analysed by Slack and Cole (2014), and by the Brookings Institution in the USA (Katz 2015), who now argue for a 'metropolitan federalism' to rebuild major city infrastructure.

Metropolitan federalism—or even the ad hoc substitute of multiple, conditional metropolitan–federal infrastructure and housing deals—might induce a faster, more elastic response to housing shortages. Glaeser and Gottlieb (2009) and Glaeser and Gyourko (2018) have emphasised supply inelasticities from stringent or slow metropolitan planning, and that is always an important set of issues to check. However, it is worth noting that the periods of prolonged, high house price inflation have coincided in time with more restrictive policy stances towards public borrowing and the public provision of major infrastructures. And since the 1980s, a reinforcing policy setting has been a conventional wisdom in market-oriented jurisdictions that public intervention in land assembly—such as compulsory purchase—is anathema in a market system and likely to erode growth and productivity. A recurrent strand in supply-side research results that is seldom emphasised is how non-price responsive new construction has become since the 1980s. This leaves open the question as to whether there may have been too little planning—in the sense of strategic planning for market provision—by metropolitan areas, or at least by those who governed them.

There are new views emerging about the potential roles for state investment in market economies with uncertainty and change (Mazzucato 2018). Given the vast scale of the housing shortages now prevailing in all the major growth localities of Australia, a serious attempt to reduce house price growth for the future and facilitate the development of significant-scale places might have to include:

- compulsory purchase of land
- requirements for inclusionary zoning.

Both of these measures 'tax' the unearned economic rents accruing to landowners, which have no negative effect on productivity—unlike housing supports raised from taxes and borrowing. That is, housing policy should be a key element in 'place-making' policy at metropolitan and neighbourhood scales. This also requires that related infrastructure and services, as well as transport links to jobs and services, are built into the proposal from the outset (ex ante), and that infrastructure and planning gains are taken, to the greatest extent possible, by metropolitan governments.

The sustained disequilibrium and rising real housing costs encountered in major metropolitan areas in recent decades suggest that 'first-best' economic instruments will have limits in shaping desired growth and distribution outcomes. The 'well-functioning' market stance that leads to policy inaction clearly needs to change. Equally 'efficient' instruments such as ex ante, income-related housing allowances may be left to play out in imperfect systems with persistent shortages and simply raise housing costs charged by providers.

Deregulating planning, of a strategic place-making nature, may well raise uncertainties over where development may occur and exacerbate mismatches between residential and production location choices. Consumer choice (ex ante allowances) and reduced regulatory burdens—such as reducing planning controls and delays—are desirable, but they require effective markets to work. In contrast, 'planning-state' solutions also have their

inherent failures and in some contexts there is a re-emergence of arguments for housing policy instruments that were extensively abandoned after the 1980s. Limited rent controls have received a new advocacy as affordability problems for renters rise; and calls for major public-housing investment programs have resurfaced. Both calls have been unmatched by any clear thinking about the housing system and economic consequences.

To deliver real gains, planning must be well designed, informed and economically literate. Going beyond the 'well-functioning' market basis for policy requires a planning approach driven by intelligent, informed, economically literate approaches to developing metropolitan infrastructure plans, rather than state power and bureaucracy. These infrastructure plans should:

- include housing
- engage multiple sectors—public, private and not-for-profit
- work collaboratively with all levels of government.

We cannot discount the possibility that a failure of politics will perpetuate the failures of markets in metropolitan management and make cities less fair and less productive than their potential. Poorly designed policy settings for the housing sector have created a context in which housing failure is a near inevitability of economic 'triumph'. That needs to change.

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Appendix: Descriptive statistics for panel datasets

Australian cities

Variables	(1) N	(2) mean	(3) sd	(4) min	(5) max
Population	2,892	43,785	85,964	81	1200000
Income	2,892	49,407	13,168	22,674	135,051
Employment in accommodation sector	2,254	168.1	349.1	3	5,342
Employment in administrative sector	2,064	171.2	379.6	3	5,865
Employment in agriculture sector	2,316	324.2	370.1	3	3,385
Employment in art sector	1,767	64.08	125.5	3	1,589
Education (bachelor degree)	964	9.941	6.119	0	35.10
Education (high school)	898	39.04	12.55	12.60	78.90
Employment in education sector	1,762	68.43	144.7	3	2,139
Employment in electricity sector	1,611	17.03	25.41	3	302
Employment in finance sector	2,179	368.6	973.0	3	15,074
Employment in health sector	1,996	264.6	616.8	3	10,271
Employment in information sector	1,463	55.14	119.0	3	1,333
Employment in manufacture sector	2,142	171.2	329.6	3	4,004
Employment in mining sector	1,608	21.27	65.12	3	898
Employment in other services sector	2,182	185.3	342.5	3	4,649
Labour participation rate	964	58.74	7.620	31.10	82.80
Education (preschool)	954	616.4	1,198	1	14,951
Employment in professional sector	2,174	504.5	1,320	3	21,077
Employment in public administration sector	1,346	23.30	39.46	3	389
Employment in rental sector	2,275	449.4	1,067	3	16,034
Employment in retail sector	2,272	248.5	492.5	3	6,874
Unemployment rate	958	6.472	5.068	0.500	62.10
Employment in wholesale trade sector	2,102	156.4	339.5	3	4,413
Working age population	2,410	64.13	5.174	47.70	87

EU cities

Variables	(1) N	(2) mean	(3) sd	(4) min	(5) max
Number of weekly hours	3,791	38.16	2.363	32.70	48.90
Wage	3,452	21,840	25,338	472.6	285,621
Employment in technology sector	3,680	810.4	763.5	13.30	6,966
GDP	3,684	45,868	53,863	954.1	597,818
Gross fixed capital	3,497	9,262	11,061	123.8	139,022
Households income	3,643	33,198	40,946	523.7	397,345
Population	3,876	1847406	1683494	25,776	12930751
Tertiary education	3,754	25.12	9.934	4.300	74.80
Employment in service sector	3,662	571.3	571.4	9.900	4,637
Employment in manufacture sector	3,686	153.5	168.8	1.500	1,670
Employment in agriculture sector	3,556	43.04	81.56	-135.8	1,088
Primary education	3,750	28.79	15.92	2.400	86
Secondary education	3,750	46.08	15.16	8.100	80.30

US cities

Variables	(1) N	(2) mean	(3) sd	(4) min	(5) max
Population	3,298	690,212	1650052	61,551	19961892
Education (less than 9th grade)	3,298	26,136	88,625	178	1098966
Education (less than 12th grade)	3,298	32,728	81,623	551	1021725
Education (high school)	3,298	118,433	269,472	5,657	3544727
Education (college without degree)	3,298	95,458	205,136	6,056	2142310
Education (associate degree)	3,298	36,952	79,799	1,943	977,945
Education (bachelor degree)	3,298	93,206	246,886	3,592	3238259
Education (graduate degree)	3,298	57,529	163,754	1,784	2354119
Labour force	3,298	348,727	852,734	23,883	10438474
Total employment	3,298	320,659	782,596	20,740	9909092
Total unemployment	3,298	27,856	71,405	597	985,655
Employment in agricultural sector	3,298	3,838	7,629	43	116,295
Employment in construction	3,298	20,132	48,091	882	587,745
Employment in manufacturing sector	3,298	31,393	70,497	721	714,693
Employment in wholesale trade sector	3,298	9,178	24,253	0	301,570
Employment in retail trade sector	3,298	36,576	83,927	2,331	1013295
Employment in transportation sector	3,298	16,094	43,519	633	636,005

Appendix: Descriptive statistics for panel datasets

Variables	(1) N	(2) mean	(3) sd	(4) min	(5) max
Employment in information sector	3,298	7,498	24,322	54	331,799
Employment in finance sector	3,298	22,900	65,195	609	907,468
Employment in professional	3,298	38,307	106,117	1,082	1379676
Employment in education sector	3,298	73,253	179,261	4,143	2579507
Employment in arts sector	3,298	30,792	73,632	1,428	887,722
Employment in other service sector	3,298	15,949	40,870	824	484,592
Employment in public administration sector	3,298	14,913	36,053	577	405,309
Household income	3,298	68,860	12,697	45,065	170,966
Mean family income	3,298	81,465	15,065	47,951	191,428
Per capita income	3,298	26,952	4,916	13,480	58,588
GDP	3,262	41,712	119,775	1,862	1772320

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