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Spatial segregation and neighbourhood change

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Acronyms and abbreviations used in this report

ABS	Australian Bureau of Statistics
AHURI	Australian Housing and Urban Research Institute
GCCSA	Greater Capital City Statistical Area
HIND	total household income (weekly)
IRSD	Index of Relative Socio-economic Disadvantage
JRF	Joseph Rowntree Foundation
JTW	journey to work
PEC	principal employment centre
SA2	Statistical Area Level 2
SEIFA	Socio-Economic Indices for Areas

Executive summary

Key points

- This study develops indicators of neighbourhood change using residential mobility and employment data.
- Highly segregated cities show a high degree of spatial sorting. This sorting could be via income and socio-economic status, ethnic or minority population groupings, or other demographic or cultural criteria. It is widely acknowledged that spatial segregation—whether ongoing, maintained or accelerating—is detrimental to social cohesion and community wellbeing. Any segregation has negative effects, whether this segregation occurs at the affluent end (rich agglomerating in some areas) or at the disadvantaged end (the poor concentrated in other areas). At both ends, the potential for integration is lowered.
- Conversely, inclusive cities exhibit lower spatial segregation, which supports social cohesion and community wellbeing.
- This research studies the extent and patterns of spatial segregation by income bands and levels of neighbourhood deprivation across Australia's five largest capital cities: Sydney, Melbourne, Brisbane, Adelaide and Perth.
- The study develops indicators of neighbourhood change based on long-term residential mobility of people to and from neighbourhoods, and short-term journey-to-work-based mobility of people to and from neighbourhoods. In doing so, it establishes a distinct functional typology for each neighbourhood in terms of its housing market, social and economic deprivation, and employment connectivity to the rest of the city and the wider region.

- **By tracking these indicators over two census periods (2011 and 2016) for the five cities, the study shows which neighbourhoods are severely or moderately exclusionary or isolated from the rest of the city in their residential characteristics—that is, clustering of high-income or low-income earners over time—and which neighbourhoods are severely or moderately disconnected from the larger employment and labour markets of the city.**

- **The study finds that segregation in Australian cities is increasing over time, with respect to the spatial clustering of socio-economic classes. Affluent areas and advantaged neighbourhoods show the agglomeration of high-income earners. This drives segregation through exclusion, since low- and moderate-income earners face barriers to entering and living in advantaged areas, with good amenities and good connectivity to jobs.**

- **The study also fills a critical research and policy gap by characterising the changing, dynamic nature of neighbourhoods in terms of their connectivity to the wider citywide housing market and employment markets.**

- **In addition to detecting dynamic processes of social displacement within gentrifying areas that are becoming more segregated, the study also seeks to measure 'porosity', which is where neighbourhoods enable dynamic movements of people to and from other neighbourhoods in the city.**

- **The results provide an evidence-base for informing place-based and accessibility-based policies that work towards reducing spatial sorting and segregation in cities based on socio-economic differences.**

Key findings

Overall, this report finds that spatial sorting and segregation is increasing in Australia's five largest capital cities. Over time, spatial sorting and segregation in Australian cities is driven by income and economic class segregation, rather than, for example, other demographic criteria such as ethnic, linguistic or minority group characteristics, as is more common in US cities (Owens and Candipan, 2019; Candipan, 2019).

Segregation in Australian cities is driven by the upper end: high-income and very-high-income earners cluster into tight spatial groups. These neighbourhoods then become socially isolated and exclude moderate-income, low-income and very-low-income earners who cannot afford to live in expensive housing markets. This is despite the economic ties that lower-income workers often have to these areas.

In Australian cities, the most affluent areas—the high-value residential neighbourhoods—are closest in spatial proximity to the areas where the highest number of jobs are clustered. This results in a labour market where the highest-income earners also travel the least to access job opportunities, whereas lower-income and moderate-income earners are forced out to the peripheries of the cities and must therefore travel more to access these same opportunities.

Such residential exclusion and the employment connectivity and dis-connectivity profiles combine to create conditions that exacerbate spatial inequalities in cities. This is in addition to the inefficiencies brought about by the locational imbalance of jobs and housing caused by the higher-income areas agglomerating closest to the major employment centres and many lower-income or moderate-income areas being farther away from major job centres.

Policy development options

In revealing the extent of socio-spatial sorting and segregation in the nation's five largest capital cities, the findings of this study have important implications for Australian urban and housing policy. In seeking to address and reduce socio-spatial inequality through urban policy and housing interventions, key priorities and options include the following.

- Recognising the potential for infrastructure and planning interventions to exacerbate existing housing-market pressures, which reinforces processes of gentrification, displacement and exclusion of lower-income earners—including key workers and those with long-term connections to the location.
- Consequently, state and local governments should monitor housing markets for displacement, exclusion and porosity at the neighbourhood scale in order to measure the impact of—and need for—particular planning and policy interventions.
- To prevent displacement of lower-income residents, strategic infrastructure investment decisions intended to improve transport accessibility should be supported by policies that preserve and increase affordable housing opportunities.
- More broadly, strategic funding and planning interventions are needed to increase the supply of affordable rental housing in accessible jobs-rich areas to reduce socio-spatial segregation and exclusion.

Overall, spatial sorting and the resulting socio-economic inequities should be an active focus for policy and should be addressed by all levels of Australian government through infrastructure, housing assistance and planning responses.

The study

This research presents the results from a standalone data project on Measuring Neighbourhood Change using residential mobility and journey to work (JTW) data. Residential mobility within the city represents long-term, low-frequency changes to patterns of residential settlement. JTW within the city represents short-term, high-frequency daily patterns of travel to work and employment.

The project draws on internal migration data to measure residential mobility and JTW data to measure jobs-housing connectivity from the 2011 and 2016 ABS censuses. We have used this data to compute indices of neighbourhood change, identifying and focussing on deprived and affluent neighbourhoods based upon residential mobility and employment connectivity. These neighbourhood-change indices were used to develop a neighbourhood-level measure of housing exclusion and neighbourhood porosity.

The neighbourhood-change indices are based on expanding existing typologies of how deprived and affluent neighbourhoods are connected to the wider city region by both:

- long-term, low-frequency residential mobility flows

- short-term, high-frequency JTW flows.

The typology developed in this research expands the typologies defined by the 2016 Joseph Rowntree Foundation (JRF) report *Overcoming deprivation and disconnection in UK cities*.

Specifically, this study extends the JRF work in two significant ways.

First, while the JRF project looked only at deprived neighbourhoods, this AHURI project develops neighbourhood typologies for all neighbourhoods in the five largest Australian cities—including the most affluent neighbourhoods. This shows that while deprivation and segregation in the city can result from deprived areas continuing to be deprived or isolated, it is also critically dependent on affluent areas being exclusionary. By putting up barriers to entry into affluent areas, there is loss of porosity of movement of people throughout the city—which results in further deprivation and segregation.

Second, this understanding and insight led to the development of a 'neighbourhood porosity' indicator, which characterises the porosity–exclusion index for each neighbourhood, thus making it a relevant evidence-base for neighbourhood and place-level policy decision-making.

The data and indices produced in this work fill a critical research and policy gap by testing and describing how the changing nature of neighbourhoods—in terms of their connectivity to the larger city and region—can serve as indicators of ongoing exclusion or displacement processes, which result in spatially sorted or segregated cities.

Data from the 2011 and 2016 ABS censuses on five-year internal migration and JTW are employed in this work. The methods, analytical framework and indices developed are demonstrated for the five largest Australian capital cities: Sydney, Melbourne, Brisbane, Adelaide and Perth. The entire study is fully reproducible for future census periods, so this project thus enables a future longitudinal framework of tracking neighbourhood change.

1. Tracking neighbourhood change

This project draws on internal migration and journey to work (JTW) data from the 2011 and 2016 ABS censuses to compute indices of neighbourhood change.

- **It identifies isolated, exclusionary and disconnected neighbourhoods based on long-term residential flows and short-term employment flows within the greater city regions of the five largest Australian capital cities.**
- **The work done in this study addresses policy concerns on socio-spatial disadvantage generated by spatial sorting and segregation processes arising from the long-term and short-term movement of people in urban regions.**
- **Section 1 presents the policy context, the existing research background and the detailed methodology for the project. The data sources and variables used for the analysis are described.**

As residential areas in cities undergo transformation over time, neighbourhood change involves a complex set of interacting social, economic, spatial and physical processes. Changes can be slow or rapid, and are revealed through:

- changes in the urban built form—for example, regeneration and new development, or decline of existing housing stock
- shifts in the social fabric—for example, through movement-in of new residents who may have demographic characteristics different from (or similar to) those already living in-place, or the movement-out of long-term residents
- through changes in the economic substructure—for example, rapid changes in the type of real estate and property development and transactions. Such changes are the basis of physical and spatial change.

Often, all these processes occur simultaneously, and are interconnected in complex ways.

This work quantifies and tracks neighbourhood change across the greater city regions of the five largest Australian capital cities: Sydney, Melbourne, Brisbane, Adelaide and Perth. It draws upon data that is both:

- *locational*—local neighbourhood socio-economic characteristics, and
- *networked*—long-term residential flows and short-term employment connectivity flows within neighbourhoods.

It seeks to advance understandings of processes of neighbourhood change, gentrification and exclusion in Australian cities, and to inform efforts to improve housing and economic opportunities for lower-income households.

1.1 Policy context

There has long been concern about housing affordability in Australian cities, as well as the processes by which lower-income renters are displaced or unable to enter specific housing markets (Randolph 2020). A series of studies have documented the social and economic consequences of these processes, which include:

- risks to labour markets when lower-income earners are unable to relocate or remain living near employment centres (Gurran, Hulse et al. 2021; Maclennan, Ong et al. 2015; Productivity Commission 2014)
- social disadvantages and stigma associated with concentrations of poverty (Randolph 2020; Randolph and Holloway 2005; Randolph and Tice 2014).

In the 1980s and 1990s, these concerns were focussed on processes of inner-city gentrification that were evolving in Australia along with broader shifts in urban and economic geography (Badcock 1995). Government interventions such as urban renewal and redevelopment processes were implicated in the displacement of long-term residents from formerly industrial inner-city areas such as Pyrmont Ultimo in Sydney (Bounds and Morris 2005). Recognising these risks, federal programs such as the Building Better Cities program of the mid-1990s sought to improve urban areas through targeted investments in infrastructure, and often included explicit provisions to maintain and increase affordable housing (Neilson 2008).

There have been sporadic state and local attempts to preserve or deliver affordable housing opportunities as part of overall efforts to increase housing supply (Atkinson, Wulff et al. 2011; Pegler et al. 2020). These include:

- requirements to include affordable housing in significant new residential projects in South Australia
- affordable housing contribution requirements in parts of inner Sydney
- voluntary planning incentives in NSW, Victoria and South Australia (Gurran, Gilbert et al. 2018).

Overall, a major focus of Australian urban policy on diversifying has been increasing housing supply in well-located areas accessible to major employment centres. However, in the absence of specific affordability requirements, there is a risk that these strategies will be insufficient to prevent the displacement or exclusion of lower-income groups.

Measuring these dynamic processes of neighbourhood change remains a persistent challenge for research and policy. In very expensive housing markets, where there is insufficient supply of social or affordable housing, lower-income renters are often already 'priced out'. As a result, exclusion rather than displacement is a more accurate characterisation of such housing markets—even if increasing opportunities for lower-income groups to access housing in these areas is an important policy goal. An alternative place-based measure of potential inclusion or exclusion based on the flow of people could be a powerful indicator of unfolding displacement or exclusion processes—while also highlighting the important policy objective of increasing affordable housing opportunities in well-located priority locations.

1.2 Existing research

The conceptual understanding of socio-spatial disadvantage in Australia has seen a tradition of comparative research and policy knowledge transfers from the US and the UK (Burke and Hulse 2015). Overall, scholars and policy makers have focussed on problems associated with entrenched, place-based exclusion, where residents of disadvantaged neighbourhoods are disconnected from communities with higher social or economic opportunities (Rae, Hamilton et al. 2016; Robson, Lymperopoulou et al. 2009b), as well as the converse issues arising from gentrification, where lower-income renters are displaced when property values and rents rise (Chapple and Zuk 2016; Wyly and Hammel 2004; Zuk et al. 2018). In comparison to traditionally disadvantaged and depopulated urban centres in North American cities, Australia's socio-spatial disadvantage is more commonly associated with middle and outer suburbs, where lower-value housing markets suffer from poor transport accessibility to jobs or natural amenities (Gleeson and Randolph 2002; Randolph and Holloway 2006; Randolph and Tice 2014b). Despite this, lower-income renters in these disadvantaged areas are equally at risk of displacement during processes of infrastructure investment or market-driven urban renewal.

The spatial processes of gentrification, displacement and exclusion imply the progressive rise of land values and rents, followed by a displacement process as lower-income renters are replaced by more affluent home purchasers or renters (Lees, Slater et al. 2008). Over time, the higher housing market becomes entrenched, and newcomers of lower-socioeconomic backgrounds are unable to move in.

In many cases, where systematic displacement has already occurred and exclusion is entrenched, the usual set of measurements that indicate gentrification, housing-affordability pressures or displacement do not work—such as rents in relation to local incomes, or rising homelessness—as there is no evidence of the poor, so no displacement can be observed. In real terms, it means that the process of displacement is complete and social exclusion is ongoing. However, on a metropolitan or regional scale, these exclusive housing markets entrench socio-spatial disadvantage and inequality. Therefore, measuring exclusion and progress towards inclusion is equally as important as measuring processes of gentrification and displacement.

This project draws on ABS census data to compute a novel derived-data series for indices of neighbourhood change of how deprived and affluent neighbourhoods are connected to the wider city region by:

1. long-term residential mobility and housing market flows, and
2. short-term JTW flows and employment connectivity, measured in terms of the numbers and proportion of workers travelling from all parts of the city to the principal employment centres.

The project expands the neighbourhood-change typology defined by the 2016 Joseph Rowntree Foundation (JRF) project (Rae, Hamilton et al. 2016; Robson, Lymperopoulou et al. 2009b), adapting it to the Australian context to test and describe indicators of neighbourhood exclusion or displacement processes that result in spatially sorted or segregated cities. The JRF project looked at long-term migration flows of people in and out of deprived neighbourhoods and developed four neighbourhood functional typologies. (Note: The JRF project used 'deprived' to mean 'disadvantaged'.) These four neighbourhood typologies are:

- ***Escalator:*** In-movers come from equally or more deprived areas, and out-movers go to less deprived areas.
- ***Gentrifier:*** In-movers come from less deprived areas, and out-movers go to equally or more deprived areas.
- ***Isolate:*** In-movers come from equally or more deprived areas, and out-movers go to equally or more deprived areas.
- ***Transit:*** In-movers come from less deprived areas, and out-movers go to less deprived areas.

Based on these definitions, the JRF project classified each of the bottom 20 per cent—or most deprived—neighbourhoods into one of the four categories. In this current work, we extend the definitions of functional neighbourhood types to all neighbourhoods—rather than just those that are deprived—and look at the resulting spatial patterns of segregation, displacement and exclusion.

Further, the JRF project also looked at employment connectivity and JTW patterns, and developed definitions of employment connectivity relevant to the UK. In this current study, we develop Australian-specific definitions for employment connectivity and classify all neighbourhoods as either 'Connected' or 'Disconnected'.

The project is also informed by previous work that explored location-based and, to some extent, residential mobility-based analyses (Burke and Hulse 2015; Hulse, Pawson et al. 2014; Hulse and Pinnegar 2015), including collection of primary data from small samples, where residents of disadvantaged areas were surveyed to understand their lived experience (Hulse, Pawson et al. 2014; Pawson and Herath 2015).

These earlier studies developed specific typologies for disadvantaged neighbourhoods, based on dynamic housing market definitions:

- Lower-priced suburbs—affordable housing markets
- Isolate suburbs—extremely disadvantaged neighbourhoods with very low prices and rents
- Marginal suburbs—low-priced markets distant from mainstream markets
- Dynamic improver suburbs—rents and prices rapidly moving towards metropolitan averages.

However, disadvantaged neighbourhoods do not sit in perfect isolation; they are connected to the rest of the city or region and play a diverse function in the housing market. So for this project an overarching conceptual framework was constructed where each neighbourhood in the city—whether disadvantaged, affluent or mixed—can be characterised in terms of its potential for exclusion or displacement. Overall, the project brings together a place-based or location-based view of exclusion and displacement with a network or flow-based view (Burke and Hulse 2015). While concentrations of spatial disadvantage and affluence capture the location-based view, the flow-based view captures how the location functions as part of a citywide housing market, and how it is connected to the city or region for employment.

Section 1.3 provides additional detail on the research evidence used to inform the methods and analytical approaches used in this study.

1.3 Research methods

The key research aim is to draw on secondary data in novel ways, to develop neighbourhood typologies based on residential mobility flows and JTW flows to provide a basis for testing:

- whether (and which) neighbourhoods in Australian cities are growing more porous and inclusionary over time, allowing movement of people between housing markets in the long-term, and showing evidence for constantly evolving housing–labour market relationships in the short term, or
- whether there is a trend towards exclusion where:
  - in the long-term, some neighbourhoods show defined resistance to the entry of low-income or medium-income earners, or a defined isolation trend trapping low-income earners
  - in the short term, there is evidence for inefficient housing–labour market relationships with job–residence spatial mismatches.

It is anticipated that some neighbourhoods will grow increasingly exclusionary over time, with rising rents and property values pricing out lower-income households. Others may grow increasingly 'porous' or inclusionary, which reflects either market processes of decline, or positive interventions that enable production of smaller developments or higher-density developments that include lower-cost rental or affordable housing.

The measures developed in this project seek to provide a timely indicator of displacement or exclusionary processes versus inclusionary processes. Importantly, the measure of 'porosity' can capture dynamic processes of the flow of people in different income bands in and out of all neighbourhoods, rather than only measuring a situation where low-income earners are 'stuck' in disadvantaged neighbourhoods—which, as emerges from this work, is only a partial story about how segregation and exclusion can be characterised.

Therefore, in developing this network and flow-focussed approach, this project brings together the conceptual characterisation of socio-spatial disadvantage to the processes of residential mobility and housing and labour market flows—in other words, socio-economic processes that shape the production of a geography of disadvantage, gentrification and exclusion.

This study was guided by three key research questions:

1. What is the extent of spatial sorting of disadvantaged/affluent neighbourhoods, and is there evidence of increasing, decreasing or constant levels of spatial sorting of deprived and affluent neighbourhoods in Australian cities over successive census periods?
2. What types of disadvantaged neighbourhoods exist, and how can these be conceptualised by not simply locational in-place indicators, but by residential mobility flows of people in and out of these neighbourhoods, and the ways in which these neighbourhoods are connected in journey to work relationships with the larger city?
3. How can the ability of neighbourhoods to accommodate lower-income groups be characterised, and how can the indicator(s) and results provide an evidence-base for place-based and connectivity-based specific policy interventions?

Accordingly, the methods are organised to answer these three research questions, as shown in Table 1.

Table 1: Research questions mapped to methodology sections

Research question	Subsection and methodology description
Pre-preparation	1.3.1: Data cleaning and processing
1: Spatial and longitudinal extents of sorting and segregation	1.3.2: Measuring evidence for spatial segregation and sorting 1.3.3: Measuring evidence of longitudinal change by income categories: towards a measure of 'neighbourhood porosity' 1.3.4: Entropy calculations as a measure of spatial sorting and segregation
2: Internal migration data and functional neighbourhood typologies	1.3.5: Establishing neighbourhood functional typologies by residential mobility (internal migration) data
2: Journey to work data and employment connectivity typologies	1.3.6: Establishing neighbourhood functional typologies by employment connectivity (JTW) data
3: Final measure of neighbourhood porosity	1.3.7: The final combined indicator for measuring neighbourhood exclusion versus neighbourhood porosity

Source: Authors.

The study first examines the extent of spatial sorting and segregation in 2011 and 2016 by income bands, and then examines longitudinal changes between the 2011 and 2016 census points: has spatial sorting in various income bands increased or decreased, or seen no significant change? Then it uses internal migration data to track residential mobility at the SA2 level for Australia's five largest capital cities. (An SA2 is a statistical area of roughly – on average – 10,000 people.) These five cities were selected because of their population size and economic importance in Australia. Thus the dynamics of neighbourhood change revealed in the analysis are likely to be generalisable across other Australian urban population centres.

We used JTW data at the SA2 level for the five cities to track employment connectivity. The JTW data captures a full population response through the census of the exact counts of people who travel from one neighbourhood to any other neighbourhood for the purpose of daily work—in other words, a full origin-destination matrix. Thus, it is one of the most comprehensive bases through which employment connectivity of each neighbourhood can be determined. Finally, the study puts together the two dimensions of residential mobility and employment connectivity to develop an indicator to assign each SA2 or neighbourhood with a score on the exclusion–porosity dimensions.

The methods developed in this study are applicable more generally to any international case where neighbourhood and metropolitan geographies are defined and small area JTW and migration data are available.

1.3.1 Data cleaning and processing

We worked with data from the 2011 and 2016 ABS censuses. The Australian census reports the number of people in income categories, by small areas (Statistical Areas Level 1, 2, 3, and 4, where 1 is smallest and 4 is largest). In this study we focus on the SA2 level, the smallest area definition for which the complete census data is available. The primary census variable in this study is total reported household income (HIND). Both income-category definitions and geographic definitions vary for each census period.

Income band computations

The number of income categories or bands is higher in the 2016 census (20 income bands) compared to the 2011 census (15 income bands). The ABS modelling of income bands considers any skewing of distributions towards the left or the right from census period to census period. Thus, the number of these bands varies from year to year because the ABS considers that income distributions change over time—which is when the overall distribution may become skewed to the right. To the best approximation possible—in the absence of actual microdata on income distributions—a reaggregation over these categories can be considered assuming a uniform distribution within each band, and is sufficient for the analysis presented here. Further, the number of income bands is very high, so it was not feasible to study each small band separately to extract meaningful insights.

Therefore, to compute our longitudinal measure, we redistributed the number of households into five uniformly defined income bands for both the 2011 and the 2016 census years, as shown in Table 2 and Table 3: very low, low, moderate, high and very high. These definitions are based on a comparison with the regional local median weekly income, and the terminology is consistent with the policy literature. For each city, the regional weekly median household income for the respective Greater Capital City Statistical Area (GCCSA) is extracted, and the lower and higher limits of each income band are computed using the percentage of median definitions.

Table 2: Income bands computed by city, 2011

City	GCCSA regional median income 2011	Bands	Definition (Percentage of the regional median income)	Low limit	High limit
Sydney	$1,447[1]	Very low	<50%	-	$724
		Low	50-80%	$725	$1,158
		Moderate	80-120%	$1,159	$1,736
		High	120-200%	$1,737	$2,894
		Very high	>200%	$2,895	-
Melbourne	$1,333[2]	Very low	<50%	-	$666
		Low	50-80%	$667	$1,066
		Moderate	80-120%	$1,067	$1,600
		High	120-200%	$1,601	$2,666
		Very high	>200%	$2,667	-
Brisbane	$1,388[3]	Very low	<50%	-	$694
		Low	50-80%	$695	$1,110
		Moderate	80-120%	$1,111	$1,666
		High	120-200%	$1,667	$2,776
		Very high	>200%	$2,777	-
Adelaide	$1,106[4]	Very low	<50%	-	$553
		Low	50-80%	$554	$885
		Moderate	80-120%	$886	$1,327
		High	120-200%	$1,328	$2,212
		Very high	>200%	$2,213	-
Perth	$1,459[5]	Very low	<50%	-	$730
		Low	50-80%	$731	$1,167
		Moderate	80-120%	$1,168	$1,751
		High	120-200%	$1,752	$2,918
		Very high	>200%	$2,919	-

Source: 2011 ABS Census QuickStats; see notes below. The Low and High limits have been computed by the authors.

Notes:

1: https://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2011/quickstat/1GSYD?opendocument&navpos=220

2: https://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2011/quickstat/2GMEL?opendocument&navpos=220

3: https://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2011/quickstat/3GBRI?opendocument&navpos=220

4: https://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2011/quickstat/4GADE?opendocument&navpos=220

5: https://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2011/quickstat/5GPER?opendocument&navpos=220

Table 3: Income bands computed by city, 2016

City	GCCSA regional median income 2016	Bands	Definition (Percentage of the regional median income)	Low limit	High limit
Sydney	$1,750[1]	Very low	<50%	-	$875
		Low	50-80%	$876	$1,400
		Moderate	80-120%	$1,401	$2,100
		High	120-200%	$2,101	$3,500
		Very high	>200%	$3,501	
Melbourne	$1,542[2]	Very low	<50%	-	$771
		Low	50-80%	$772	$1,234
		Moderate	80-120%	$1,235	$1,850
		High	120-200%	$1,851	$3,084
		Very high	>200%	$3,085	-
Brisbane	$1,562[3]	Very low	<50%	-	$781
		Low	50-80%	$782	$1,250
		Moderate	80-120%	$1,251	$1,874
		High	120-200%	$1,875	$3,124
		Very high	>200%	$3,125	-
Adelaide	$1,265[4]	Very low	<50%	-	$632
		Low	50-80%	$633	$1,012
		Moderate	80-120%	$1,013	$1,518
		High	120-200%	$1,519	$2,530
		Very high	>200%	$2,531	-
Perth	$1,643[5]	Very low	<50%	-	$822
		Low	50-80%	$823	$1,314
		Moderate	80-120%	$1,315	$1,972
		High	120-200%	$1,973	$3,286
		Very high	>200%	$3,287	-

Source: 2016 ABS Census QuickStats; see notes below. The Low and High limits have been computed by the authors.

Notes:

1: https://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/1GSYD?opendocument

2: https://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/2GMEL?opendocument

3: https://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/3GBRI?opendocument

4: https://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/4GADE?opendocument

5: https://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/5GPER?opendocument

In redistributing the number of people into five uniformly defined income bands, we count the number of households in the defined income categories in the individual census, then aggregate the numbers into the above five bands. When the band limits fall in the middle of an income category, we proportionally divide the number of people.

For example, for 2016 in Sydney, very-low-income households earn up to $875, but the relevant census income category is $800–$999. So we assume a uniform distribution of income earners in this category and compute a proportional amount (875 – 800) / (999 – 800) = 38 per cent of the people in this category into 'very low', and (999 – 875) / (999 – 800) = 62 per cent of the people in this category into the next band, 'low'. This is done for all five bands, and then the number of households in each band are added. The result is a redistribution of all 20 census income bands into five policy-relevant bands. This redistribution computation is done for each defined small area in the census—the SA2 level.

Finally, we also remove the very low population or zero population areas—these are the industrial areas, airports, parks, etc. This is done by adding up the total number of households in each SA2, arranging them in ascending order, and then removing all SA2s with very low or zero populations.

Geography computations

Like the income categories being different for the years 2011 and 2016, the geography of small areas also varies per census year. This again introduces a methodological complication since, to compute a longitudinal measure, the area definitions need to be consistent across the two census periods. The geography definitions of SA2 areas in the two census periods were different, as areas were merged, split, new areas were created, or existing areas had name changes. The ABS provides correspondence files that define how 2011 data can be projected on to 2016 geography definitions. The research has employed the use of these correspondence files to recompute the 2011 populations for each SA2 by the 2016 geography. That is, all the area definitions were standardised to the 2016 definitions, and the correspondence map was used to recompute the 2011 populations in each income band in accordance with the 2016 geography definitions, so that the computation on gains or losses could be performed. As a result of this re-computation, we obtain a standard defined set of areas with standardised population counts for both 2011 and 2016.

As mentioned earlier, an SA2 is a statistical area of roughly 10,000 people. SA2s have been specifically chosen as neighbourhoods for this study as they represent 'a community that interacts together socially and economically' (Australian Bureau of Statistics, 2023), and also because they are the smallest (finest) geographic level for which full and complete data on every census variable is available.

1.3.2 Measuring evidence of spatial segregation and spatial sorting

The first measure is a correlation study between all possible pairs of income bands, to study how the numbers of households in two bands co-vary with each other within each SA2. Given that x is the number of households in an income band j, in area i, and y is the number of households in income band k, $k \neq j$, then examine the linear model:

$$y_i = \alpha x_i + \epsilon,$$

where the value and sign of the slope α will reveal if there is spatial sorting. If α is high and positive, this means that there is a positive correlation between the number of households from income bands j and k in the neighbourhood: high numbers in j correspond to high numbers in k. If α is high and negative, this means that there is a negative correlation between the number of households in income bands j and k in the neighbourhood: high numbers in j correspond to low numbers in k. If there is spatial sorting by income, then the bigger the gap between two income bands—for example, very low and very high—the higher will be the strength of the negative α.

A more compact way of capturing and visualising the same relationships is via Pearson's correlation coefficients, which are symmetric between the pairs of variables studied, and capture the strength of the linear relationship between them.

The results of this analysis are presented in Section 2.2. Significant evidence for spatial sorting and segregation was found in all five cities.

1.3.3 Measuring evidence of longitudinal change by income bands: a measure of neighbourhood porosity

Based on observations from Section 1.3.2, we developed a new measure of ***neighbourhood porosity*** in order to measure the extent to which a neighbourhood offers a supply of diverse and affordable rental housing opportunities that allow lower-income earners ongoing entry over time. While a direct measure of rental opportunities is not considered directly, a proxy indicator is considered—the gain or loss of very-low-income, low-income, medium-income, high-income and very-high-income earners in a neighbourhood over the two census periods 2011 and 2016. This longitudinal measure then serves as an indicator for identifying entrenched exclusion or disadvantage—including poverty.

Gains and losses (with the differences represented by D) are computed per income band for every SA2, as follows:

1. $D_{VeryLow} = \frac{\#\ Very\ Low\ income\ housholds\ in\ 2016}{Total\ number\ of\ households\ in\ 2016} - \frac{\#\ Very\ Low\ income\ households\ in\ 2011}{Total\ number\ of\ households\ in\ 2011}$
2. $D_{Low} = \frac{\#\ Low\ income\ housholds\ in\ 2016}{Total\ number\ of\ households\ in\ 2016} - \frac{\#\ Low\ income\ households\ in\ 2011}{Total\ number\ of\ households\ in\ 2011}$
3. $D_{Moderate} = \frac{\#\ Moderate\ income\ housholds\ in\ 2016}{Total\ number\ of\ households\ in\ 2016} - \frac{\#\ Moderate\ income\ households\ in\ 2011}{Total\ number\ of\ households\ in\ 2011}$
4. $D_{High} = \frac{\#\ High\ income\ housholds\ in\ 2016}{Total\ number\ of\ households\ in\ 2016} - \frac{\#\ High\ income\ households\ in\ 2011}{Total\ number\ of\ households\ in\ 2011}$
5. $D_{Very\ High} = \frac{\#\ Very\ High\ income\ housholds\ in\ 2016}{Total\ number\ of\ households\ in\ 2016} - \frac{\#\ Very\ High\ income\ households\ in\ 2011}{Total\ number\ of\ households\ in\ 2011}$

Thus, the measure is based on the proportion of people in an income band in 2016 minus the proportion of people in that same income band in 2011. This gives us a basis for defining our measure of exclusion versus porosity. For example, there is evidence of exclusion if an area shows either:

- losses of very-low-income or low-income households, and gains of moderate-income, high-income or very-high-income band households
- no gains of very-low-income or low-income earners, but gains or no changes in moderate-income, high-income or very-high-income earners.

Conversely, a porous area will show no defined trend, but will show gains and losses across all income bands, without a definite pattern or trend in any specific direction.

The results of this analysis can be found in Section 2.3.

Overall, the neighbourhood porosity measure will capture changes with the assumption that entire neighbourhoods have not seen sudden declines or rise in the incomes of residents without them moving. In such a case, the measure will show a large change, but without capturing whether new people moved in or out. It is possible that a neighbourhood sees no new influx of people, but sees sudden changes in overall income patterns within a span of five years—but this is extremely unlikely. However, in the next stage of the research, actual movements of people between neighbourhoods are also captured in an exclusion–porosity measure using internal migration data.

1.3.4 Entropy calculations as spatial indicators of sorting and segregation

Shannon's information-based entropy measure examines the concentration versus spread characteristics of a probability distribution. The measure is defined as follows, adapted for the current use and notation for the purposes of this study:

$$H = -\sum_{i=1}^{n} p_i \ln p_i$$

where, n is the total number of neighbourhoods, H is the entropy measure, p_i is the proportion of very-low-income / low-income / medium-income / high-income / very-high-income earners in a particular SA2.

The interpretation of the entropy measure is as follows: If all the income in an income category was concentrated in a single area—that is, maximum concentration—then H would take its minimum value at 0. This indicates maximum segregation: all households of an income band are clustered in a single area in the city. Conversely, if all the households in a particular category were equally spread in all areas—that is, maximum inclusion—then H would take its maximum value at ln n. This indicates maximum inclusion, as all households of all incomes are equally mixed across each neighbourhood or area.

We decided to use the entropy measure because of its robust validity in assessing segregation across multiple groups, as required in this research. Massey and Denton (1988: 311) noted in their article 'The Dimensions of Residential Segregation', when comparing Shannon's entropy measure to other more widely used measures of segregation, such as the Dissimilarity Index D:

> There is one application where D might not be the best choice, however, and that is in computing a single measure of segregation across a variety of groups. D does not extend readily to the multi-group case. For example, if one wants to compare occupational segregation in different cities, separate values of D would have to be computed between all pairs of occupations and averaged to get a single measure. The entropy index, on the other hand, generalizes readily to the multi-group case, and can be decomposed into portions corresponding to different groups (Pielou 1972; White 1986).

Entropy calculations were separately performed for each of the five income bands—in other words, the number of households in each income band were counted and summed. Then, for each SA2, the number of households in that category were divided by the total number of households in that income category to compute p_i.

Section 2.4 presents the results of this analysis.

The analysis presented by the application of methods in subsections 1.3.2, 1.3.3 and 1.3.4 sheds light on research question 1:

- What is the extent of spatial sorting of disadvantaged/affluent neighbourhoods, and is there evidence of increasing, decreasing or constant levels of spatial sorting of deprived and affluent neighbourhoods in Australian cities over successive census periods?

1.3.5 Establishing neighbourhood functional typologies by residential mobility (internal migration) data

In this subsection, methods are developed to shed light on the first part of research question 2, which deals with internal migration:

- What types of disadvantaged neighbourhoods exist, and how can these be conceptualised by not simply locational in-place indicators, but by residential mobility flows of people in and out of these neighbourhoods, and the ways in which these neighbourhoods are connected in journey to work relationships with the larger city?

Internal migration data captures long-term, low-frequency flows of people, connecting their previous places of usual residence to their current places of usual residence. Such data provide an insight into how populations are moving within a particular city.

Five-year and one-year internal migration data was extracted at the SA2 level for the 2011 and 2016 census years for the five capital cities in this study.

Each SA2 is characterised by its SEIFA IRSD score. The SEIFA is the Socio-Economic Indexes for Areas series produced by the ABS based on census data and presents four indicators per area per census period:

1. IRSD: The Index of Relative Socio-Economic Disadvantage
2. IRSAD: The Index of Relative Socio-Economic Advantage and Disadvantage
3. IEO: The Index of Education and Occupation
4. IER: The Index of Economic Resources

In this study, each SA2 area's SEIFA IRSD score (Index of Relative Socio-economic Disadvantage) is extracted as a decile score. That is, each area is classified in 10 per cent deciles based on its SEIFA-IRSD score. Then the areas falling in each decile get a score from 1 to 10, with 1 being the most disadvantaged and 10 being the least disadvantaged.

We discovered that the results from using the one-year migration data do not significantly alter the insights, so we only reported the findings from the use of the five-year migration data. But testing the methods on both datasets helped to strengthen the reliability of the results.

While the analysis in the previous sections focussed on in-place or in-location analysis, migration data captures actual movement of people across the city, as network flows and interactions. These flows are tracked, counted, and then aggregated by SEIFA scores by calculating the following six numbers for each SA2:

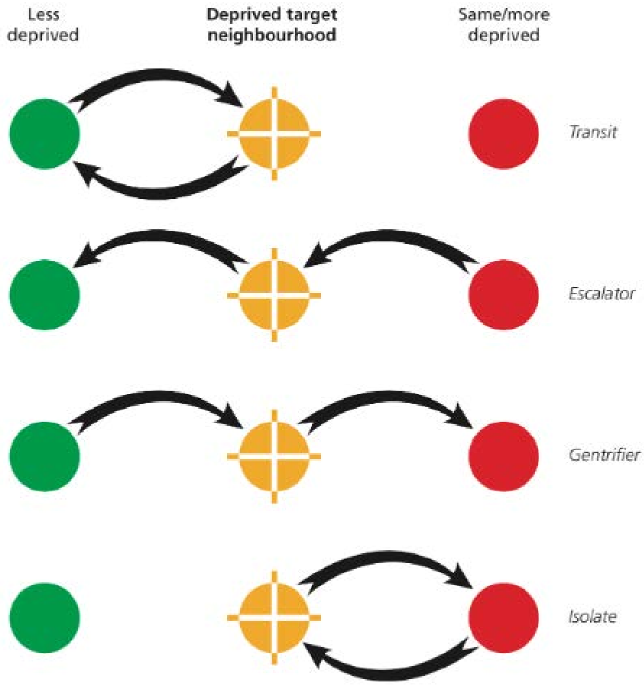
1. The number of in-movers from neighbourhoods with the same SEIFA score
2. The number of in-movers from neighbourhoods with a lower SEIFA score
3. The number of in-movers from neighbourhoods with a higher SEIFA score
4. The number of out-movers to neighbourhoods with the same SEIFA score
5. The number of out-movers to neighbourhoods with a lower SEIFA score
6. The number of out-movers to neighbourhoods with a higher SEIFA score.

The ***relaxed criteria*** for classifying SA2s into the different neighbourhood functional types, using the same nomenclature as the JRF study from Rae, Hamilton et al. (2016) and Robson, Lymperopoulou et al. (2009b) are outlined below. Note: the JRF study uses 'deprived' to mean 'disadvantaged':

- ***Escalator:*** In-movers come in from equally or more disadvantaged SA2s (those with the same or lower SEIFA score), and out-movers go to less disadvantaged SA2s (those with a higher SEIFA score).
- ***Gentrifier:*** In-movers come in from less disadvantaged SA2s (those with a higher SEIFA score), and out-movers go to equally or more disadvantaged SA2s (same or lower SEIFA score).
- ***Isolate:*** In-movers come in from equally or more disadvantaged SA2s (those with the same or lower SEIFA score), and out-movers go to equally or more disadvantaged SA2s (those with same or lower SEIFA score) .
- ***Transit:*** In-movers come in from less disadvantaged SA2s (those with a higher SEIFA score), and out-movers go to less disadvantaged SA2s (those with a higher SEIFA score).

These types have been adapted to the Australian context (Rae, Hamilton et al. 2016; Robson, Lymperopoulou et al. 2009b). Figure 1 provides a visual explanation for the four typologies, with arrows depicting the direction of the predominant residential flows.

Figure 1: Neighbourhood typology definitions



Source: A typology of deprived neighbourhoods. Adapted from Rae, Hamilton et al. (2016) and Robson, Lymperopoulou et al. (2009 a,b).
Note: Arrows depict the direction of the predominant residential flows.

It's worth noting that where the UK-based JRF report studied only 20 per cent of the most disadvantaged neighbourhoods, we have applied the criteria to all neighbourhoods across the whole city, for each of our analyses. This will have implications for our results, as we found that the behaviour of flows of people across the least-disadvantaged neighbourhoods—that is, SA2s that correlate strongly with the most affluent neighbourhoods—can critically affect how people are distributed across the whole city. Segregation can be driven equally by a disproportional concentration of highly advantaged areas just as much as it can be driven by a concentration of highly disadvantaged and isolated areas.

At the end of this analysis, we have a record of every SA2 classified into one of the four neighbourhood types.

1.3.6 Establishing neighbourhood functional typologies by employment connectivity data

In this section, methods are developed to shed light on the second part of research question 2, journey to work (JTW):

- What types of disadvantaged neighbourhoods exist, and how can these be conceptualised by not simply locational in-place indicators, but by residential mobility flows of people in and out of these neighbourhoods, and the ways in which these neighbourhoods are connected in journey to work relationships within the larger city?

JTW data captures daily high-frequency flows of people connecting their places of usual residence to their workplaces. This provides an insight into the daily patterns of people's movement within the city.

JTW data was extracted from the 2016 ABS Census at the SA2 level for all five cities. The principal employment centres (PECs) for each capital city were identified using the methods of computing centricities of areas outlined in Moylan and Sarkar (2019a) and Sarkar, Wu et al. (2019a). Then flows or counts of people travelling from every other SA2 to these identified centres was performed, and each SA2 was given a connection or disconnection score on a continuous spectrum, which was computed as the proportion of total number of workers residing in a particular SA2 who travel to the PEC.

These scores were then used to classify suburbs as 'Connected' or 'Disconnected' using a threshold parameter value. For example, setting the threshold parameter to t=0.25:

- if the proportion is high (t>0.25), the SA2 in focus is classified as Connected
- if the proportion is low (t<0.25), the SA2 in focus is classified as Disconnected.

Values of t=0.25,0.30,0.35 etc. are used to study the general spatial patterns of Connection and Disconnection that emerge across the city.

The definition for employment connectivity we use differs from that used in the JRF study. The JRF study definitions depend on indicators that are specific to the UK cities. For the Australian case, we defined our own framework, as previous studies showed that the UK definitions were not strictly applicable to the Australian case. For example, in the UK, travelling to work within five kilometres of usual residence is highly correlated to disconnected, isolated suburbs—in other words, deprived suburbs. In contrast, some of the least disadvantaged, and mostly affluent, Australian neighbourhoods are those which are closest to the PEC, and therefore, highly Connected. More deprived neighbourhoods that are Disconnected involve longer commutes to the PEC – this is the exact opposite in some sense to the UK definition.

It is also worth noting that our definition of Connected and Disconnected is characterised in terms of economic connectivity, which is reflected in the transport systems connectivity only indirectly or weakly. In Australia, the PEC concentrates the largest number of jobs in each major city, and therefore represents areas of high economic opportunity. Thus, an SA2 that is connected implies a large number of people from that SA2 are able to access these PEC opportunities, and the reverse for disconnected SA2s.

1.3.7 The final combined indicator for measuring neighbourhood exclusion versus neighbourhood porosity

In this subsection, we combine the functional neighbourhood typology with the employment connectivity typology, and perform a qualitative correlation analysis mapping the combinations. We then counted the number of SA2s in each combination, and graded them on a porosity scale with three types or categories: Exclusionary, Towards Exclusionary and Porous, as shown in Table 4. Different qualitative insights are then discussed for each city, based on the results.

Table 4: Cross-tabulating neighbourhood counts by functional neighbourhood type and employment connectivity type

Functional neighbourhood type	Employment connectivity type	
	Connected	Disconnected
Escalator	Porous	Towards Exclusionary
Gentrifier	Towards Exclusionary	Towards Exclusionary
Isolate	Exclusionary	Exclusionary
Transit	Porous	Towards Exclusionary

The basic logic used for classifying SA2s as Exclusionary, Porous or Towards Exclusionary is based on the movement into or out of that area.

A *Porous* area is one where there is movement from more deprived, same or less deprived areas into or out of that area, and the area is more or less connected. This is classified as a Porous area, since there appear to be no barriers to people of any specific economic band driving spatial clustering in these areas. By this definition, Escalator and Transit neighbourhoods that are Connected are clearly Porous.

An *Exclusionary area*, by contrast, can be either an Isolate neighbourhood dominated by extremely affluent and advantaged households, or dominated by poor and disadvantaged households. Both are Exclusionary areas, but they present radically different interpretations for policy:

- If an Isolate neighbourhood is affluent and Connected, it is Exclusionary: it presents barriers to entry for moderate-income or low-income earners, and therefore indirectly lowers their access to good and plentiful employment opportunities.
- If an Isolate neighbourhood is poor, disadvantaged and Disconnected, it is Exclusionary: it traps lower-income earners, and possibly creates barriers to entry for moderate-income and higher-income earners (for living there)—trapping them in spatially disadvantaged pockets and directly preventing their access to good and plentiful employment opportunities.
- The alternate combinations could also be true—for example, affluent neighbourhoods that are disconnected (which is not ideal, but ok, since a larger income correlates to larger choice of work opportunities in the PEC or elsewhere), or disadvantaged neighbourhoods that are well connected (which is good, as in the future there may be upwards social mobility possible). However, the number of these is minimal in the Australian context, and they do not represent an area of priority policy concern.

Finally, Escalator and Transit neighbourhoods that are Disconnected, and Gentrifier neighbourhoods—whether Connected or Disconnected—show a tendency for movement towards becoming Exclusionary.

1.4 Report structure

The following sections of this report present the key results.

- **Section 2** presents the findings on research question 1, tracking the state of spatial and longitudinal spatial segregation and sorting in the five study cities.
- **Section 3** present findings on research question 2, classifying neighbourhoods into residential mobility typologies.
- **Section 4** presents further findings on research question 2, classifying neighbourhoods into employment connectivity typologies.
- **Section 5** presents findings on research question 3, bringing together the two typology families to classify neighbourhoods by an exclusion–porosity measure.
- **Section 6** presents the conclusions.

2. The extents of spatial sorting and segregation

- **This section examines the extent of spatial sorting and segregation by income bands across the five largest Australian capital cities.**
- **Several different analytic measures are used to analyse how income bands are organised in space, how they change over time, and whether this change in time is leading towards more concentration of specific income bands.**
- **Findings show that segregation is well established and on the rise across all Australian cities studied in this analysis. Such segregation has arisen as an inevitable outcome of market forces playing out in the housing system, in the absence of policy intervention.**
- **The findings of this section establish that spatial segregation and sorting—and consequent economic disadvantage and exclusion—will continue to occur in Australian cities unless there is policy intervention to deliver more affordable homes in jobs-rich locations, and to connect disadvantaged areas to economic opportunities.**

2.1 Studying spatial sorting and segregation

A classic and widely accepted model of spatial sorting and segregation was proposed in 1969 by Thomas Schelling (Schelling 1969; 1978). In Schelling's model, a grid of locations is drawn, and each box can be chosen by one of two classes of people—say, 'red' and 'black', as depicted in Figure 2.

Figure 2(a) shows a starting position where, in an integrated system, neighbours of both colours are balanced—a red star has exactly four other red stars and four black dots as neighbours, and vice versa for the black dots. In a system where each person does not mind having dissimilar neighbours provided they have an equal number of similar neighbours, this is a perfectly integrated system. The neighbourhood is at an equilibrium. Everyone is satisfied with their home and neighbourhood, and no one has any incentive to move.

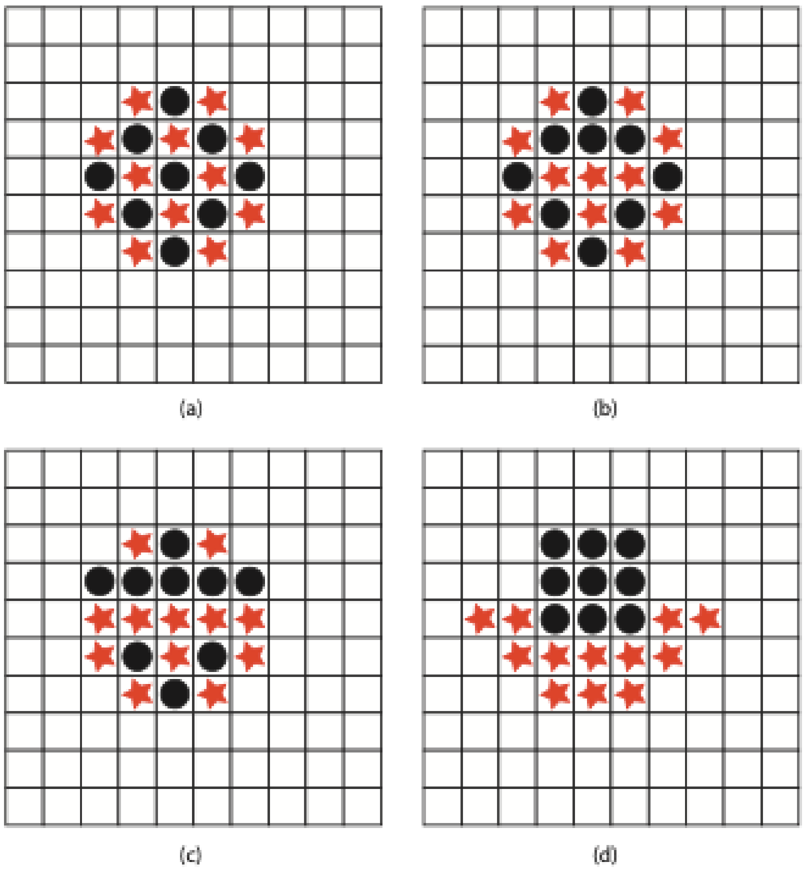
However, Schelling demonstrated that this is actually an *unstable* equilibrium. He observed that if only one pair of neighbours has a slightly higher preference for a slightly greater number of neighbours to be similar than dissimilar, then even a single local change can cascade into a series of local swaps—and very soon the system completely reorganises into clusters. As each local swap occurs, more people become dissatisfied with the new conditions, and are forced to swap to ensure that they have at least an equal number of similar and dissimilar neighbours. Soon the whole system cascades through intermediate 'swap' stages—depicted in Figure 2(b) and Figure 2(c)—and finally ends up with an entirely segregated and spatially sorted pattern—depicted in Figure 2(d)—which becomes a stable *equilibrium* that is then hard to change. The critical thing to note here is that just a single swap, shown in Figure 2(b), based on a slightly higher preference for similar neighbours causes this global spatial signature change through entirely local sets of preferences being expressed individually.

Schelling's model led to an explosion of research in the urban, economic and geographic sciences. Critically, it showed that clustering, segregation and spatial sorting can arise as an entirely self-organised phenomenon out of even a small local preference for similarity by local residents in an area, expressed as housing or location preferences. Such preferences could be based along the lines of either:

- race, ethnic or linguistic groupings—which is more common in the USA (Massey and Denton, 1986, Owens and Candipan, 2019, Candipan, 2019)
- economic classes—which our research finds is more common in Australia. This finding is supported by previous research findings—for example, Randolph (2020).

Unless direct policy intervention occurs, segregation is inevitable.

Figure 2: Demonstration of Schelling's model



Source: Authors, adapted from Krugman (1996) and Schelling (1978).

Notes: The figure above illustrates Schelling's model. It shows the successive stages of how an integrated system can move towards segregation. In part (a), the system is completely integrated. In part (b) a single red-black pair in the middle switch positions, triggering a series of swtiches, snapshots shown in parts (c) and (d), till the final state of the system in part (d) shows a completely segregated spatial outcome.

This section examines evidence for spatial sorting and segregation across Australia's five largest capital cities, based on income bands. As described in subsections 1.3.2, 1.3.3 and 1.3.4, it explores the following three questions, respectively:

1. Is there evidence of static signatures of spatial segregation in Australian cities: do people from similar income classes cluster together in space, such that closer income bands are positively correlated, while income classes farther apart are progressively negatively correlated in terms of spatial organisation?
2. What do longitudinal patterns show? How do neighbourhoods change between census periods in terms of the proportions of different income classes constituting the total population in a neighbourhood?
3. How can the longitudinal measures be characterised with an overall summary measure that reliably shows whether segregation is increasing or decreasing?

The longitudinal measure used here is Shannon's entropy measure, which is widely accepted in urban science as a useful measure for studying spatial concentration and aggregation patterns and their changes (Batty 1976).

2.2 Income-band correlation studies: spatial trends

Correlations between all possible pairs of the five income bands in the five capital cities are examined in the sections that follow. The five income bands are: very-low income, low income, moderate income, high income and very-high income.

As outlined earlier, pairwise correlations are computed between the proportions of the numbers of households in terms of their total household weekly incomes—based on the census variable HIND—in the five income bands in each SA2 in each city. As these are all measured at the SA2 level, the spatial trend of segregation—if any exists—is clearly captured in the correlations.

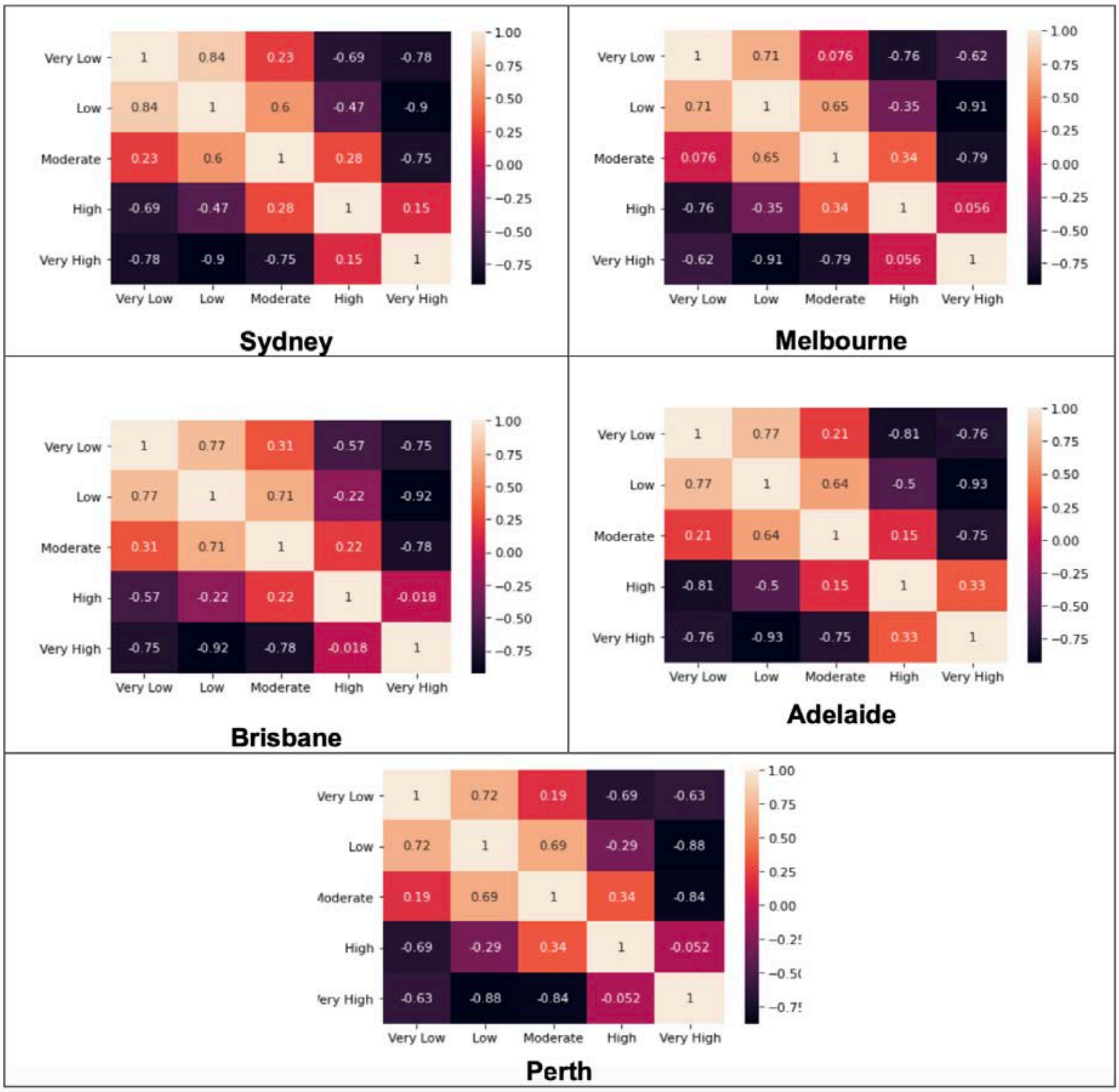
Figure 3 shows heatmaps of the Pearson's correlation coefficient for each pair of income bands across the five cities. The data show that the same trend for spatial segregation is observed in each city. Similar income bands stay close to each other, which is shown in the positive correlation, while a negative correlation is observed the farther the income bands are from each other.

For example, the very-low-income and low-income households show highly positive correlations, while very-low-income and very-high-income households show highly negative correlations. This general pattern shows that very-low-income and low-income households are extremely spatially segregated from high-income and very-high-income households—that is, they live in different parts of each city. Importantly, this relationship holds for all five cities, regardless of size.

However, moderate-income households mix well with all income bands apart from the very-high-income band. Thus, the general trend is that spatial inequalities are primarily driven by extreme clustering of very-high-income households—but there is also evidence of general segregation by income band overall.

Note: in each city, the respective aggregation of households in the five income bands is driven by the local capital city median household weekly income—which is measured using the census variable HIND for the Greater Capital City Statistical Area (GCCSA). Thus the trends observed are relatively defined sensitive to the local regional context, rather than being an absolutely defined measure of very-high incomes to very-low incomes. So it is even more striking that the same segregation pattern is observed across each city.

Figure 3: Heat maps of pairwise correlations between income bands



Source: Authors, based on 2016 ABS Census data.

Figure 4 shows an example for Sydney, where the correlations between very-low-income households and all other households are plotted as scatterplots. Each dot is one SA2, and its relative position is plotted according to the proportion of the number of households in each income band on the x- and y-axes. This clearly shows:

- a strong positive correlation between very-low-income and low-income households
- a relatively positive correlation between very-low-income and moderate-income households
- a negative and strongly negative correlation between very-low income and high-income households, and also between very-low income and very-high income households.

This means that neighbourhoods with high proportions of very-low-income earners also have:

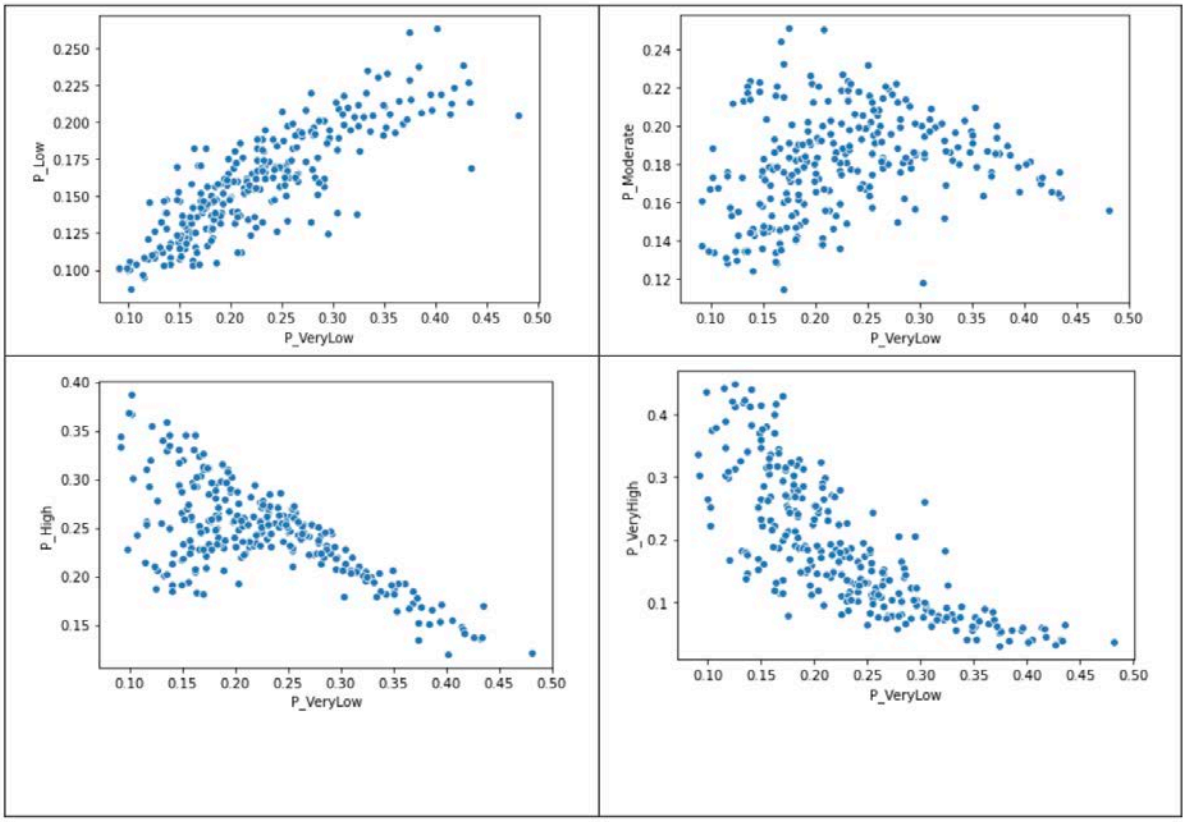
- higher proportions of low-income or moderate-income earners, but
- very low proportions of high-income or very-high-income earners.

Neighbourhoods with low proportions of very-low-income earners also have:

- lower proportions of low-income and moderate-income earners, but
- very high proportions of high-income or very-high-income earners.

The same pattern is echoed if correlations are studied between all possible pairs, as demonstrated in Figure 3. And although Sydney has been used to illustrate the correlation scatterplot in Figure 4, the scatterplots for all five cities show similar patterns.

Figure 4: Correlation scatterplot between very-low-income households and all other income bands, Sydney



Source: Authors, based on 2016 ABS Census data.

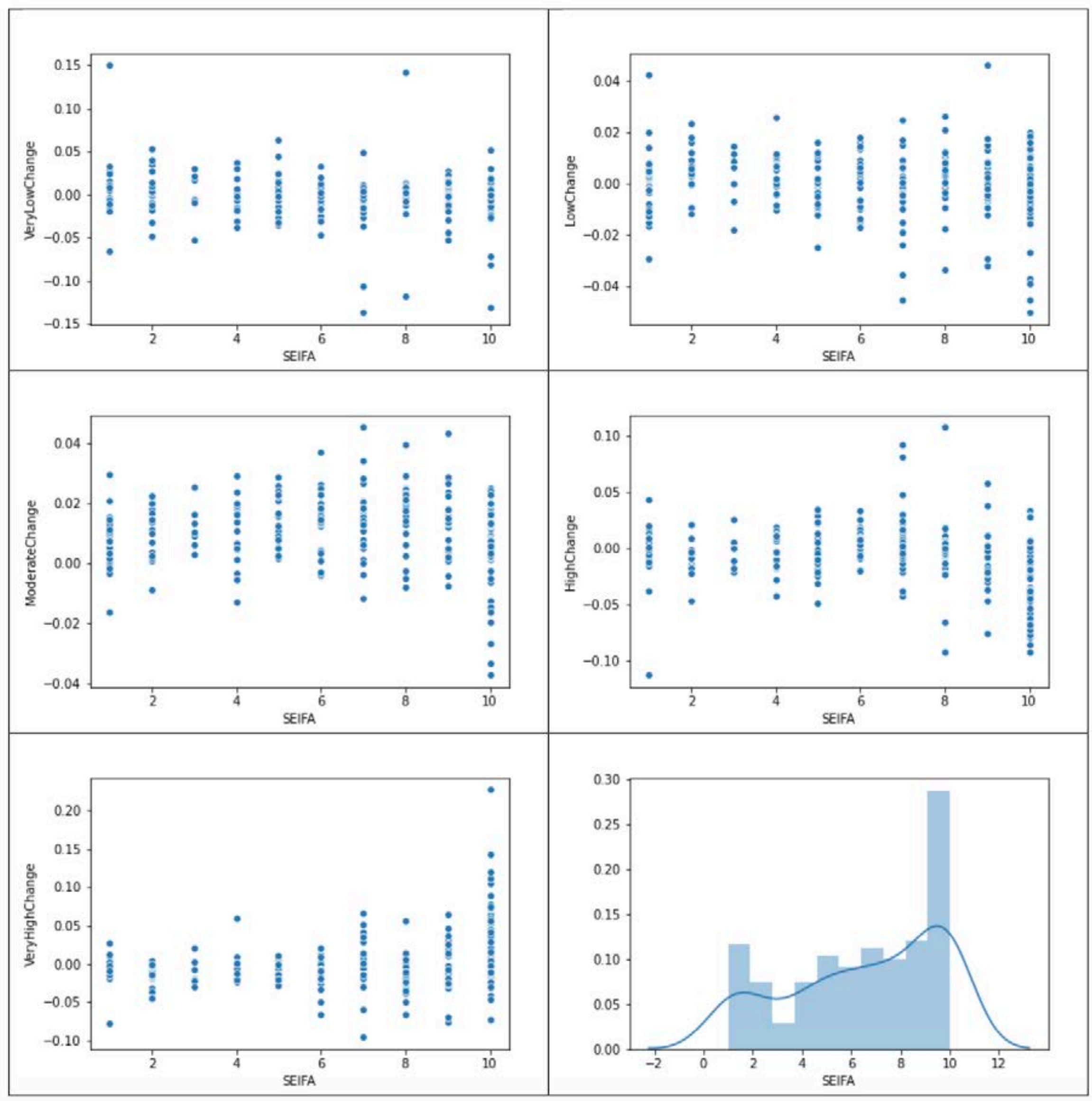
2.3 Income-band correlation studies: longitudinal trends

Where Section 2.2 presented the spatial static patterns of segregation for the 2016 ABS Census data, this section looks at the longitudinal trends of segregation as measured by the degree of transition between the 2011 and 2016 censuses. As discussed in subsection 1.3.3, the difference between the proportion of households in an income band per SA2 in 2016 and the proportion of households in an income band per SA2 in 2011 is examined.

Thus, we have a measure of the gains or losses of the number of households measured in an income category for each SA2. These results indirectly and partially capture the movements of households in and out of SA2s by their income band, provided we assume that between 2011 and 2016 entire populations in SA2s did not suddenly and simultaneously change income bands (assumption known as 'general stationarity').

Figure 5–Figure 9 show the results for the five largest capital cities. Each dot in a figure represents an SA2. The gains or losses per SA2 are then plotted against the SEIFA IRSD scores. This helps to uncover the movements of gains and losses by levels of neighbourhood deprivation. The histogram in the final cell of each artwork figure shows the proportion of households in each SEIFA decile, from 1 to 10.

Figure 5: Longitudinal change (gains or losses) of households per SA2 by income band, compared against SEIFA IRSD levels, Sydney



Source: Authors, based on 2016 ABS Census data.

Note: The histogram in the final cell shows the proportion of households in each SEIFA decile, from 1 to 10.

Key findings for Sydney

The key findings for Sydney are as follows.

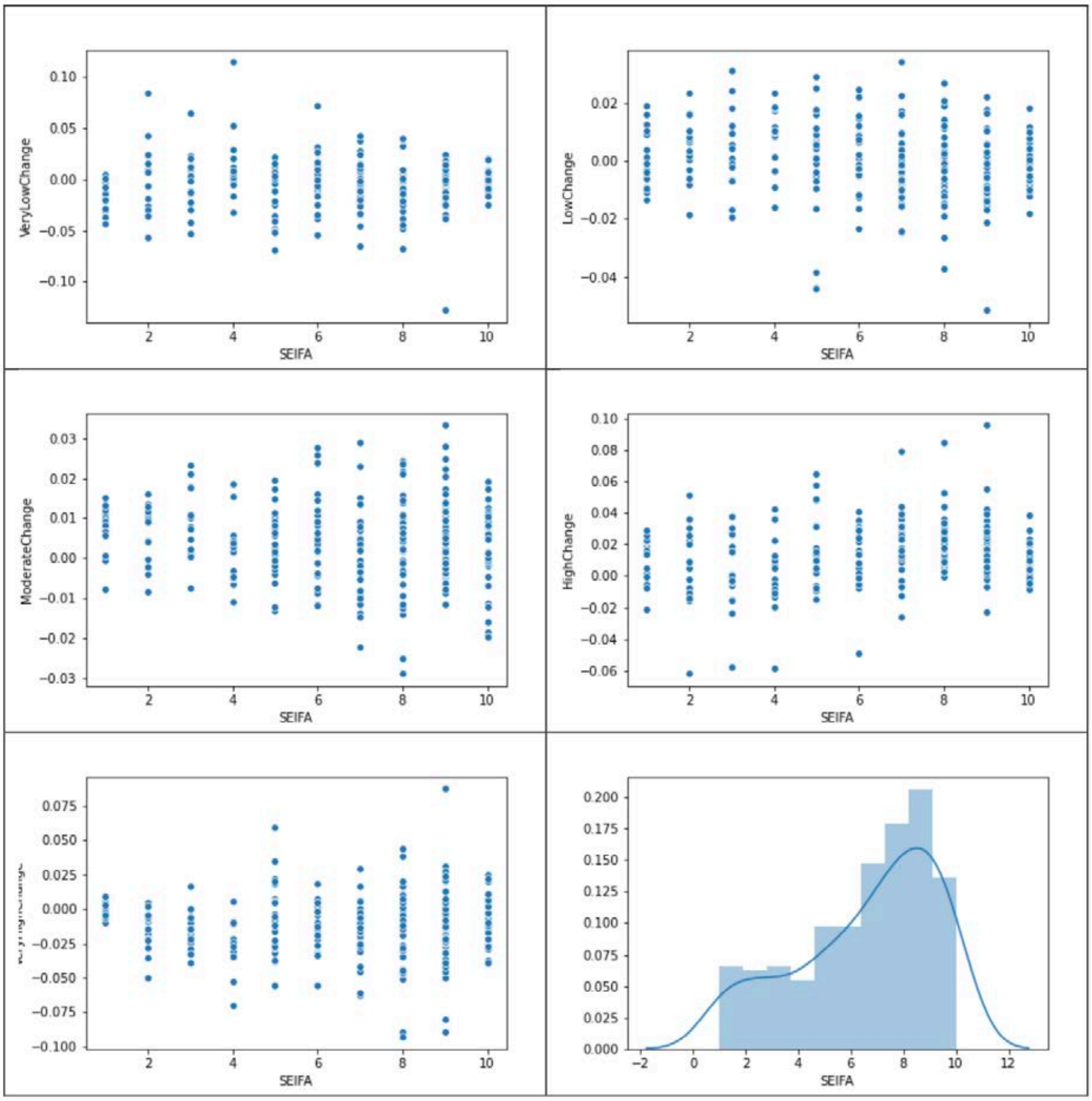
Very-high-income households show the most pronounced gains in the highest SEIFA-decile areas—which is decile 10 or 'least disadvantaged'. High-income households also show some gains in the higher SEIFA decile areas, which are deciles 7–9. This drives spatial segregation at the higher end, as the least-disadvantaged areas—that is, the most advantaged—agglomerate the very-high-income and high-income households. The lack of lower-income households entering these areas is an indicator of their 'exclusion'—in other words, housing-market barriers are reinforcing social stratification.

Both moderate and high-income households show losses in the highest SEIFA-decile areas—which is decile 10 or 'least disadvantaged'. But they show more gains and losses in areas in deciles 7–9, which are the higher SEIFA deciles. This is evidence that these areas could be gentrifying.

Very-low-income households show little change overall, with small gains and losses across most areas, and a few exceptions as outliers. But very-low-income and low-income households show a trend of more losses than gains across all of the higher SEIFA-decile areas for deciles 7–10.

Of the five cities in this study, Sydney shows significant and pronounced trends towards increasing spatial inequality and segregation. This is driven by the clustering of very-high-income households in the least-disadvantaged areas—that is correlated with the most advantaged areas —rather than by the clustering of very-low-income or low-income households. This segregation is compounded by Sydney having a very high count of SEIFA decile 10 SA2s—which means that a large part of the city is 'least disadvantaged' but is closed to lower-income households.

A peculiar paradoxical condition is that if a city agglomerates very high-income households, pushing out low income households, then any inequality measurement will not show high degrees of inequality – in essence, there



are no poor people left to count, so inequality is low.

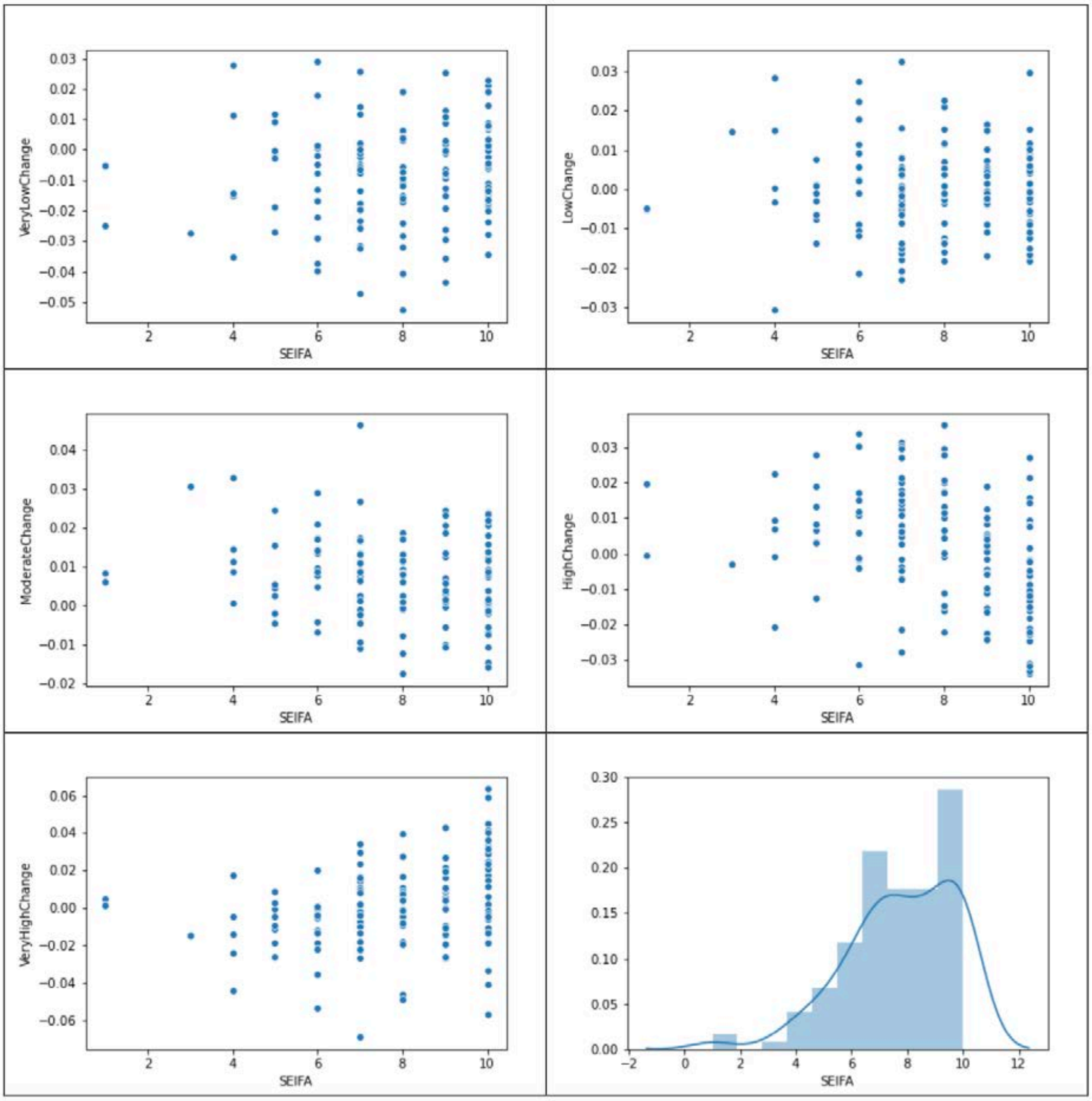
Figure 6: Longitudinal change (gains or losses) of households per SA2 by income band, compared against SEIFA IRSD levels, Melbourne

Source: Authors, based on 2016 ABS Census data.

Note: The histogram in the final cell shows the proportion of households in each SEIFA decile, from 1 to 10.

Key findings for Melbourne

Melbourne emerges as a much more equitable city than Sydney under this analytical framework. Melbourne showed similar movements of gains and losses for all the income bands, balanced around an overall average of 0. This result implies that small movements of gains and losses across all income bands occur regardless of the level of neighbourhood disadvantage or income. Thus, compared to Sydney, Melbourne appears to be the more 'porous' city.



Despite this porosity, the trend of high-income and very-high-income households gaining in the higher SEIFA-decile areas (deciles 7–9) and the highest decile (10) areas is also somewhat observed. In Melbourne's case, the segregation effects are not as strong as in Sydney—but there is still some evidence of segregation occurring at the higher ends of the market, rather than at the lower ends.

Figure 7: Longitudinal change (gains or losses) of households per SA2 by income band, compared against SEIFA IRSD levels, Brisbane

Source: Authors, based on 2016 ABS Census data.

Note: The histogram in the final cell shows the proportion of households in each SEIFA decile, from 1 to 10.

Key findings for Brisbane

Brisbane has relatively fewer households with lower SEIFA scores and progressively larger numbers of households with higher SEIFA scores—as shown in the histogram in the final cell of Figure 7. The scatterplots echo this, as hardly any gains or losses are observed in the lower SEIFA scores. In the higher SEIFA scores, movements of gains or losses across all income categories appears well balanced around the 0 mark, although a slight trend of more losses than gains is observed for the moderate-income and high-income households.

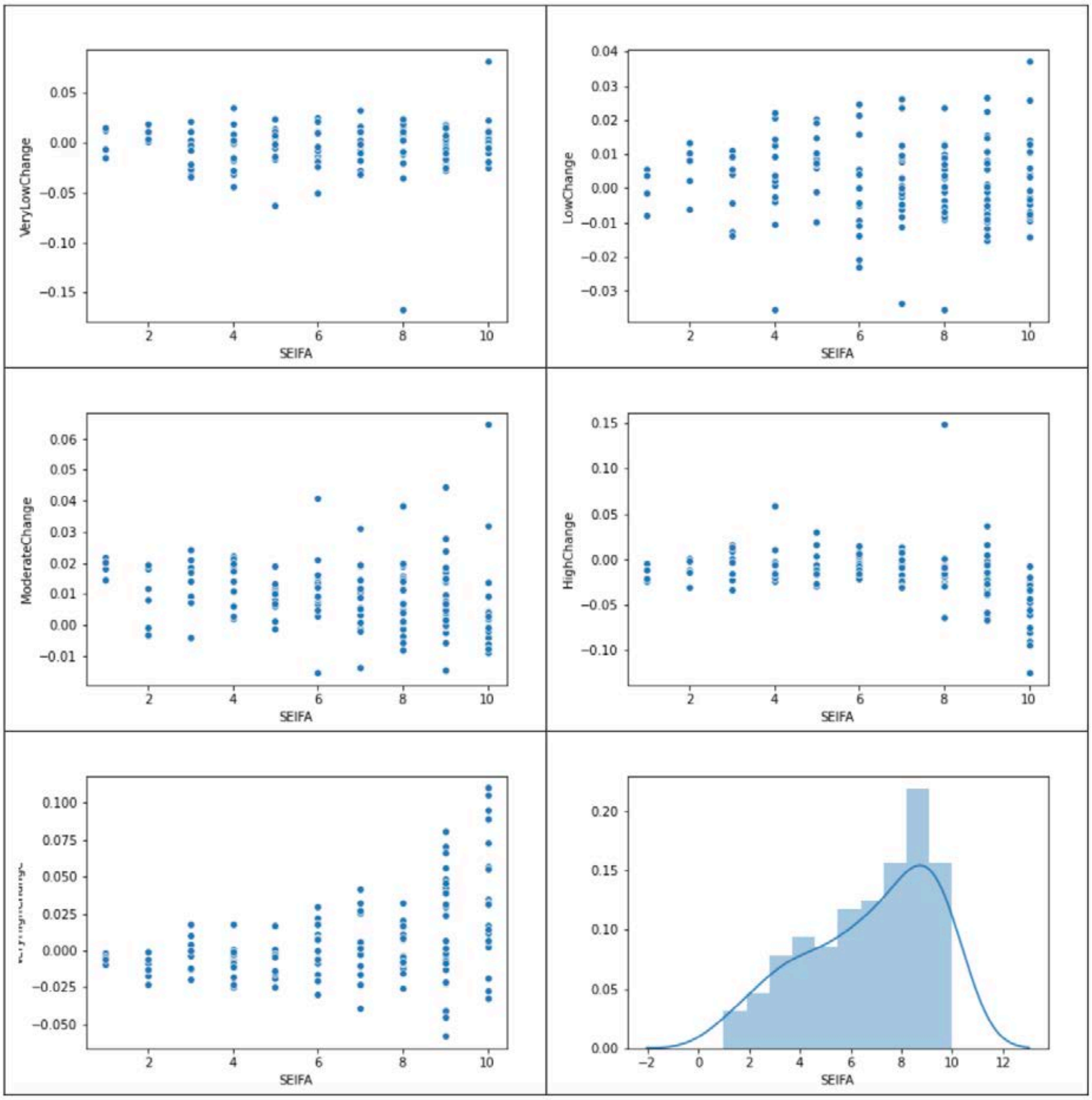


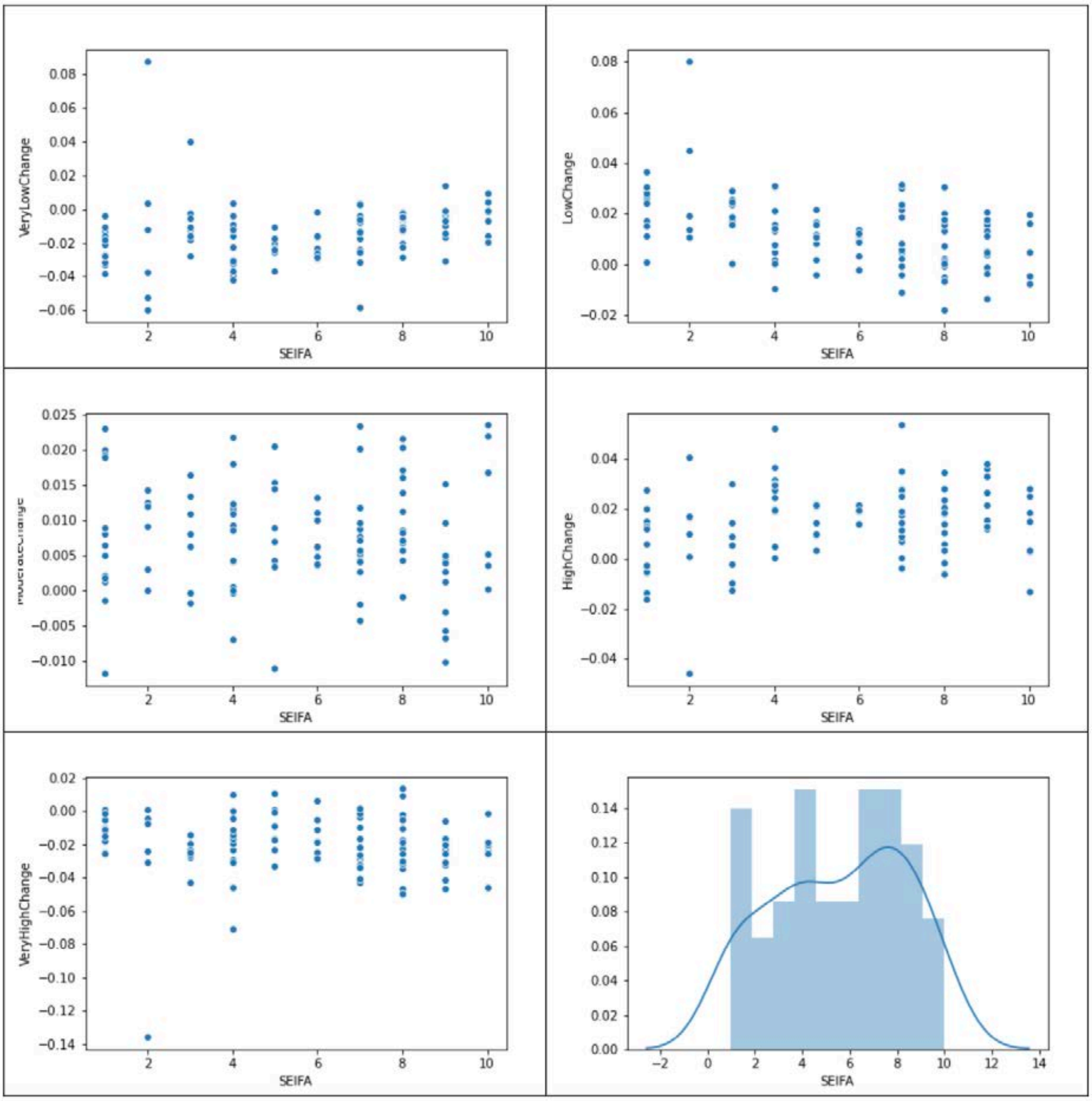
Figure 8: Longitudinal change (gains or losses) of households per SA2 by income band, compared against SEIFA IRSD levels, Perth

Source: Authors, based on 2016 ABS Census data.

Note: The histogram in the final cell shows the proportion of households in each SEIFA decile, from 1 to 10.

Key findings for Perth

Perth has a gradually rising count of SA2s in relatively higher SEIFA-decile areas. A pronounced trend of gains in very-high-income households is observed in deciles 9 and 10, which are the two least-disadvantaged SEIFA decile scores—in other words, the most advantaged neighbourhoods. This trend is accompanied by a pronounced



loss of high-income households in the same neighbourhoods. Further, some low gains are observed across the moderate-income and low-income households into the higher SEIFA decile areas.

Figure 9: Longitudinal change (gains or losses) of households per SA2 by income category, compared against SEIFA IRSD levels, Adelaide

Source: Authors, based on 2016 ABS Census data.

Note: The histogram in the final cell shows the proportion of households in each SEIFA decile, from 1 to 10.

Key findings for Adelaide

Adelaide has a relatively balanced count of SA2s in almost all SEIFA deciles. The key differences are the higher proportion of SA2s in deciles 1 and 3 compared to Brisbane or Perth, and the lower number of SA2s in decile 10 compared to the much higher number in deciles 7, 8 and 9. Most income bands show very little change or movement, but there is some evidence that high-income households have made gains in some of the lower decile 4 areas, and also in areas with the higher scores of deciles 7–9.

2.4 Income-band correlation studies: entropy measures

While the longitudinal gains and losses of the five income bands in an SA2 over two census periods show general trends of how spatial concentration has increased or decreased, characterising this through an entropy measure provides a summary statistic: it brings out evidence, via a single number, whether spatial concentration is increasing or decreasing over time.

As explained in subsection 1.3.4, Shannon's entropy measure captures the degree of spatial concentration of a single income band across SA2s, and can be compared against the most 'equitable' distribution condition. If every SA2 had exactly the same proportion of households from an income band, the entropy statistic would take its maximum possible value at $\ln N$, where N is the total number of SA2s in a city. If the actual entropy value is compared against this maximum value, the degree of concentration can be summarised through a single number. Measuring the trend on this value between 2011 and 2016 can then show the percentage change of spatial concentration, and whether it is increasing or decreasing.

Table 5 - Table 10show the entropy calculations for the five capital cities in this study. As the total number of SA2s changed between the 2011 and 2016 censuses, the maximum value of entropy also changed. Thus, the deviation from the maximum values was calculated per census year. Then the percentage change of these deviations was calculated to reveal the proportion of change of concentration that occurred in each income band.

The results clearly show that the very-high-income band shows a positive percentage change across all five cities. Between 2011 and 2016, the spatial concentration of very-high-income households has shown increased segregation. Results are particularly stark for Sydney, where the spatial concentration for all households has increased—but the higher the income, the higher the trend towards segregation. Melbourne emerged as much more equitable, showing positive increases of concentration only in very-high-income households, whereas all other categories showed a slight negative trend. Perth echoes Sydney, but weakly—showing increases of spatial concentration in moderate-income, high-income and very-high-income households. Brisbane and Adelaide are the most stable cities in this study, although the general trend towards segregation observed in Sydney, Melbourne and Perth is maintained.

Table 5: Entropy calculations, Sydney

	Very Low	Low	Moderate	High	Very High
H_2011	5.336232	5.366508	5.378497	5.371150	5.260287
H_max_2011	5.459586	5.459586	5.459586	5.459586	5.459586
Distance from maximum (2011)	0.123353	0.093077	0.081089	0.088435	0.199299
H_2016	5.458920	5.485767	5.486266	5.479338	5.316185
H_max_2016	5.587249	5.587249	5.587249	5.587249	5.587249
Distance from maximum (2016)	0.128329	0.101482	0.100982	0.107911	0.271064
Percentage change (2011 to 2016)	4.033384	9.029885	24.532944	22.022727	36.008851

Source: Authors, using 2011 and 2016 ABS Census data.

Table 6: Entropy calculations, Melbourne

	Very Low	Low	Moderate	High	Very High
H_2011	5.401965	5.429210	5.435013	5.437158	5.352962
H_max_2011	5.552960	5.552960	5.552960	5.552960	5.552960
Distance from maximum (2011)	0.150995	0.123749	0.117947	0.115802	0.199997
H_2016	5.512101	5.540974	5.548890	5.556940	5.434242
H_max_2016	5.655992	5.655992	5.655992	5.655992	5.655992
Distance from maximum (2016)	0.143891	0.115018	0.107102	0.099051	0.221750
Percentage change (2011 to 2016)	-4.704987	-7.055534	-9.194853	-14.464956	10.876392

Source: Authors, using 2011 and 2016 ABS Census data.

Table 7: Entropy calculations, Brisbane

	Very Low	Low	Moderate	High	Very High
H_2011	4.742508	4.772400	4.777620	4.790922	4.777947
H_max_2011	4.882802	4.882802	4.882802	4.882802	4.882802
Distance from maximum (2011)	0.140294	0.110402	0.105182	0.091880	0.104855
H_2016	4.743941	4.766879	4.779942	4.790517	4.775037
H_max_2016	4.882802	4.882802	4.882802	4.882802	4.882802
Distance from maximum (2016)	0.138861	0.115923	0.102860	0.092285	0.107765
Percentage change (2011 to 2016)	-1.021618	5.001318	-2.208169	0.440583	2.774942

Source: Authors, using 2011 and 2016 ABS Census data.

Table 8: Entropy calculations, Perth

	Very Low	Low	Moderate	High	Very High
H_2011	4.765403	4.809047	4.820885	4.830508	4.783364
H_max_2011	4.955827	4.955827	4.955827	4.955827	4.955827
Distance from maximum (2011)	0.190424	0.146780	0.134942	0.125319	0.172463
H_2016	4.794701	4.819224	4.817996	4.820137	4.768099
H_max_2016	4.955827	4.955827	4.955827	4.955827	4.955827
Distance from maximum (2016)	0.161126	0.136603	0.137831	0.135690	0.187728
Percentage change (2011 to 2016)	-15.385510	-6.933271	2.141005	8.276042	8.850821

Source: Authors, using 2011 and 2016 ABS Census data.

Table 9: Entropy calculations, Adelaide

	Very Low	Low	Moderate	High	Very High
H_2011	4.456447	4.501244	4.520351	4.530822	4.466917
H_max_2011	4.624973	4.624973	4.624973	4.624973	4.624973
Distance from maximum (2011)	0.168526	0.123728	0.104622	0.094151	0.158056
H_2016	4.472659	4.509166	4.528675	4.535347	4.467105
H_max_2016	4.634729	4.634729	4.634729	4.634729	4.634729
Distance from maximum (2016)	0.162070	0.125563	0.106054	0.099382	0.167624
Percentage change (2011 to 2016)	-3.830860	1.482396	1.368928	5.556187	6.053780

Source: Authors, using 2011 and 2016 ABS Census data.

2.5 Policy development implications

This section examined the static and longitudinal trends of spatial segregation by income bands in five Australian cities: Sydney, Melbourne, Brisbane, Perth and Adelaide. We then employed an entropy measure as a summary statistic to characterise this trend.

The key result is that spatial concentration is significant and is either maintained or increasing in these cities. Sydney emerges as the worst performer, with very pronounced trends of segregation by income band. Moreover, this trend is driven by the upper end of the market, with high-income and very-high-income households clustering in space and therefore implicitly creating barriers to entry into specific parts of the city for other lower-income bands.

The policy implication from this finding is that policies that encourage a healthy spatial mix of housing and tenure types should be encouraged for each neighbourhood or local government area, but especially in affluent neighbourhoods—which, in the typical Australian case, are in close proximity to the richest employment and social opportunities. If lower-income residents face barriers to entry into more affluent neighbourhoods that are also well connected to other social and economic opportunities, the trend towards increasing segregation and spatial clustering is likely to increase. This will result in increasingly more pronounced losses of living and working opportunities for people from lower-income bands.

3. Neighbourhood typologies by residential mobility

- **Section 3 examines internal migration data and SEIFA (Socio-Economic Indices for Areas) data in tandem to classify SA2 neighbourhoods into four major functional types: Escalator, Transit, Gentrifier and Isolate.**
- **This functional typology classification for neighbourhoods has been adapted and extended from an earlier research report by the Joseph Rowntree Foundation (JRF) (Robson, Lymperopoulou, et al., 2008, 2009a, 2009b). But where the JRF report focussed only on classifying the lowest 20 per cent—or most disadvantaged—neighbourhoods in the UK, this section uses the definitions to classify every neighbourhood, spreading the analysis over all income bands.**
- **The results show that the least-disadvantaged neighbourhoods—that is, those with higher SEIFA decile scores—drive segregation and isolation much more than disadvantaged neighbourhoods do.**
- **The findings of this section provide evidence that established exclusion is more dominant as a spatial signature than gentrification. In essence, displacement of lower-income households and the movement of higher-income households into neighbourhoods can cannot be measured simply, because exclusion is already firmly entrenched.**

Current literature describes disadvantaged neighbourhoods as often facing a double disadvantage: they are concentrated in low-income households and cut off from principal employment opportunities. This results in deprived and disadvantaged neighbourhoods that act like traps. Such isolated pockets present barriers to upward social mobility, as higher-income households do not typically move into disadvantaged neighbourhoods, while low-income households remain trapped, unable to move out (Robson, Lymperopoulou et al. 2008; 2009a; 2009b).

As noted earlier, the JRF studies used the term ‘deprived’ to mean ‘disadvantaged’. The JRF studies classified the 20 per cent most deprived neighbourhoods in the UK by measuring movements of people into and out of these areas, and whether they were coming from or going to neighbourhoods with a higher or lower level of affluence.

However, as shown by the results in Section 2, spatial segregation in Australia appears to be driven more by the higher, more affluent and advantaged parts of the housing market and the city, rather than by the lower end.

Therefore, this section has adapted the JRF functional neighbourhood typology definitions for the Australian context. Instead of using the UK measure of deprivation, the ABS SEIFA series was used to characterise advantaged and disadvantaged neighbourhoods. Further, internal migration data from the 2011 and 2016 censuses were then used to study movements into and out of all SA2 neighbourhoods, and whether those movements were into or from lower or higher SEIFA decile neighbourhoods. In essence, we extended the JRF typology to include all neighbourhood types, and looked at the entire spectrum of internal migration between the 2011 and 2016 censuses for the five capital cities in the study.

Each SA2 neighbourhood was then characterised as one of four neighbourhood types: Escalator, Transit, Gentrifier or Isolate. The methods were described in detail in subsection 1.3.5 and the detailed results and analysis are presented in Section 3.1.

3.1 Neighbourhood typologies classification scheme

This section addresses the first part of research question 2:

- What types of disadvantaged neighbourhoods exist, and how can these be conceptualised by not simply locational in-place indicators, but by residential mobility flows of people in and out of these neighbourhoods?

We began by conceptualising neighbourhood typologies based on long-term residential mobility flows. This study tracked residential mobility at the SA2 level for the five largest Australian capital cities—Sydney, Melbourne, Brisbane, Perth and Adelaide—using five-year internal migration data from the 2011 and 2016 censuses to capture the physical movement of people between neighbourhoods in a city.

The analysis in Section 2 revealed that the SEIFA Index of Relative Socio-economic Disadvantage (IRSD) measure is the best index for describing the state of disadvantage by neighbourhood. Neighbourhoods were classified based on their relative disadvantage, which was measured by scoring the areas falling in each decile of the SEIFA IRSD score from 1 to 10, with:

- a score of 1 being the most disadvantaged
- a score of 10 being the least disadvantaged.

While "least disadvantaged" does not naturally translate to "most advantaged", there is a clear and positive correlation between highly advantaged and least disadvantaged.

By tracking internal migration data and aggregating by SEIFA scores, neighbourhoods were classified into four neighbourhood functional types. These types were adapted from the JRF study, and applied to every neighbourhood in each city:

- **Escalator:** In-movers come from SA2s with the same or lower SEIFA scores, and out-movers go to SA2s with higher SEIFA scores.
- **Gentrifier:** In-movers come from SA2s with higher SEIFA scores, and out-movers go to SA2s with the same or lower SEIFA scores.
- **Isolate:** In-movers come from SA2s with the same or lower SEIFA scores, and out-movers go to SA2s with the same or lower SEIFA scores.
- **Transit:** In-movers come from SA2s with higher SEIFA scores, and out-movers go to SA2s with higher SEIFA scores .

In general:

- Escalator neighbourhoods signify upward social mobility.
- Transit neighbourhoods show maintained but not deteriorating mobility.
- Gentrifier neighbourhoods show gentrification effects.
- Isolate neighbourhoods show established exclusion effects.

In order to classify each neighbourhood into one of the four types, the relaxed definitions from the JRF study were used, as listed in Table 5:

Table 10: Description of terms for computing neighbourhood typologies

Key	Description
IS	In-movers from SA2s with same SEIFA IRSD scores
IB	In-movers from SA2s with higher SEIFA IRSD scores
IW	In-movers from SA2s with lower SEIFA IRSD scores
OS	Out-movers to SA2s with same SEIFA IRSD scores
OB	Out-movers to SA2s with higher SEIFA IRSD scores
OW	Out-movers to SA2s with lower SEIFA IRSD scores

Source: JRF Relaxed Neighbourhood Typologies, JRF Report (Rae et. al, 2016).
Note: S: Same, B: Better, W: Worse.

Table 11: Description of relaxed definitions from the JRF study to compute neighbourhood typologies

Neighbourhood functional type	Relaxed definitions from JRF study applied to Australian cities
Escalator	((IS>IB and IS>IW) and (OB>OW and OB>OS)) or ((IW>IB and IW>IS) and (OB>OW and OB>OS))
Transit	((IB>IS and IB>IW) and (OB>OS and OB>OW))
Gentrifier	((IB>IS and IB>IW) and (OS>OB and OS>OW)) or ((IB>IS and IB>IW) and (OW>OB and OW>OS))
Isolate	((IS>IB and IS>IW) and (OS>OB and OS>OW)) or ((IS>IB and IS>IW) and (OW>OB and OW>OS)) or ((IW>IB and IW>IS) and (OS>OB and OS>OW)) or ((IW>IB and IW>IS) and (OW>OB and OW>OS))

Source: JRF Relaxed Neighbourhood Typologies, JRF Report (Rae et. al, 2016).

Results of this analysis are presented in Section 3.2.

3.2 Neighbourhood distributions and longitudinal change, 2011 and 2016

Figure 10 shows the classification of SA2s into neighbourhood typologies by number for the census years 2011 and 2016. Figure 11 shows the same classification, but by percentage.

Figure 10: Classification of SA2 neighbourhoods into typologies by number, 2011 and 2016.

City 2011	Escalator	Transit	Gentrifier	Isolate	Total SA2s
Sydney	25	87	8	115	235
Melbourne	15	111	10	122	258
Perth	8	60	5	67	140
Brisbane	1	63	6	62	132
Adelaide	2	37	6	57	102

City 2016	Escalator	Transit	Gentrifier	Isolate	Total SA2s
Sydney	43	89	7	128	267
Melbourne	23	120	8	135	286
Perth	9	58	7	68	142
Brisbane	5	62	3	62	132
Adelaide	7	36	6	54	103

Source: Authors, using 2011 and 2016 ABS Census data.

Figure 11: Classification of SA2 neighbourhoods into typologies by percentage, 2011 and 2016

City 2011	Escalator	Transit	Gentrifier	Isolate
Sydney	11%	37%	3%	49%
Melbourne	6%	43%	4%	47%
Perth	6%	43%	4%	48%
Brisbane	1%	48%	5%	47%
Adelaide	2%	36%	6%	56%

City 2016	Escalator	Transit	Gentrifier	Isolate
Sydney	16%	33%	3%	48%
Melbourne	8%	42%	3%	47%
Perth	6%	41%	5%	48%
Brisbane	4%	47%	2%	47%
Adelaide	7%	35%	6%	52%

Source: Authors, using 2011 and 2016 ABS Census data.

The neighbourhood distributions by functional typologies for the census years 2011 and 2016 show the dominance of Transit and Isolate neighbourhoods in all five capital cities in this study.

Such dominance provides evidence that established exclusion is much more dominant as a spatial signature than gentrification. In essence, displacement of lower-income households and movements-in of higher-income households is difficult to measure, as exclusion is already entrenched.

The Gentrifier percentages for both 2011 and 2016 are minimal in all five cities. Combined, the dominance of Isolate neighbourhoods and the low number of Gentrifier neighbourhoods provide evidence that exclusion is firmly set in place.

Both Sydney and Melbourne recorded increases in the number of Isolate neighbourhoods:

- Sydney rose from 115 Isolate neighbourhoods in 2011 to 128 in 2016
- Melbourne rose from 122 Isolate neighbourhoods in 2011 to 165 in 2016.

Both Sydney and Melbourne also had small increases in the number of Transit and Escalator neighbourhoods.

Table 12 shows the increases and decreases in the absolute number of SA2s between 2011 and 2016. It also shows the percentage point changes (pp) in each type of neighbourhood.

Table 12: Increases and decreases in absolute number of SA2s, 2011–2016

Neighbourhood type	Syd	pp	Melb	pp	Per	pp	Bri	pp	Ade	pp
Escalator	+18	5.47	+8	2.33	+1	0.62	+4	3.03	+5	4.84
Transit	+2	-3.69	+9	-1.07	-2	-2.01	-1	-0.76	-1	-1.32
Gentrifier	-1	-0.78	-2	-1.08	+2	1.36	-3	-2.27	0	-0.06
Isolate	+13	-1.00	+13	-0.08	+1	0.03	0	0.00	-3	-3.46

Source: Authors, using 2011 and 2016 ABS Census data.

Note: pp = percentage points

In absolute numbers, Sydney showed big gains in both Escalator and Isolate neighbourhoods. Melbourne showed gains in the number of Escalator and Transit neighbourhoods—but also an increase in the number of Isolate neighbourhoods.

The pronounced gain in Isolate neighbourhoods in both Sydney and Melbourne is the surest sign of increasing and maintained exclusion. Analysis of the percentage point change confirms that while there are some gains in Escalator neighbours in all five cities, there is an overall loss in the percentage of Transit neighbourhoods, while the percentage of Isolate neighbourhoods is maintained. Adelaide is an exception, as it shows a reduction in the percentage of Isolate neighbourhoods.

3.3 Neighbourhood typology against SEIFA-IRSD scores

When the four neighbourhood typologies are cross-tabulated against SEIFA IRSD scores—as shown in Figure 12—a clear signature emerges across all five cities:

- the dominance of Isolate neighbourhoods in the highest SEIFA categories—the neighbourhoods that are the *least disadvantaged*
- the dominance of Transit neighbourhoods in the lower SEIFA categories—the neighbourhoods that are more or most disadvantaged.

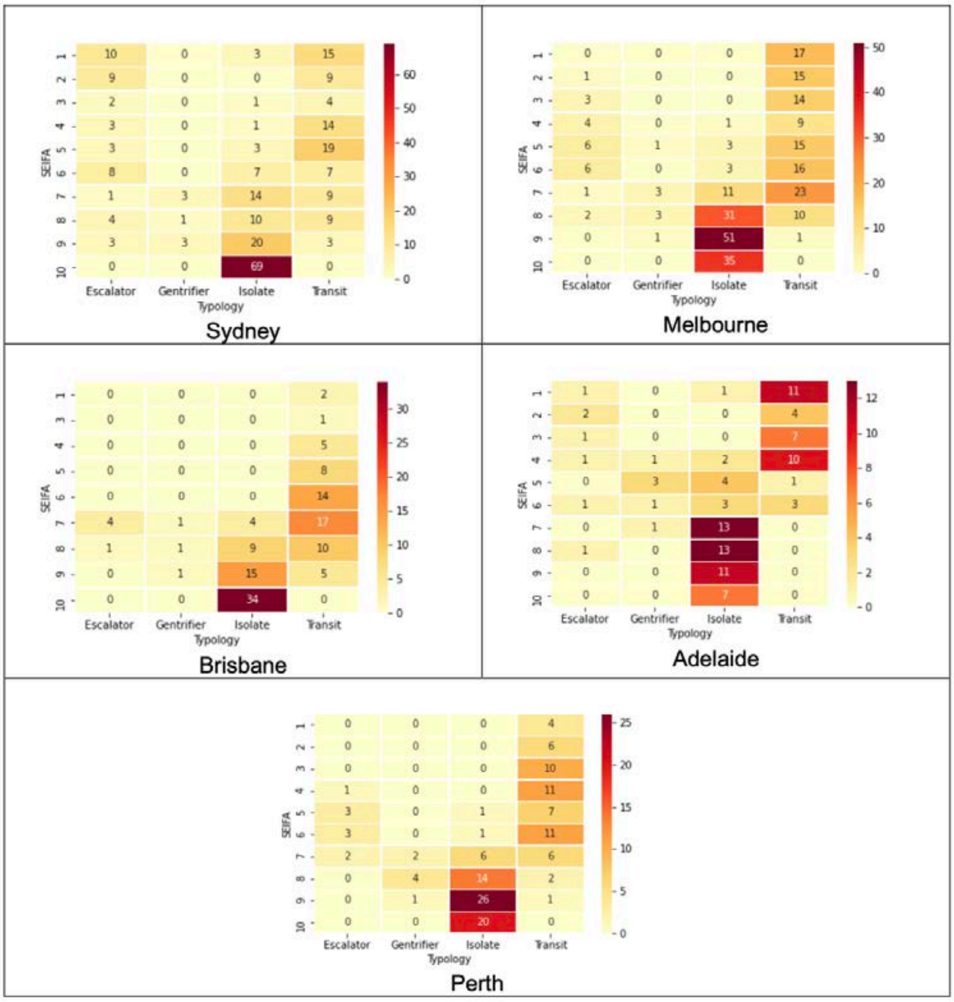
Sydney emerges as the city where the effects of segregation and exclusion appear to be the most pronounced. Sydney has:

- a total of 69 Isolate neighbourhoods in the highest SEIFA decile (10)
- a high number of Isolate neighbourhoods in the higher SEIFA deciles (6–9)
- a very low number of Isolate neighbourhoods in the lower SEIFA deciles (1–5).

This shows that the problem of exclusion is not characterised by disadvantaged neighbourhoods being isolated—but by affluent neighbourhoods isolating from the rest of the city.

Melbourne shows a similar signature to Sydney, but also shows a higher number of Transit neighbourhoods in the lower SEIFA deciles. Brisbane, Perth and Adelaide echo similar signatures: there are hardly any neighbourhoods in the highest SEIFA deciles that are classified as Transit, Escalator or Gentrifier neighbourhoods.

Figure 12: Cross-tabulation count of neighbourhoods - the four neighbourhood typologies against SEIFA IRSD scores



Source: Authors, based on 2016 ABS Census data.

The results from the cross-tabulation reveal the following:

1. Transit neighbourhoods are where in-movers come in from higher SEIFA neighbourhoods, and out-movers also go to higher SEIFA neighbourhoods. Since Transit neighbourhoods are dominant in the lower SEIFA categories, this shows flows of people within neighbourhoods with lower-SEIFA and mid-SEIFA scores. Thus, neighbourhoods with lower-SEIFA and mid-SEIFA scores are porous and open to movements in and out for moderate-income and lower-income earners.
2. Isolate neighbourhoods are those where in-movers are from neighbourhoods with the same or lower SEIFA scores, and out-movers also go to neighbourhoods with the same or lower SEIFA scores. However, Isolate neighbourhoods are dominant in the higher SEIFA deciles. This shows that, in general, high-income and very-high-income earners churn and move within neighbourhoods that have higher SEIFA scores.
3. When these observations are combined, they show that Isolate neighbourhoods are not trapping lower-income earners in-place. To the contrary, Isolate neighbourhoods exclude lower-income and moderate-income earners.

4. Neighbourhood typologies by connectivity to PECs

- **Section 4 examines the journey to work (JTW) data in tandem with the SEIFA IRSD data at the SA2 neighbourhood level for the five cities, and measures the degree of connectedness or disconnectedness to principal employment centres (PECs) for each neighbourhood.**
- **The proportion of workers going to work in PECs is an indicator to measure employment connectivity, and is computed for each SA2 for all five cities. There is no clear cut-off to decide at what point a neighbourhood becomes disconnected.**
- **Testing the cut-off parameter at different values shows that larger numbers of neighbourhoods with higher SEIFA scores—those that are the least disadvantaged—emerge as more connected than neighbourhoods with lower SEIFA scores—those that are the most disadvantaged.**
- **In Australia, the least-disadvantaged neighbourhoods are also those that are the most connected to the PECs in each city.**

4.1 Identifying principal employment centres

This section focusses on the second part of research question 2:

- What types of disadvantaged neighbourhoods exist, and how can these be conceptualised by not simply locational in-place indicators, but by residential mobility flows of people in and out of these neighbourhoods, and the ways in which these neighbourhoods are connected in journey to work relationships within the larger city?

Journey to Work (JTW) data that captures daily, high-frequency flows of people connecting their places of usual residence to their workplaces was analysed to provide an insight into the daily patterns of people's movement within each city.

Using the methods of computing trip, density and accessibility centricities (Moylan and Sarkar 2019b; Sarkar, Wu et al. 2019b), PECs have been identified using the JTW data from the 2016 Census at SA2 level for Sydney, Melbourne, Brisbane, Perth and Adelaide.

Following are the identified PECs for the five cities:

- Sydney: six SA2s have been identified as PECs (Moylan and Sarkar 2019b; Sarkar, Wu et al. 2019b):
    - the top level accounted for 15 per cent of the total number of work trips: Sydney / Haymarket / The Rocks
    - secondary-level centres accounted for about 10 per cent of the total number of work trips: Parramatta / Rosehill; Macquarie Park / Marsfield; North Sydney / Lavender Bay; Pyrmont / Ultimo; Chatswood (East) / Artarmon.
    - With the exception of Parramatta, all others are spatially clustered – forming essentially a large Central Business District (CBD) area.
- Melbourne: the SA2 'Melbourne', with 11 per cent of the total number of work trips.
- Brisbane: the SA2 'Brisbane City', with 16.9 per cent of the total number of work trips.
- Perth: the SA2 'Perth City', with 15 per cent of the total number of work trips.
- Adelaide: the SA2 'Adelaide', with 18 per cent the total number of work trips.

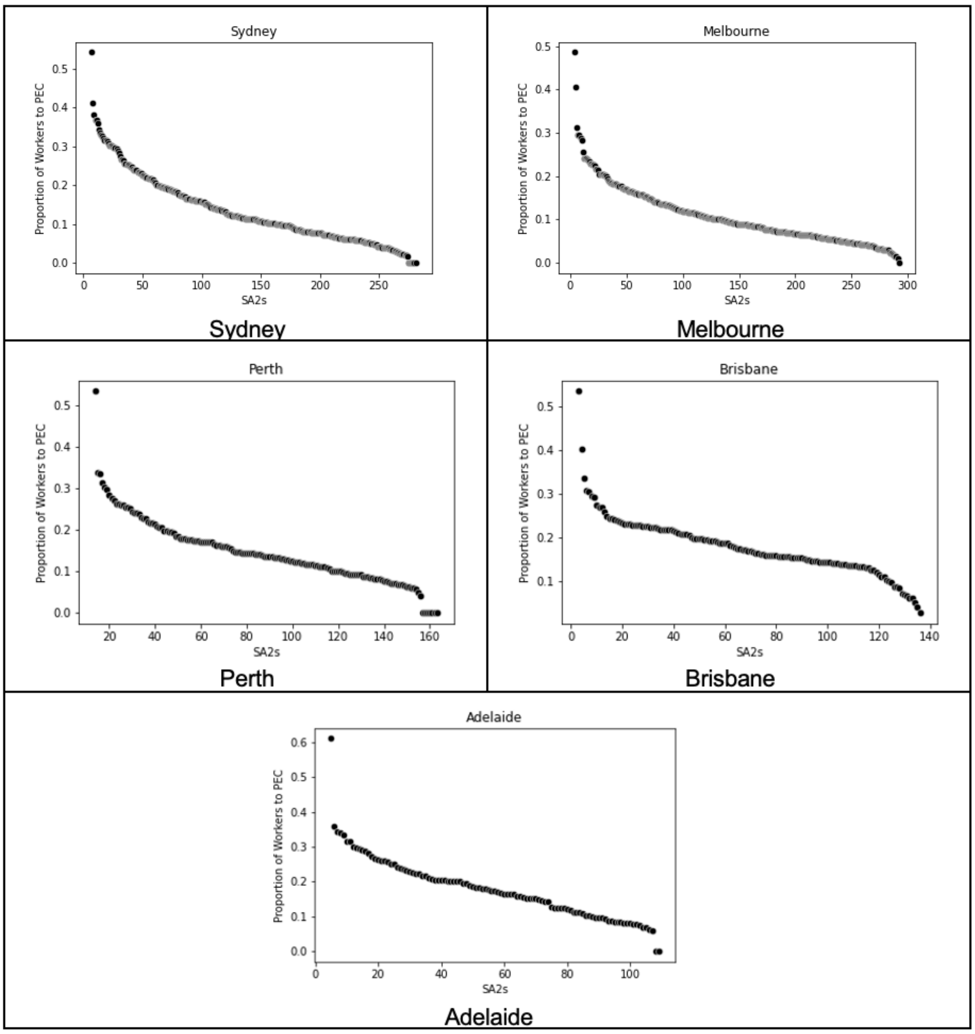
4.2 Tracking the flow of workers to PECs

The flows of people travelling from every SA2, i.e. JTW flows from the census, to the PECs in each city were computed in proportion to the total number of workers in each SA2. SA2s have been scored on a continuous spectrum and classified as Connected or Disconnected, based on a threshold cut-off parameter.

For example, if the threshold cut-off is set to 20 per cent, then every SA2 where 20 per cent or more of the workers travel to the PEC is Connected, while the other SA2s are Disconnected. This necessarily implies that we are defining the top 20 per cent of SA2s as Connected and the remaining 80 per cent as Disconnected. But this threshold parameter can be changed to see which neighbourhoods gradually come into the Connected category.

The graphs in Figure 13 depict the proportion of workers in each SA2 who travel to the PECs, and show why any threshold is arbitrary. In general, the few SA2s that are highest in terms of being employment centres emerge as the most Connected, followed by big gaps, and then a gradual fall-off. Thus, any threshold beyond these 'gaps' is arbitrary. So the threshold must be tested as a parameter, and gradually varied to check which neighbourhoods emerge as more Connected than others.

Figure 13: Proportion of workers travelling to PECs



Source: Authors, based on 2016 ABS Census data.

4.3 Tracking the connectivity index against SEIFA deciles

This section deals with tracking the connectivity classification against SEIFA IRSD deciles. The tables in Figure 19 show the top 20 per cent Connected neighbourhoods cross-tabulated against their SEIFA counts, along with the bottom 80 per cent Disconnected neighbourhoods.

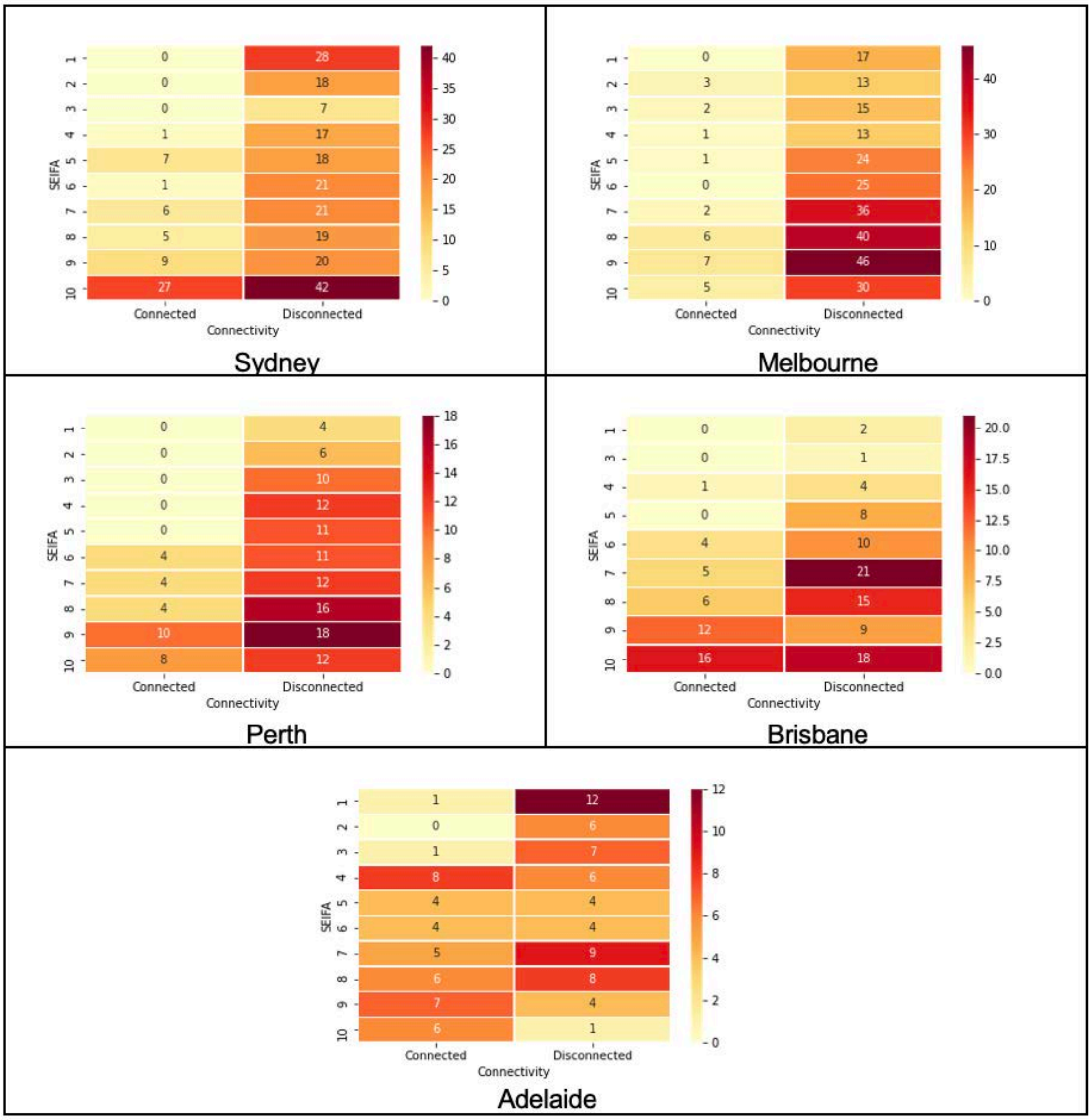
Overall, there are two clear trends:

- a higher number of Connected neighbourhoods have higher SEIFA scores—which implies that there are very few Connected neighbourhoods with low SEIFA scores.
- Sydney, Melbourne, Perth and Brisbane show a high number of Disconnected neighbourhoods with higher SEIFA scores. However Adelaide shows a high number of Disconnected neighbourhoods with lower SEIFA scores.

Overall, these trends relate to the finding that Sydney, Melbourne, Perth and Brisbane have a higher number of Connected neighbourhoods with scores in the higher SEIFA range. Also, there are more Connected neighbourhoods in the higher SEIFA scores.

As a general pattern, the results show that the least-disadvantaged areas—that is, the most affluent neighbourhoods—also enjoy high connectivity to the PECs in all capital cities. Conversely, very few neighbourhoods in the lower SEIFA IRSD deciles—that is, the most disadvantaged neighbourhoods—appear to be as Connected.

Figure 14: Number of Connected and Disconnected SA2s, by SEIFA IRSD deciles



Source: Authors, based on 2016 ABS Census data.

The way in which employment connectivity is defined in this study is by counting the proportion of people in each neighbourhood who work in PECs. This definition does not make any claims about the total nature of employment in a city. After all, the total employment patterns could be quite dispersed, with a major portion of jobs scattered throughout the metropolitan areas rather than being concentrated in the centres. However, the PECs are still dominant as they attract, relatively, the highest proportion of workers—especially in knowledge-based and skills-based professional occupational categories that generate the highest incomes (Sarkar et al., 2020).

The results in Figure 19 show that a relatively higher proportion of neighbourhoods with higher SEIFA deciles are Connected for each city, as a larger proportion of people from those neighbourhoods work in the PECs. And although many neighbourhoods with higher SEIFA deciles are Disconnected, it is clear that a very high number of neighbourhoods with lower SEIFA deciles are Disconnected—and hardly any are Connected.

Thus, this view on employment connectivity works in tandem with the earlier classification on functional neighbourhood types: its main purpose is that we can use it to characterise the segregation of relative advantage and disadvantage.

5. A measure of neighbourhood porosity

- **Section 5 brings together the results from Section 3 and Section 4 to cross-tabulate the number of SA2 neighbourhoods by their typologies and connectivity to principal employment centres (PECs).**
- **We have developed an applied measure of neighbourhood porosity based on combining the interpretations of the functional typologies and connectivity typologies for neighbourhoods.**
- **The results show that there is strong evidence for maintained and growing trends towards exclusion across all five cities. Sydney emerges as the worst performer—characterised by the highest level of exclusion and the least neighbourhood porosity.**

5.1 Conceptualising and measuring neighbourhood porosity

Section 5 brings together results from Section 3 and Section 4 to characterise a measure of 'neighbourhood porosity'. In Section 1.3.7, we described in detail how neighbourhood porosity is characterised, and proposed a summary table of measurement bringing together the four functional neighbourhood typologies—Escalator, Gentrifier, Isolate and Transit—along with the two employment connectivity typologies: Connected and Disconnected.

These results are summarised across all the five cities in Table 13 to Table 17, with the 'count' columns showing the number of SA2s in each category.

Table 13: Neighbourhood porosity summary table, Sydney

Functional neighbourhood type	Employment connectivity type			
	Connected	**Count**	**Disconnected**	**Count**
Escalator	Porous	1	Towards Exclusionary	42
Gentrifier	Towards Exclusionary	6	Towards Exclusionary	1
Isolate	Exclusionary	33	Exclusionary	95
Transit	Porous	16	Towards Exclusionary	73

Source: Authors, based on 2016 ABS Census data.

Note: The table shows the number of SA2 neighbourhoods falling in the cross-tabulation counts between the functional neighbourhood types and the employment connectivity types.

Sydney has the second-lowest porosity score of the five cities, with only 17 out of 267 SA2s (6.3%) classified as porous. About 48 per cent of the neighbourhoods are Exclusionary and Isolate, and most of them are concentrated in the highest SEIFA deciles. About 45.6 per cent of SA2s are rated as Towards Exclusionary.

Table 14: Neighbourhood porosity summary table, Melbourne

Functional neighbourhood type	Employment connectivity type			
	Connected	**Count**	**Disconnected**	**Count**
Escalator	Porous	1	Towards Exclusionary	22
Gentrifier	Towards Exclusionary	2	Towards Exclusionary	6
Isolate	Exclusionary	14	Exclusionary	122
Transit	Porous	10	Towards Exclusionary	110

Source: Authors, based on 2016 ABS Census data.

Note: The table shows the number of SA2 neighbourhoods falling in the cross-tabulation counts between the functional neighbourhood types and the employment connectivity types.

Melbourne has the lowest porosity score of the five cities, with only 11 out of 287 SA2s (3.8%) classified as porous. About 47.3 per cent of the neighbourhoods are Exclusionary and Isolate, and most of those are concentrated in the highest SEIFA deciles. About 48.8 per cent of SA2s are rated as Towards Exclusionary.

Table 15: Neighbourhood porosity summary table, Brisbane

Functional neighbourhood type	Employment connectivity type			
	Connected	**Count**	**Disconnected**	**Count**
Escalator	Porous	0	Towards Exclusionary	5
Gentrifier	Towards Exclusionary	1	Towards Exclusionary	2
Isolate	Exclusionary	24	Exclusionary	38
Transit	Porous	19	Towards Exclusionary	43

Source: Authors, based on 2016 ABS Census data.

Note: The table shows the number of SA2 neighbourhoods falling in the cross-tabulation counts between the functional neighbourhood types and the employment connectivity types.

For Brisbane, 19 out of 132 SA2s (14.4%) are classified as porous. About 47 per cent of the neighbourhoods are Exclusionary and Isolate, and most of those are concentrated in the highest SEIFA deciles. About 38.6 per cent of SA2s are rated as Towards Exclusionary.

Table 16: Neighbourhood porosity summary table, Perth

Functional neighbourhood type	Employment connectivity type			
	Connected	**Count**	**Disconnected**	**Count**
Escalator	Porous	0	Towards Exclusionary	9
Gentrifier	Towards Exclusionary	3	Towards Exclusionary	4
Isolate	Exclusionary	20	Exclusionary	48
Transit	Porous	7	Towards Exclusionary	51

Source: Authors, based on 2016 ABS Census data.

Note: The table shows the number of SA2 neighbourhoods falling in the cross-tabulation counts between the functional neighbourhood types and the employment connectivity types.

For Perth, seven out of 142 SA2s (5%) are classified as porous. About 47.9 per cent of the neighbourhoods are Exclusionary and Isolate, and most of those are concentrated in the highest SEIFA deciles. About 47.2 per cent of SA2s are rated as Towards Exclusionary.

Table 17: Neighbourhood porosity summary table, Adelaide

Functional neighbourhood type	Employment connectivity type			
	Connected	**Count**	**Disconnected**	**Count**
Escalator	Porous	1	Towards Exclusionary	6
Gentrifier	Towards Exclusionary	3	Towards Exclusionary	3
Isolate	Exclusionary	26	Exclusionary	28
Transit	Porous	12	Towards Exclusionary	24

Source: Authors, based on 2016 ABS Census data.

Note: The table shows the number of SA2 neighbourhoods falling in the cross-tabulation counts between the functional neighbourhood types and the employment connectivity types.

For Adelaide, 13 out of 103 SA2s (12.6%) are classified as porous. About 52.4 per cent of the neighbourhoods are Exclusionary and Isolate, and most of those are concentrated in the highest SEIFA deciles. About 35 per cent of SA2s are rated as Towards Exclusionary.

In general, the findings point out that a large majority of the least-disadvantaged neighbourhoods—that is, those that are the most advantaged—are both Isolated and Connected. Conversely, while many of the least-disadvantaged neighbourhoods also fall into the Disconnected Isolate category, all of the most disadvantaged neighbourhoods fall into the Disconnected Isolate category.

- Sydney and Melbourne emerge as the worst performing cities. Although none of the Connected Isolate neighbourhoods in Sydney have a SEIFA IRSD score of less than 9 or 10, 29 out of the 95 (30%) Disconnected Isolate neighbourhoods have a SEIFA IRSD score of less than or equal to 7. Thus Sydney emerges as the most exclusionary and the least porous of the five cities.
- In Melbourne, although none of the Connected Isolate neighbourhoods have a SEIFA IRSD score of less than 8, 18 out of the 122 (15%) Disconnected Isolate neighbourhoods have a SEIFA IRSD score of less than or equal to 7.

- Under this framework, the three smaller cities Brisbane, Perth and Adelaide emerge as much more equitable than Sydney or Melbourne. And they also emerge as much more porous and less exclusionary then either Sydney or Melbourne.

Overall, barriers to entry into more affluent areas are high for lower-income and moderate-income earners—and at the same time the neighbourhoods that are Connected to the best opportunities remain Exclusionary.

Therefore, a formal measure of neighbourhood porosity characterised in this framework brings out a critical policy direction:

- Encouraging the development of mixed housing types and tenures in the most Connected and most affluent neighbourhoods—as well as in the most disadvantaged Isolate neighbourhoods—will actively work to reduce the degree of ongoing and increasing segregation and exclusion that is observed in the five largest capital cities, especially Sydney.

5.2 Spatial signatures

This section presents a series of maps showing the spatial signatures of the neighbourhood typologies and shows how the neighbourhoods are spatially organised. Each city is discussed separately. Note the maps have some “empty” SA2s – these represent non-residential areas with negligible populations and have been excluded from analysis (e.g. cemeteries, industrial areas, airports, etc.)

5.2.1 Sydney

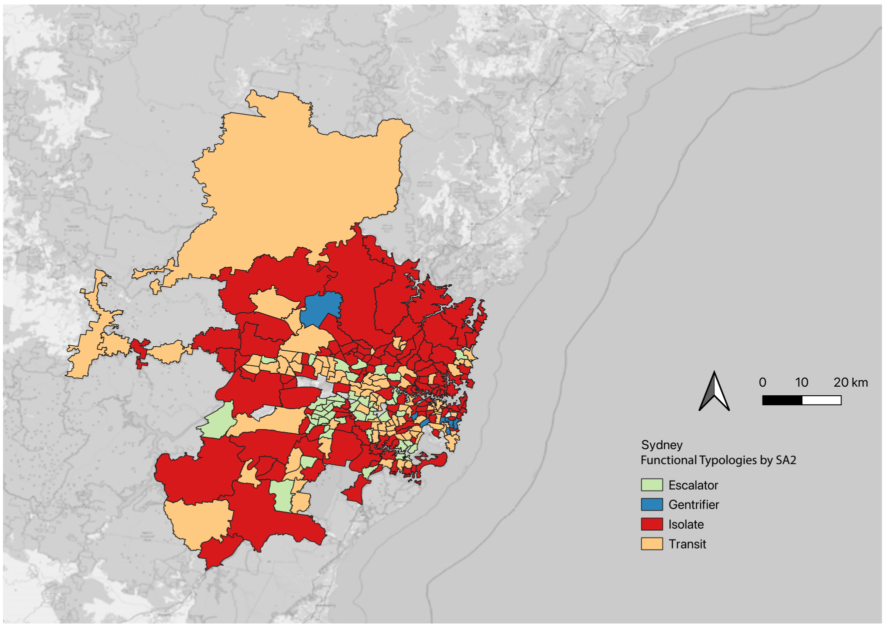
There are three maps for Sydney, all based on 2016 Census data. They show the functional neighbourhood types by residential mobility (Figure 15), employment connectivity typology by JTW data (Figure 16) and SEIFA deciles for the neighbourhoods (Figure 17).

Figure 17 shows that Sydney’s northern and eastern neighbourhoods fall into higher SEIFA deciles, whereas the western and southern neighbourhoods fall into lower SEIFA deciles. However, Figure 15 shows that there are Isolate neighbourhoods towards the north and east—and also to the west and south. These Isolate neighbourhoods are very different, as those:

- to the north and east are affluent area Isolates
- to the west and south are disadvantaged area Isolates.

Interestingly, the Transit neighbourhoods are closely tied around the existing public metro/rail line, which shows that neighbourhoods that are close to public transit serve a functional role in increasing porosity, as they allow movements into and out of similar areas of advantage or disadvantage. Figure 16 shows that the most highly Connected neighbourhoods cluster around the existing largest cluster of PECs, which is not surprising.

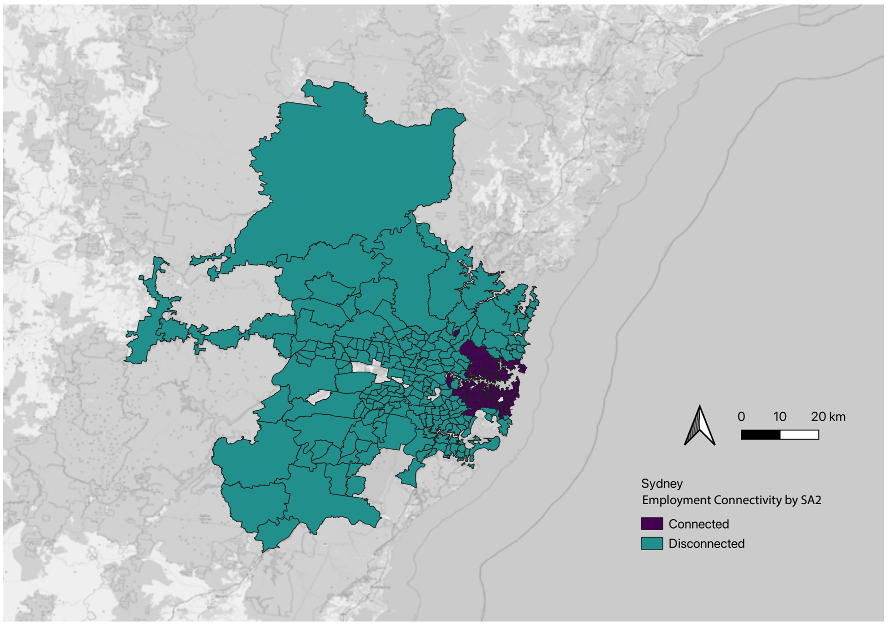
Figure 15: Functional neighbourhood typologies based on residential mobility, Sydney



Source: Authors, based on 2016 ABS Census data.

Note: The blank areas are non-residential areas of extremely low population and have been excluded from the analysis.

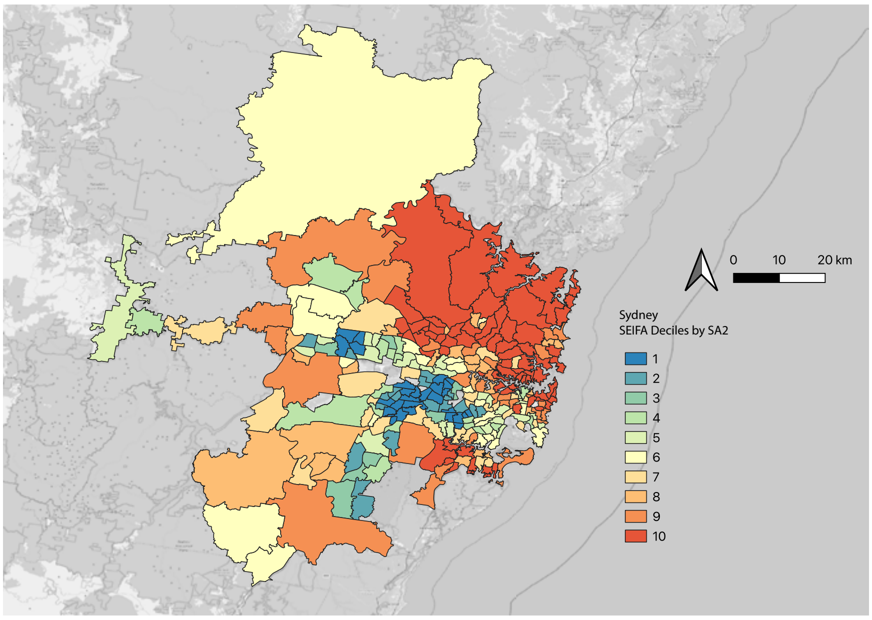
Figure 16: Employment connectivity typologies, Sydney



Source: Authors, based on 2016 ABS Census data.

Note: The blank areas are non-residential areas of extremely low population and have been excluded from the analysis.

Figure 17: Neighbourhood SEIFA deciles, Sydney



Source: Authors, based on 2016 ABS Census data.

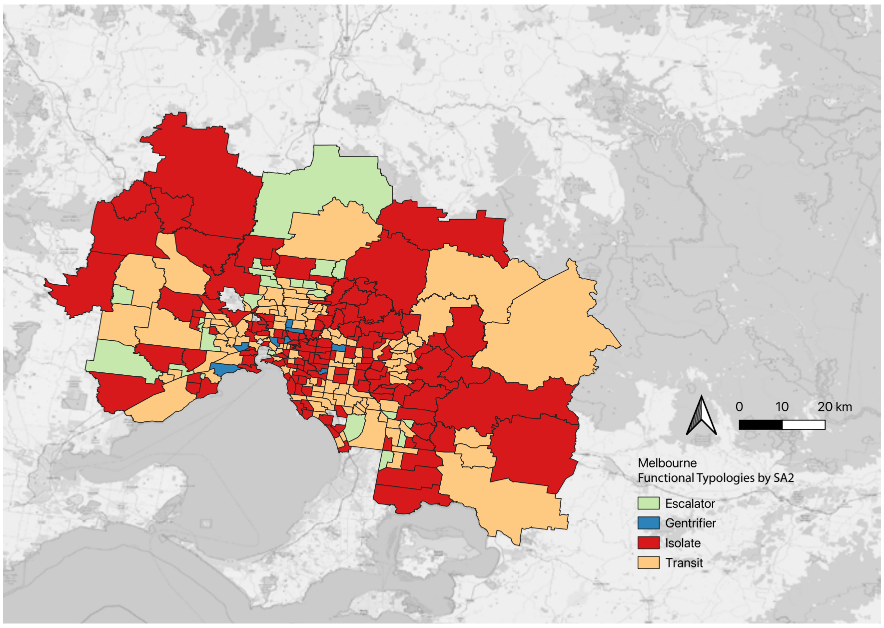
Note: The blank areas are non-residential areas of extremely low population and have been excluded from the analysis.

5.2.2 Melbourne

The maps for Melbourne show the functional neighbourhood types by residential mobility (Figure 18), employment connectivity typology by JTW data (Figure 19) and SEIFA deciles for the neighbourhoods (Figure 20).

Figure 20 shows that Melbourne has a SEIFA spatial signature with a cluster of the least-disadvantaged areas extending out from the current principal city centre. However, there are also clusters of more disadvantaged areas on the sides. Comparing Figure 30 with Figure 18, we can see that both disadvantaged and less-disadvantaged areas show up as Isolate, but a few disadvantaged areas also show up as Transit neighbourhoods. Figure 19 shows that a very small cluster of neighbourhoods around the PEC rate as Connected, and Figure 20 shows that most of these fall under the higher SEIFA deciles, compared to the Escalator suburbs, which all lie at a distance from the PEC.

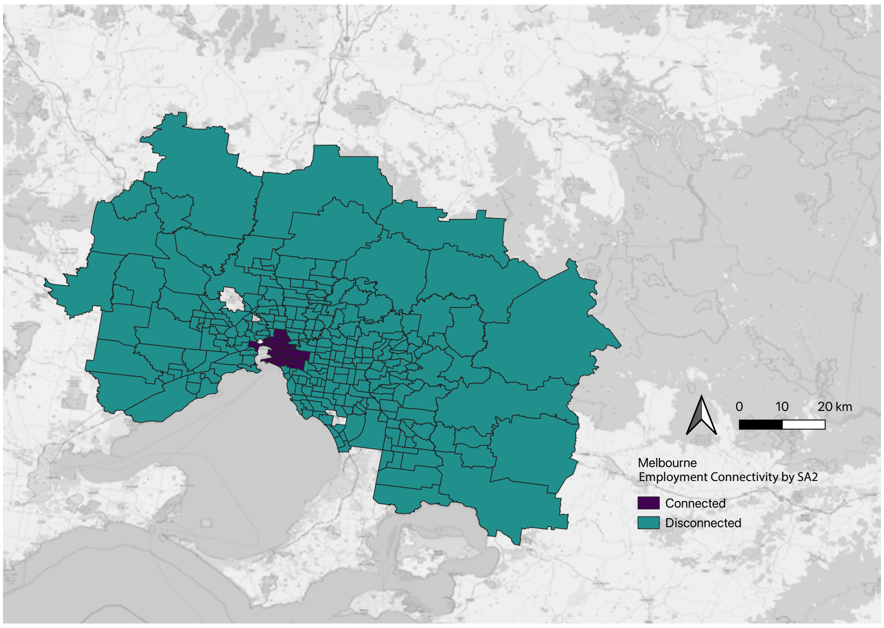
Figure 18: Functional neighbourhood typologies based on residential mobility, Melbourne



Source: Authors, based on 2016 ABS Census data.

Note: The blank areas are non-residential areas of extremely low population and have been excluded from the analysis.

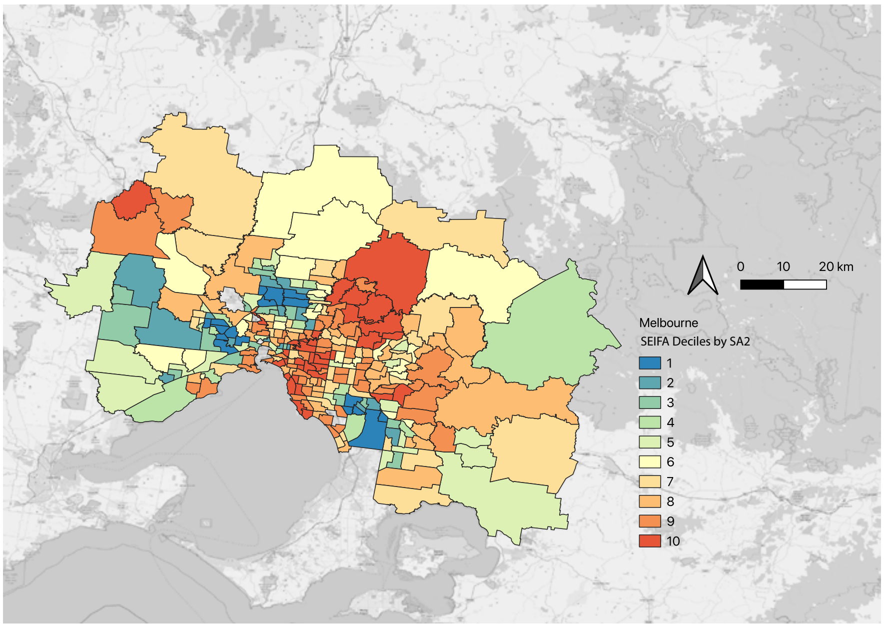
Figure 19: Employment connectivity typologies, Melbourne



Source: Authors, based on 2016 ABS Census data.

Note: The blank areas are non-residential areas of extremely low population and have been excluded from the analysis.

Figure 20: Neighbourhood SEIFA deciles, Melbourne



Source: Authors, based on 2016 ABS Census data.

Note: The blank areas are non-residential areas of extremely low population and have been excluded from the analysis.

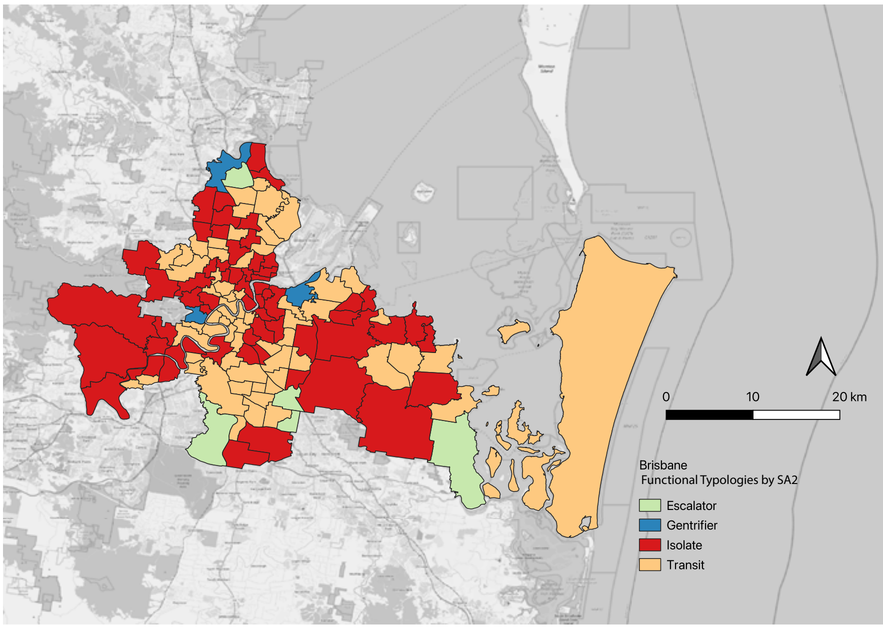
5.2.3 Brisbane

The maps for Brisbane show the functional neighbourhood types by residential mobility (Figure 21), employment connectivity typology by JTW data (Figure 22) and SEIFA deciles for the neighbourhoods (Figure 23).

Figure 23 shows the SEIFA IRSD spatial signature for Brisbane neighbourhoods. Interestingly, the Brisbane city centre is a mix of several deciles, although the neighbourhoods that surround those in the PEC are the highest SEIFA decile, as shown in Figure 22. Figure 21 shows that many of the Isolate neighbourhoods correspond with the higher or highest SEIFA deciles, and that some lower SEIFA decile neighbourhoods are Transit neighbourhoods.

Figure 22 echoes the employment connectivity signature, where the highest Connected neighbourhoods are closest to the PEC. These are the neighbourhoods where the largest proportion of people go to work in the PEC. This signature is repeated across all five cities, and shows that there is a strong geographic effect operating between employment connectivity patterns and urban structure.

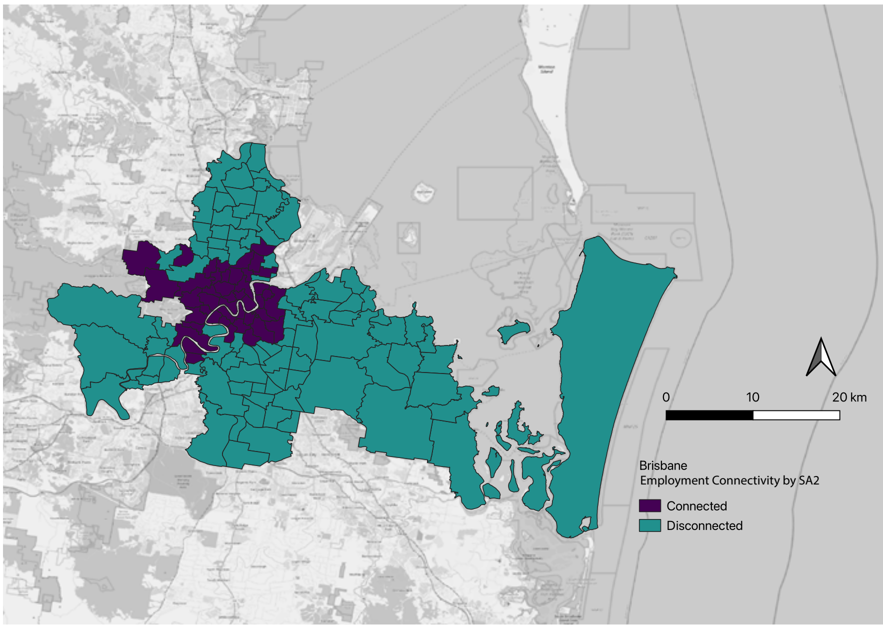
Figure 21: Functional neighbourhood typologies based on residential mobility, Brisbane



Source: Authors, based on 2016 ABS Census data.

Note: The blank areas are non-residential areas of extremely low population and have been excluded from the analysis.

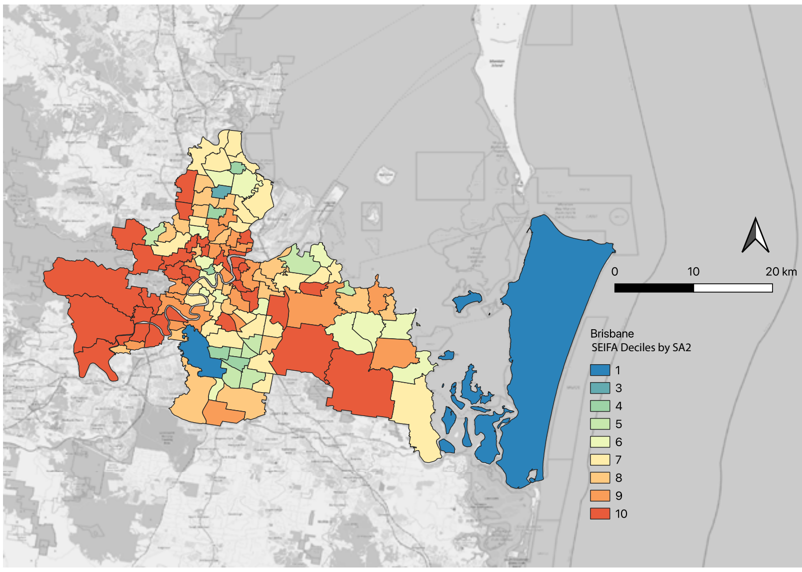
Figure 22: Employment connectivity typologies, Brisbane



Source: Authors, based on 2016 ABS Census data.

Note: The blank areas are non-residential areas of extremely low population and have been excluded from the analysis.

Figure 23: Neighbourhood SEIFA deciles, Brisbane



Source: Authors, based on 2016 ABS Census data.

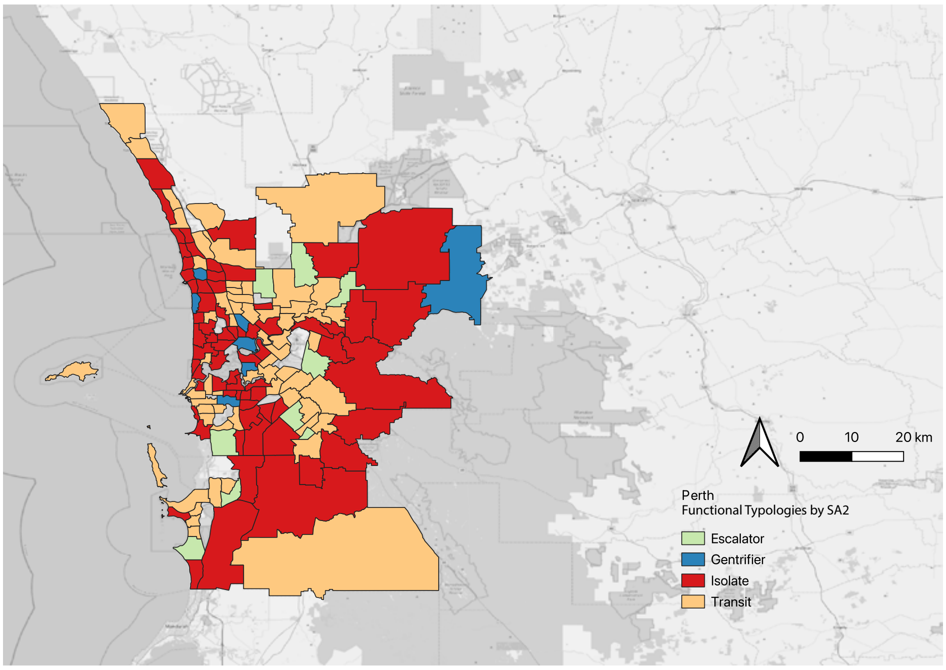
Note: The blank areas are non-residential areas of extremely low population and have been excluded from the analysis.

5.2.4 Perth

The maps for Perth show the functional neighbourhood types by residential mobility (Figure 24), employment connectivity typology by JTW data (Figure 25) and SEIFA deciles for the neighbourhoods (Figure 26).

Perth roughly has two vertical bands of high SEIFA decile neighbourhoods, as shown in Figure 26. One band is around the existing city centre and one is farther away, and the two bands are interleaved with a vertical band of lower SEIFA decile neighbourhoods. Figure 24 shows that there is a corresponding spatial similarity: many Isolate areas also occur in these two bands, while the interleaving band of neighbourhoods with lower SEIFA scores corresponds mostly to Transit neighbourhoods. Figure 25 shows the location of the PEC, and the reach of employment connectivity into the surrounding neighbourhoods, which echoes patterns from the other cities.

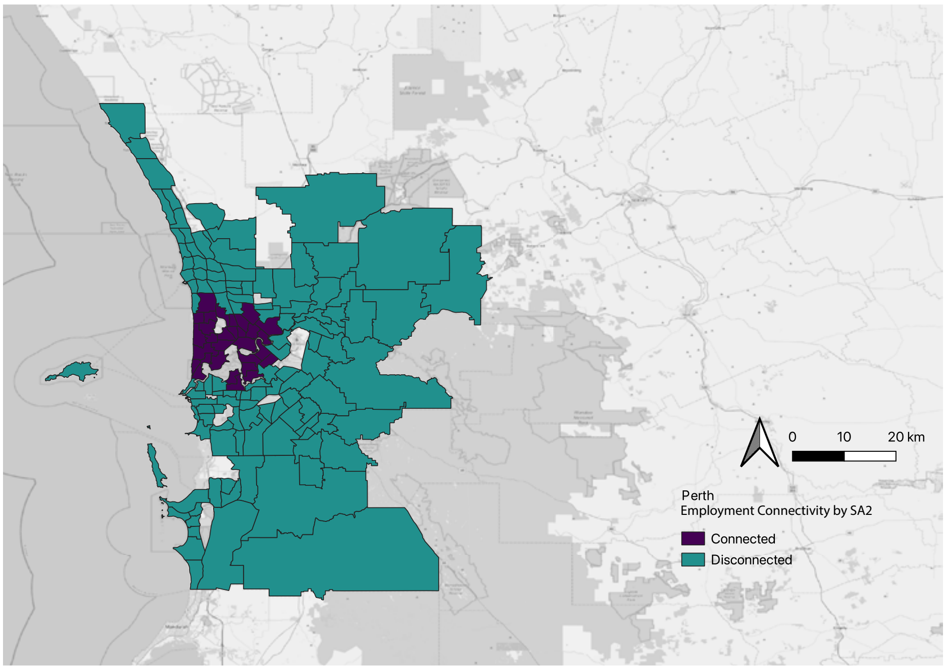
Figure 24: Functional neighbourhood typologies based on residential mobility, Perth



Source: Authors, based on 2016 ABS Census data.

Note: The blank areas are non-residential areas of extremely low population and have been excluded from the analysis.

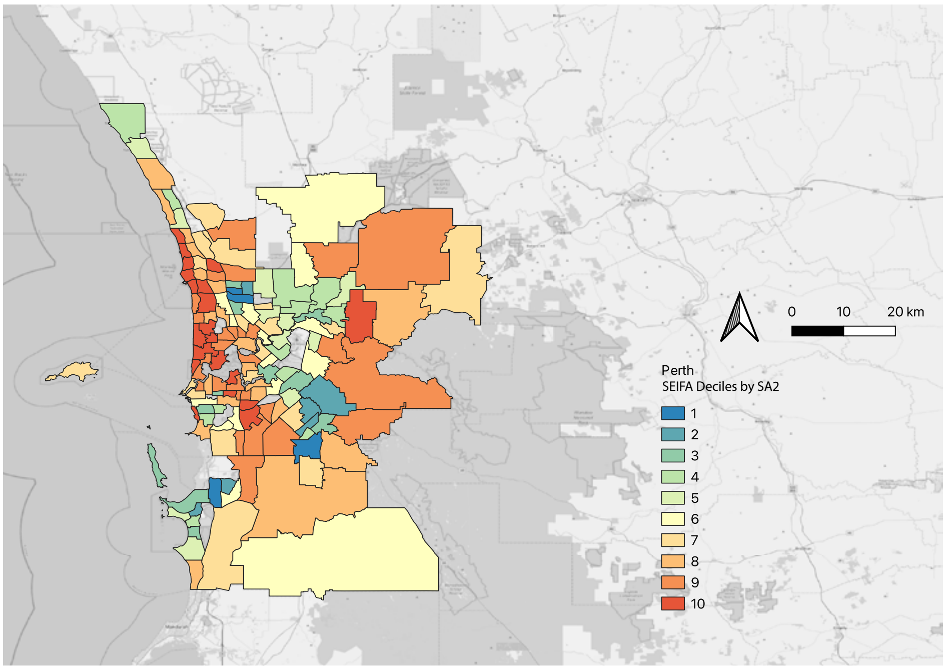
Figure 25: Employment connectivity typologies, Perth



Source: Authors, based on 2016 ABS Census data.

Note: The blank areas are non-residential areas of extremely low population and have been excluded from the analysis.

Figure 26: Neighbourhood SEIFA deciles, Perth



Source: Authors, based on 2016 ABS Census data.

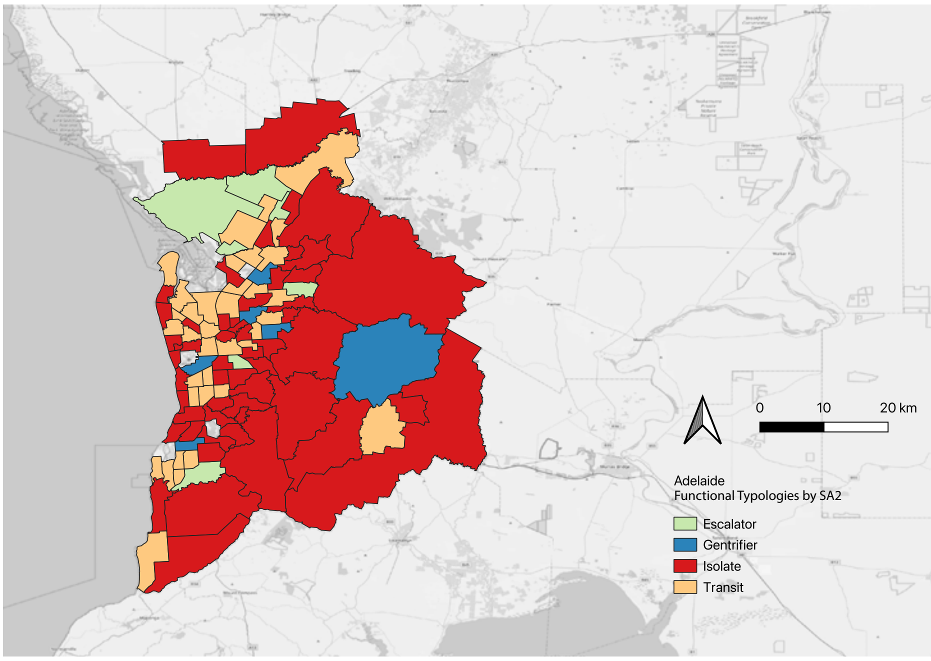
Note: The blank areas are non-residential areas of extremely low population and have been excluded from the analysis.

5.2.5 Adelaide

The maps for Adelaide show the functional neighbourhood types by residential mobility (Figure 27), employment connectivity typology by JTW data (Figure 28) and SEIFA deciles for the neighbourhoods (Figure 29).

Adelaide has clear spatial segregation between the lower and higher SEIFA deciles, as shown in Figure 29. The neighbourhoods with lower deciles are clustered towards the north and the west, whereas the higher deciles are clustered to the east and the south. Strikingly, Figure 27 shows that the pattern of Isolate and Transit neighbourhoods echoes this pattern, with higher SEIFA deciles mostly corresponding to the Isolate neighbourhoods, and the lower SEIFA deciles mostly corresponding to the Transit neighbourhoods. Figure 28 shows the location of the PEC and the surrounding Connected neighbourhoods.

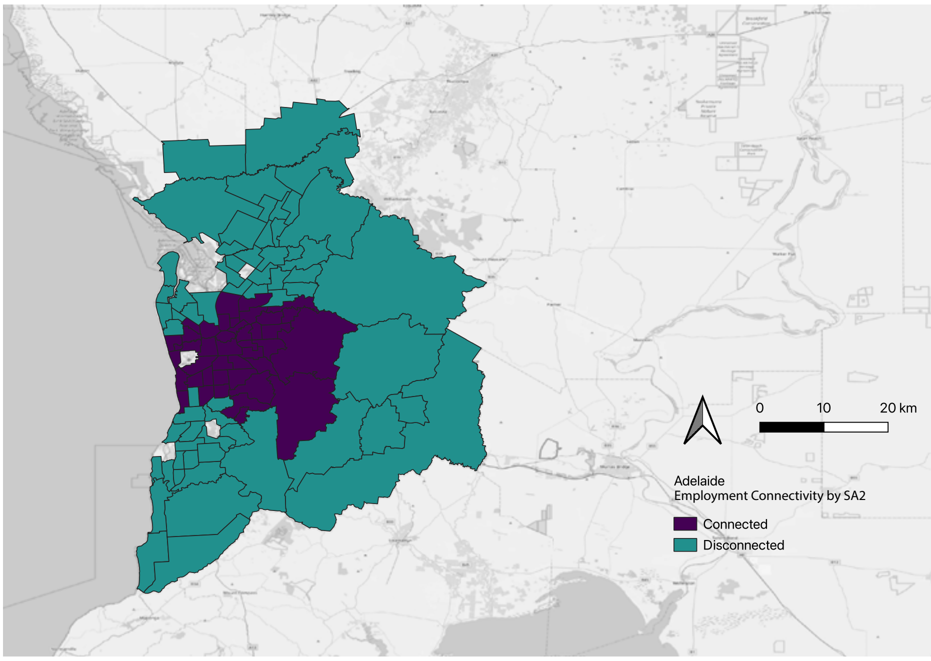
Figure 27: Functional neighbourhood typologies based on residential mobility, Adelaide



Source: Authors, based on 2016 ABS Census data.

Note: The blank areas are non-residential areas of extremely low population and have been excluded from the analysis.

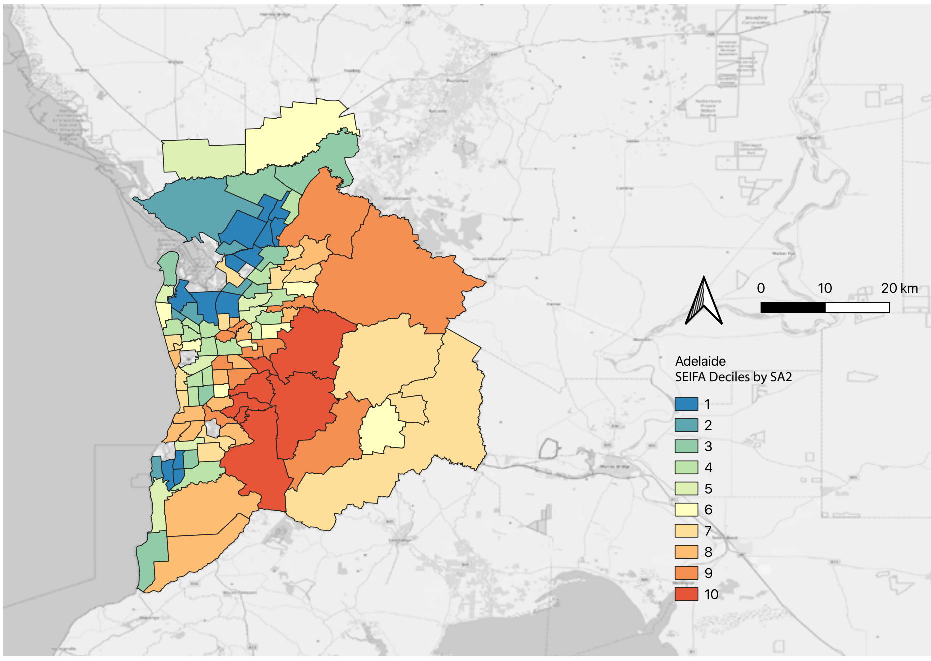
Figure 28: Employment connectivity typologies, Adelaide



Source: Authors, based on 2016 ABS Census data.

Note: The blank areas are non-residential areas of extremely low population and have been excluded from the analysis.

Figure 29: Neighbourhood SEIFA deciles, Adelaide



Source: Authors, based on 2016 ABS Census data.

Note: The blank areas are non-residential areas of extremely low population and have been excluded from the analysis.

5.3 Policy implications

These findings suggest that there are three areas to focus on.

1. The first area is the Connected Isolate neighbourhoods, which should be a focus for policy intervention. The policy focus should be on encouraging a mix of housing types and tenure in these areas, so that the barriers to entry for lower-income and moderate-income earners are lowered and policy can actively intervene against maintained or rising spatial segregation.
2. The second focus area is the Disconnected neighbourhoods across all four categories. Increasing transit and infrastructure accessibility for progressively more Disconnected neighbourhoods across all four functional typologies would ensure that they move towards being less exclusionary. Thus, policy focus should rest on a combination of provision of affordable housing options and improved access to transport.
3. The third main focus area is to provide extra support for the Connected Transit neighbourhoods—as they are highly porous and appear to play a major role in ensuring upward social mobility for lower-income and moderate-income earners. Support can be conceptualised through both housing policy and transport policy.

6. Conclusions: summary of findings, policy development options and implications

This research presents the results from a standalone data project on measuring neighbourhood change via residential mobility and journey to work. The motivation to measure neighbourhood change reflects the policy objective of providing increased accessibility to good affordable housing, infrastructure, amenities and services in-place, along with increased connectivity to employment opportunities for lower-income and moderate-income earners in a city.

Housing, land use and transport policies frequently focus only on increasing overall housing supply or providing increased transit or transport connectivity, and operate within the confines of the market. However, housing market structures and the spatial organisation of jobs and housing in a city are the result of stronger market forces that drive spatial concentration of people into segregated clusters, defined primarily on income stratification.

The usual way of defining neighbourhood change that adversely affects lower-income and moderate-income earners is through the terminology of gentrification and displacement:

- *Gentrification* is the process where land values in a neighbourhood rise because of redevelopment. This is accompanied by new residents moving in—generally people who earn higher incomes.
- *Displacement* is the parallel process. In-coming high-earning residents cause an outflux—usually forced—of lower-income renters from the neighbourhood into other lower-cost areas. Often these areas are characterised by lower levels of access to transport, services and employment opportunities.

There are ongoing debates in the research literature over appropriate measures of gentrification and displacement. This study developed a method for measuring existing spatial segregation and clustering, as well as levels of stasis or dynamism—which we describe as 'exclusion' and 'porosity'.

- An *exclusionary neighbourhood* is one that shows a high degree of spatial sorting by income and socio-economic status, and presents a barrier to entry for income earners of other bands.
- A *porous neighbourhood* is one that is open to dynamic movements of people to and from other neighbourhoods in the city, and presents very low barriers to entry for income earners of all bands.

Exclusionary neighbourhoods drive further gentrification, displacement and maintained exclusion, which increases the segregation effects. Conversely, porous neighbourhoods work to reverse segregation effects and increase integration effects, thereby contributing to enhanced social mix, cohesion and community wellbeing.

6.1 Measuring displacement and exclusion to inform policy

In general, measuring displacement presents several methodological difficulties. For example, it is difficult to differentiate voluntary migration and forced displacement:

- *voluntary migration*—a low-income or moderate-income family might choose to purchase a house in a lower-priced sub-market, moving out of a higher rent market
- *forced displacement*—a low-income or moderate-income family is forced out of a market due to unaffordability.

Thus, different quantitative methods identify wildly different sets of neighbourhoods undergoing gentrification and displacement. In turn, this affects how much displacement is measured, and any ensuing policy responses.

A much better idea might be to look at place-based characteristics of exclusion and porosity. This means that we are not interested in defining whether or not a certain neighbourhood is gentrifying and displacing people, but whether a certain neighbourhood remains open to movements in from and out to other areas that are lower or higher in the socio-economic-advantage hierarchy. Policy options can then directly focus on lowering barriers to entry for lower-income earners, providing affordable housing options—in both housing types and tenures—in neighbourhoods that are specifically identified as exclusionary, but are otherwise advantaged in terms of accessibility to employment, infrastructure, amenities, and social and economic opportunities.

Overall, this study finds that spatial sorting and the resulting socio-economic inequities should be an active focus for policy that should be addressed by all levels of Australian government through infrastructure, housing assistance and planning responses. Strategic infrastructure investment decisions intended to improve transport accessibility should be supported by policies that preserve and increase affordable housing opportunities—which would prevent displacement of lower-income residents. Strategic funding and planning interventions are also needed to increase the supply of affordable rental housing in accessible, jobs-rich areas to reduce socio-spatial segregation. State and local governments should monitor housing markets for displacement, exclusion and porosity at the neighbourhood scale in order to measure the impact of—and need for—particular planning and policy interventions.

Drawing on the functional neighbourhood typologies and employment connectivity typologies, this study identified three specific solution and evidence pathways for policy:

1. The first and most critical focus area is the Isolate neighbourhoods—especially those that are Connected. These are typically highly advantaged areas that are connected to the best services, infrastructure, and economic and social opportunities—but they present barriers to entry for lower-income and moderate-income earners. The policy focus should be on encouraging a mix of housing types and tenure in these areas, so that the barriers to entry for lower-income and moderate-income earners are lowered and policy can actively intervene against maintained or rising spatial segregation.
2. The second focus area is the Disconnected neighbourhoods across all four categories. Increasing transit and infrastructure accessibility for progressively more Disconnected neighbourhoods across all four functional typologies would ensure that they move towards being less exclusionary. Thus, policy focus should rest on a combination of provision of affordable housing options, as well as increased transport accessibility.
3. The third focus area is to provide extra support for the Connected Transit neighbourhoods, as they are highly porous and appear to play a major role in ensuring upward social mobility for lower-income and moderate-income earners. Support could be conceptualised through both housing policy and transport policy.

Current policies focus only indirectly on the adverse effects of spatial segregation and clustering. However, this research establishes that segregated cities arising naturally as a result of market forces are detrimental to social and economic wellbeing and stability—and should therefore become an explicit policy focus. This research framework can be strengthened in the future by developing more data sources that provide a finer spatio-temporal view of the movements of people within neighbourhoods in the city, and the reasons for their movements. The existing analytical methods—which have currently only been applied to the five-yearly census data—can then be applied to monitor and track neighbourhood change at finer longitudinal scales. This would enable policy to be more adaptive and responsive to market forces and neighbourhood changes as they occur.

6.2 Limitations

Quantitative analytics offer a narrow lens, as overall spatial patterns can be captured but not their detailed causal explanations. Thus, the findings of this study should be extended and enriched by further qualitative exploration and further quantitative statistical modelling. Conversely, many qualitative in-depth case studies could benefit from the large-scale, citywide quantitative research carried out in this study.

In this study, we have not addressed or tested different policy scenarios, but hope that our findings help to inform the potential development of policy responses to address gentrification.

Despite these limitations, this present study provides a new contribution to analyses and debates about processes of gentrification, displacement and exclusion in Australian cities, and should inform the development of new policy aspirations supporting greater porosity or housing opportunity across established and new communities.

6.3 Policy development implications and options

The findings of this study have important implications for Australian urban and housing policy. They reveal the extent of socio-spatial sorting and segregation in the nation's five largest capital cities, based on 2016 Census data. The findings suggest that spatial sorting and the resulting socio-economic inequities should be an active and explicit focus for policy—rather than a weak, passive or implied response targeted through other strategies—and should be addressed at all levels of Australian government through infrastructure, housing assistance and planning responses. Key priorities and options include the following:

- Recognising that infrastructure and planning interventions may exacerbate existing housing market pressures, as they reinforce processes of gentrification, displacement and exclusion of lower-income earners—including key workers and those with long-term connections to the location.
- Recognising the need for state and local governments to monitor housing markets for displacement, exclusion and porosity at the neighbourhood scale. This is in order to measure the impact of—and the need for—particular planning and policy interventions.
- Recognising that strategic infrastructure investment decisions intended to improve transport accessibility should be supported by policies that preserve and increase affordable housing opportunities. This is to prevent displacement of lower-income residents.
- Recognising more broadly that strategic funding and planning interventions are also needed to increase the supply of affordable rental housing in accessible, jobs-rich areas in order to reduce socio-spatial segregation and exclusion.

6.4 Final remarks

This study developed indicators of neighbourhood change using residential mobility and employment data. Overall, the report found that spatial sorting and segregation is increasing in Australia's five largest capital cities. Over time, spatial sorting and segregation in Australian cities is driven primarily by income and economic-band segregation. Segregation is driven by the upper end: high-income earners and very-high-income earners cluster into tight spatial groups, which means that these neighbourhoods then become isolated and exclusionary for moderate-income, low-income and very-low-income earners. The residential exclusion and the employment connectivity profiles combine to create conditions that exacerbate spatial inequalities in cities.

The indicator developed for neighbourhood change characterises the exclusionary or porous capacity or potential for each neighbourhood. This indicator should be used to inform policy on spatial interventions that can work to reduce spatial inequalities and inequalities of housing, transport, employment and infrastructure access in major capital cities.

First, this study employed a specific set of variables, which produced a set of analytical measures. However, the study of gentrification and displacement is a rapidly growing area of research and policy focus internationally. There are many more approaches, datasets, tools and techniques that can be used as alternative lenses. For example, many gentrification studies also employ a full suite of land price, housing market price and rent structures—along with other demographic characteristics such as occupations and industry-based employment numbers—to characterise gentrification, displacement and exclusion. In future studies, extensions to the methods proposed here are feasible.

Second, the results presented here are only as good as the availability of data. Since census data is captured once every five years in Australia, augmenting these analyses with datasets that are finer in spatial terms—and especially temporal terms—would really provide the scope for richer insights.

The same analyses, repeated for the 2016–2021 census period, will reveal changes that have occurred in the most recent five-year period.

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