Infrastructure investment and housing supply

SGS Economics & Planning

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Findings

This study has found that:

- A location's access to employment and service opportunities, measured by its '*effective job density (EJD*[1]*)*', is a key explanatory factor in its attraction of apartment construction activity.
- Investment in transport infrastructure can galvanise apartment activity in a location, but the infrastructure in question needs to be of sufficient scale and scope to substantially boost an area's linkages to major employment nodes. More minor transport upgrades which improve localised circulation are less likely to substantially lift apartment activity.
- The nexus between EJD boosting transport projects and housing intensification appears to be much stronger in Melbourne than Sydney, but this may reflect data limitations in Sydney rather than inherent behavioural differences.
- Correctly targetted 'city shaping' transport infrastructure can effectively boost the supply of housing land within existing urban footprints, by raising the intensity of its use. Such expansion in effective land supply for housing can place downward pressure on housing prices, other things equal.
- Optimising the housing benefits from major transport investments requires a suite of supportive policies including development assessment reforms, active involvement of public sector development corporations, various forms of land value capture and mechanisms to ensure that areas undergoing intensification maintain a reasonable supply of affordable housing.

Purpose

Recent Australian research suggests that improving the connectivity of housing developable land, whether this be situated in the established urban footprint or on the urban fringe, may improve the housing yield from these areas. This is premised on the hypothesis that households will be prepared to give up some space in return for better access to employment and service opportunities.

To explore these issues, the current study set out to address the following questions:

- To what extent can infrastructure investment that improves connectivity and accessibility within a metropolitan district boost its housing productivity?
- What would this uplift in housing development potential and yield amount to in terms of residual land value?
- What kinds of supplementary or complementary public sector initiatives, by way of statutory planning adjustments, land assembly, demonstration projects and value capture, amongst other things, are required to optimise the latent housing potential generated by investment in transport infrastructure?

The research method focussed on two metropolitan case examples – Sydney and Melbourne. In broad terms the principal study tasks were as follows:

[1] EJD is statistical index of agglomeration in economic activity; it comprises the number of jobs in a locality plus all the jobs situated elsewhere that can be reached from that locality, divided by the travel time involved in reaching them. In this context, the number of jobs is a proxy for firms.

- For each metropolis in turn, cross sectional micro area data on housing density, housing development and transport infrastructure was analysed to identify the elasticity of housing yield versus connectivity and accessibility versus a comprehensive field of other explanatory variables.
- A base case scenario for housing development across these metropolitan areas was defined assuming no major investment in transport projects.
- Alternative scenarios were posed representing an uplift in accessibility and connectivity across the metropolitan areas, contingent upon the implementation of major transport projects.
- Applying the elasticities identified earlier, the increase in housing development and mix (by type and geography) across the metro areas and the associated uplift in land value occasioned by the investment in transport infrastructure were estimated assuming no change in statutory planning settings and facilitation strategies.
- Desk top research was conducted to identify the types of planning, governance, funding and other interventions required to make the most of the housing boost promised by investment in major transport projects.

Current housing patterns

Prior to the statistical exploration of the links between investment in transport infrastructure and housing development, the study profiled housing conditions across the two metropolises. This found that new housing development in Melbourne and Sydney has been of a denser form than the existing stock. This is particularly evident in Sydney. Unsurprisingly, perhaps, apartment growth in both cities has been focused in inner locations and near public transport, while detached housing construction has been focused in outer growth corridors. In general housing development in Melbourne has been more polarised than Sydney; that is, Sydney features a more distributed pattern of non-detached housing, reflecting its more pronounced 'poly-centric' character compared to Melbourne.

Estimated housing impacts of major infrastructure projects

Statistical analysis suggests that, in Melbourne, an area's potential to attract apartment construction is, in large part, dependent on:

- Relative Effective Job Density (EJD). EJD is a composite index of an area's accessibility. It embodies travel time by all modes to employment and service opportunities from any given location. Areas with higher EJD were found to have a greater share of the net change in apartments.
- Location in coastal areas.
- Location near universities.

Compared to the *East/South East regions* of the metropolitan area, the *North/West regions* are likely to have a slightly higher share of the net change in apartments, possibly due to the more accommodating Council attitude to development in these areas.

Together, these four factors explained some 43% of the variation in apartment activity across the established parts of the Melbourne metropolitan area between 1996 and 2011.

A similar set of factors was found to be shaping the geography of apartment activity in metropolitan Sydney, though the influence of connectivity was found to be weaker than in Melbourne. This may be a function of data constraints in Sydney, where only a more limited form of statistical analysis was possible.

The key explanatory variables in Sydney were found to be:

- Relative EJD;

- The situation of an area within a targeted urban renewal site; and
- Location near universities.

These factors explained almost 50% of the variation in apartment activity, though as noted, with a lower coefficient for EJD.

A key finding from the research is that infrastructure investment must be of sufficient scale to influence EJD if it is to materially affect the propensity for apartment activity. More minor or localised transport projects, such as light rail extensions or bus improvements, may not have a substantial impact on housing outcomes (though they may well be warranted on other grounds).

Scenario testing of major project impacts

A scenario approach was taken to assessing the impact of transport projects on housing supply and urban form. This contemplated investment in 'major' or 'city-shaping' rail and road projects in Melbourne and Sydney. The projects were not specified in terms of route, service levels and cost but, rather, in terms of their assumed impacts on EJD in different parts of the city.

Implicitly, the projects in question were deemed to be of the same scale and scope as investments such as CityLink or the metropolitan Rail Loop in Melbourne, and the M7 Orbital in Sydney. That is, they are assumed to substantially shift accessibility contours across these cities.

The scenarios are 'realistic' in the sense that assumed impacts are benchmarked against those achieved in earlier, similar projects.

The Sydney and Melbourne metropolitan areas were divided into three broadly comparable concentric rings covering inner, middle and outer suburbs. Each ring was applied an assumed percentage uplift in relative EJD arising from the notional transport projects. As noted, these uplifts were based on previous work completed by SGS on major transport infrastructure projects. However, they should be interpreted as hypothetical scenarios, devised for analytical purposes only.

The percentage EJD uplifts are shown below. They were set at slightly higher levels for Melbourne reflecting the less fragmented structure of that metropolis.

ASSUMED PERCENTAGE UPLIFTS TO RELATIVE EJD BY RING

Ring	Melbourne	Sydney
Inner	14%	10%
Middle	7%	5%
Outer	2%	1%

Source: SGS Economics & Planning

The table below presents the outcomes from four hypothetical scenarios regarding increases in apartment activity and land values, and the reduction in land areas required for urban fringe expansion, assuming that the EJD uplifts shown above have taken full effect over the period 2011-2031. The four scenarios are as follows:

- Outcomes in Sydney with Sydney equation and EJD coefficient
- Outcomes in Sydney with Sydney equation and Melbourne EJD coefficient
- Outcomes in Melbourne with Melbourne equation and Sydney EJD coefficient
- Outcomes in Melbourne with Melbourne equation and Melbourne EJD coefficient.

This procedure encompassed a form of sensitivity testing, recognising that the estimated Sydney elasticities were beset with data limitations. By cross-deploying the city elasticities, the broad range of possible outcomes in urban development could be explored.

The impacts using the Melbourne EJD coefficient are much larger than those where the Sydney EJD coefficient is used, given the stronger statistical relationship that was observed between accessibility (EJD) and higher density housing development in Melbourne. However, the land value uplift is shown to be higher in Sydney than in Melbourne due to the higher residual land values that occur in Sydney. As a result of the transport investment increasing housing density in the existing urban area, the amount of land that would be required on the urban fringe for detached housing is reduced in both cities. In Melbourne, the reduction in land required for urban fringe expansion resulting from this hypothetical scenario was estimated to be 7,500 hectares. This represents 3% of the existing urban area of Melbourne. In Sydney using the Sydney EJD coefficient scenario the reduction in urban fringe land was estimated to be 933 hectares, equivalent to 0.2% of the existing urban area.

SYDNEY AND MELBOURNE SCENARIO OUTCOMES

	Sydney Metropolitan Outcomes		Melbourne Metropolitan Outcomes	
	With Sydney EJD coefficient	**With Melbourne EJD Coefficient**	**With Sydney EJD coefficient**	**With Melbourne EJD Coefficient**
Additional apartments	14,000	109,100	14,400	112,700
Proportion of base case stock	9%	72%	13%	101%
Land value uplift ($millions)	3,958	28,037	2,879	22,130
Reduction in land required in urban fringe expansion (ha)	933	7,273	960	7,513
Share of existing urban area	0.2%	1.8%	0.4%	3.0%

Source: SGS Economics & Planning

Optimising the benefits from city shaping transport projects

In terms of policy responses to optimise the housing supply impacts from major infrastructure projects, the research suggests that the area of influence of key transport investments such as those cited in the aforementioned scenarios can be broken down into the following components:

- The **zone of *moderate* EJD impact** defined by the aggregation of those small areas which collectively accommodate (say) two thirds of the EJD uplift generated by the project. In this broader sphere of influence of major transport investments, the principal policy thrust may be to make the general planning system work better. Important themes in this regard include; depoliticising the planning process by applying subsidiarity to the allocation of plan making roles across the different levels of governance; following the Development Assessment Forum principles for greater use of code assessable and independent panel assessable development applications; and ensuring greater transparency and conceptual clarity in the application of upfront development contributions.
- The **zone of *high* EJD impact** defined by those areas collectively enjoying (say) a 50% share of the total lift in effective job density. **Key redevelopment districts** showing a heightened potential for transport induced housing intensification are likely to be situated within this zone of high EJD impact. Here the principal policy focus may be on commissioning State development corporations to overcome barriers to private sector investment in housing and related regeneration projects. Such barriers or market failures include land fragmentation, land contamination, local infrastructure gaps and poor co-ordination between government land holders.
- **Land value capture districts** which would involve a conservative 'in-board' delineation of the zone of moderate EJD impact. This can be seen as the 'benefitted area' of the transport project and might be a candidate for special funds raising strategies linked to the uplift in land value enjoyed by constituent properties. A range of mechanisms can be used to capture a portion of this land value uplift for reinvestment in infrastructure, including area wide 'regional level' infrastructure contributions (as per those contemplated in the current White Paper on a new

planning system for NSW) or specific district taxes (along the lines of the historic Melbourne Underground Rail Loop levy).

In terms of **affordable housing**, the research confirms that investment in city shaping transport projects can effectively expand the supply of land available for housing development. Other things equal, this will place downward pressure on housing prices.

Spatially, this affordability benefit from an expanded land supply is likely to be felt most in outer urban and less well connected parts of the metropolis, which will have to compete more strenuously on price to attract buyers and tenants. Areas enjoying a boost in connectivity and therefore higher housing activity can be expected to maintain a price premium (though this might escalate at a slower pace compared to a scenario where the city shaping transport project is not built).

For reasons of community sustainability and local economic functionality (e.g. access to key workers), the reservation of some housing for lower and middle income groups in the EJD uplift areas, particularly in zones of high EJD impact, is likely to be warranted. This can occur in one of two ways (or a combination thereof):

- Dedicating a proportion of the proceeds from any tax on broad area value uplift to the provision of social housing in these advantaged areas
- Applying area wide inclusionary zoning so that all development in the advantaged areas are required to incorporate a proportion of affordable housing or make cash in lieu contributions so that this obligation might be met elsewhere within the same broad district..

INTRODUCTION

1 INTRODUCTION

1.1 The challenges of housing supply in the sprawling metropolis

It has become clear through a succession of NHSC reports and other recent research that the housing supply conundrum in Australia ranges well beyond questions of aggregate land supply and the cost of labour and materials that go into dwelling construction. For example, facilitating land release on the urban fringe may once have been a valid strategy for boosting supply side elasticity, but is now increasingly problematic given the prodigious spread of Australia's large cities and the inward drift of higher order jobs.

In the more modestly proportioned Sydneys and Melbournes of the long post war boom, residents on the urban fringe could reach a reasonably large share of what the metropolis had to offer in employment, education and recreational opportunities. This share is now being eroded as new suburbs are established in ever more distant locations.

By way of illustration, when the suburb of Lynbrook, just north of Cranbourne in Melbourne's south eastern growth corridor, was in its early development phase in 1996, new residents could reach more than 370,000 jobs within a 30 minute drive in the morning peak. This represented almost a quarter of the total jobs in metropolitan Melbourne.

Fast forward to 2011 and the suburb of Cranbourne East, which is in the next batch of fringe urban development in the south eastern growth corridor. At this time, these new subdivisions were at a similar early stage of development as Lynbrook had been 15 years earlier. Between 1996 and 2011, the total metropolitan job stock had grown by almost 40 percent. But the pool of jobs accessible within a 30 minute drive for the new residents of Cranbourne East had shrunk to about 345,000, representing only 16 percent of all jobs in Melbourne. The Cranbourne East residents also faced a sharp fall in access to knowledge intensive jobs. They could reach eight percent of Melbourne's high paying services jobs within a half hour drive, compared to 14 percent for the Lynbrook pioneers back in 1996.

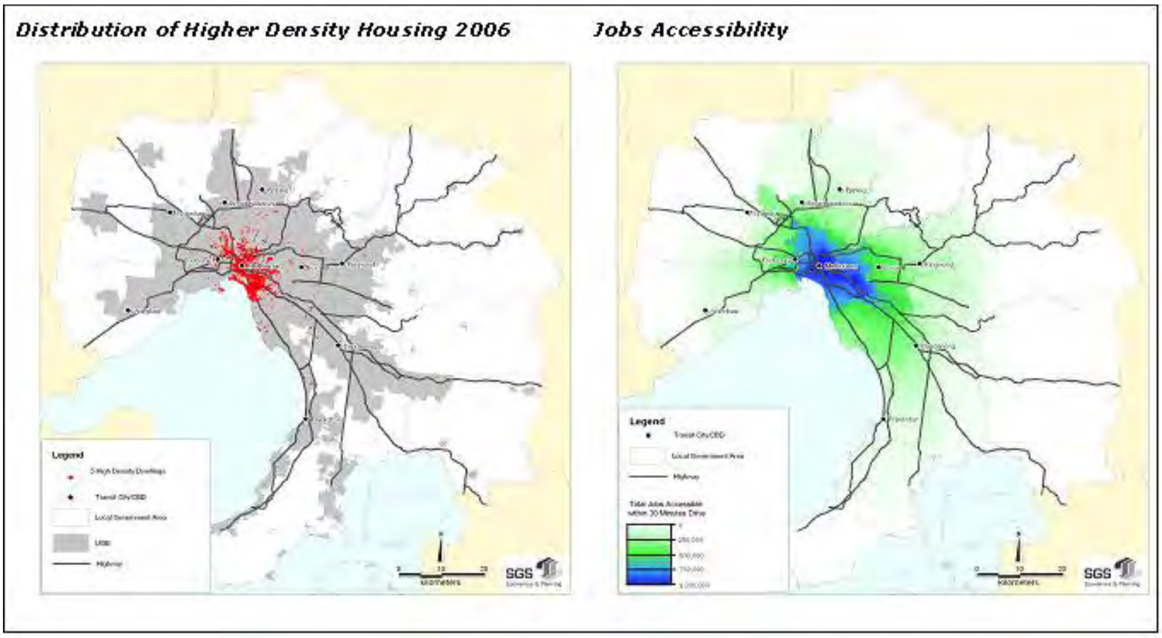
To be effective, housing supply needs to be well connected to employment, education, health, retail and other urban services. Without these connections, there is a significant risk of foregone human capital development as households on the urban fringe are denied learning opportunities delivered through job churn as well as formal training. Moreover, there is anecdotal evidence that households are beginning to think twice about taking up these fringe housing opportunities in the bigger cities, notwithstanding their relative affordability, because they curtail life opportunities for families.

Meanwhile, improving the connectivity of housing developable land, whether this be situated in the established urban footprint or on the urban fringe, appears likely to improve the housing yield from these areas. This is premised on the hypothesis that households will be prepared to give up some space in return for better access to opportunity.

A relationship of this kind is broadly evident in Figure 1, taken from previous SGS research. In terms of greenfield development, SGS has estimated that the extension of rail services to growth areas in Melbourne's north would enable a 20 percent lift in housing yield (i.e. density) within the 10 minute drive catchments of stations[2].

[2] SGS Economics & Planning Pty Ltd (2007) *Epping to South Morang Rail Extension; Housing Affordability, Sustainability, Urban Form and Economic Impacts*, a report prepared for the City of Whittlesea

FIGURE 1. ACCESSIBILITY AND THE DISTRIBUTION OF HIGHER DENSITY HOUSING



Source: SGS, data from ABS Census and DoT Travel Time Matrices

In short, it would appear that better transport can effectively *expand the supply* of land available for housing other things equal.

In recent work completed for the Residential Development Council (RDC), SGS found that the quality of public transport services in an area is a strong determinant of achievable density. Indeed, the apparent strength of this relationship suggests that investments in this infrastructure could operate as a de facto land supply initiative as well as an exercise in transport management. However, the same work found that the public policy challenge involved in reforming the planning, funding and delivery of transport improvements so as to support housing development ought not be underestimated. It would require something of a 'step change' in transport planning philosophy and practice across the metropolitan areas.

1.2 Research questions

Against this background, the current project set out to address three questions:

- To what extent can infrastructure investment that improves connectivity and accessibility within a metropolitan district boost its housing productivity?
- What would this uplift in housing development potential and yield amount to in terms of residual land value?
- To what extent might supplementary or complementary public sector initiatives, by way of statutory planning adjustments, land assembly, demonstration projects and the like, provide a further premium on the housing yield boost made possible by infrastructure investment?

1.3 Method

The research method pursued by SGS was broadly as follows:

- For Sydney and Melbourne, cross sectional micro area data on housing density and transport infrastructure was analysed to identify the elasticity of housing yield versus connectivity and accessibility versus other explanatory variables.
- A base case scenario for housing development across these metropolitan areas was defined assuming no major investment in 'city shaping' transport projects.
- Alternative scenarios were posed representing an uplift in accessibility and connectivity across the metropolitan areas, contingent upon the implementation of major transport projects.
- Applying the elasticities identified earlier, the increase in housing development and mix (by type and geography) across the metro areas and the associated uplift in land value, occasioned by the investment in transport infrastructure was estimated assuming no change in statutory planning settings and the involvement of development corporations and other implementation agencies.
- Desk top research was conducted to identify the types of planning, governance, funding and other interventions required to optimise the housing boost promised by investment in major transport projects.

HOUSING DEVELOPMENT TRENDS

Independent insight.

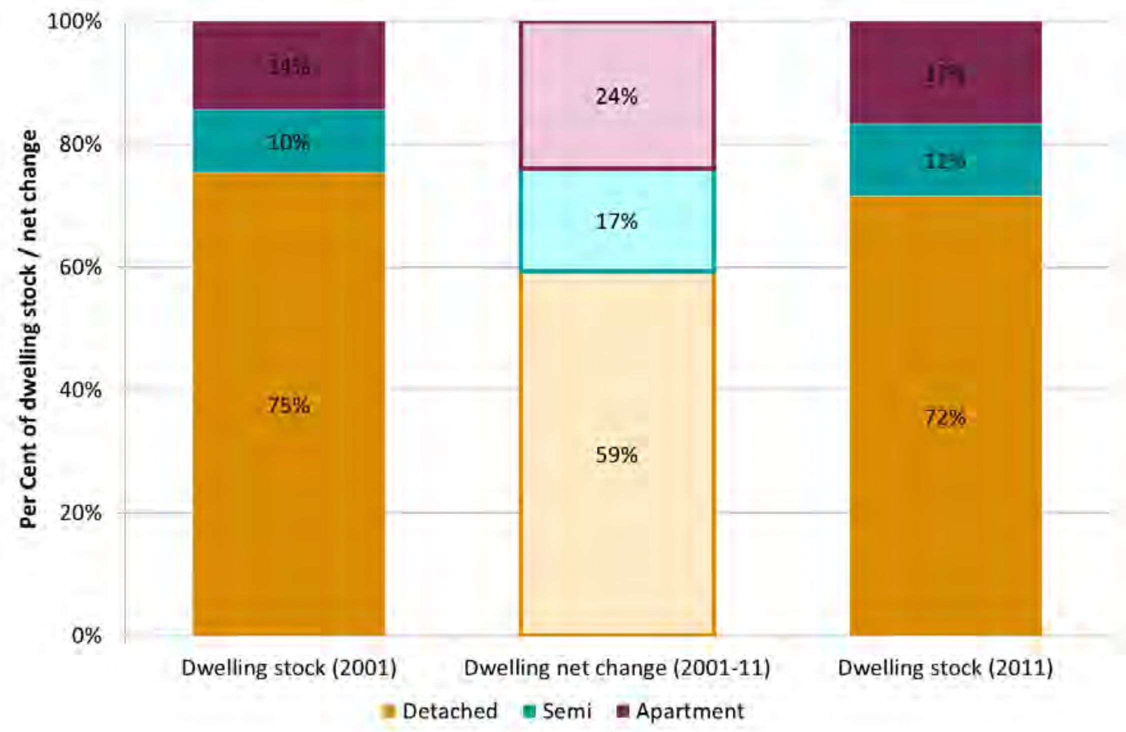
2 HOUSING DEVELOPMENT TRENDS

This section provides a brief overview of housing development trends evident in Melbourne and Sydney. The preliminary analysis seeks to distil any broad trends, particularly with regard to transport infrastructure, prior to the detailed statistical regression analysis.

2.1 Housing development trends

Melbourne[3] has 1.6 million dwellings, predominantly in the form of detached housing (72 per cent as of 2011). Approximately 25-35,000 dwellings are added to the housing stock each year. Over the past 10 years there has been increasing diversity in the new housing stock produced, with more apartments and semi-detached housing (see Figure 2). However, the majority (59 per cent) has still been traditional detached housing. This change in the type of housing stock has had a relatively small impact on the overall mix of housing in Melbourne.

FIGURE 2. **DWELLING STOCK AND NET CHANGE BY TYPE, MELBOURNE 2001-11**

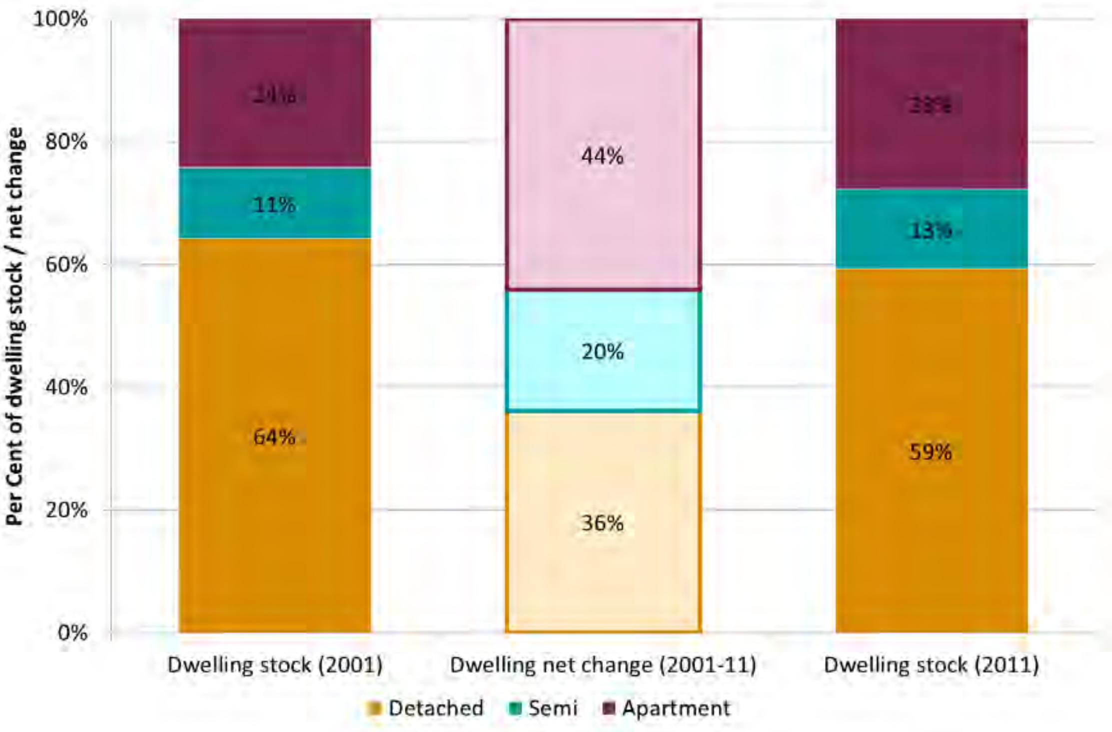


Source: 2001 -11 ABS Census

[3] For the purposes of this analysis "Melbourne" is defined based on its urban extent. Surrounding peri-urban and rural areas have been excluded even if within the Greater Melbourne SD/GCCSA. Refer to Figure 13.

Sydney[4] has 1.7 million dwellings, also predominantly in the form of detached housing (59 per cent as of 2011). At present, approximately 20-30,000 dwellings are added to the housing stock each year. Over the past 10 years there has been increasing diversity in the new housing stock produced, with more growth in apartments than detached housing (see Figure 3). Unlike Melbourne, the lion's share of growth (44 per cent) has been in apartments. This change in the type of housing stock has had a significant impact on the overall mix of housing in Sydney.

FIGURE 3. **DWELLING STOCK AND NET CHANGE BY TYPE, MELBOURNE 2001-11**



Source: 2001 -11 ABS Census

Distribution of recent housing development

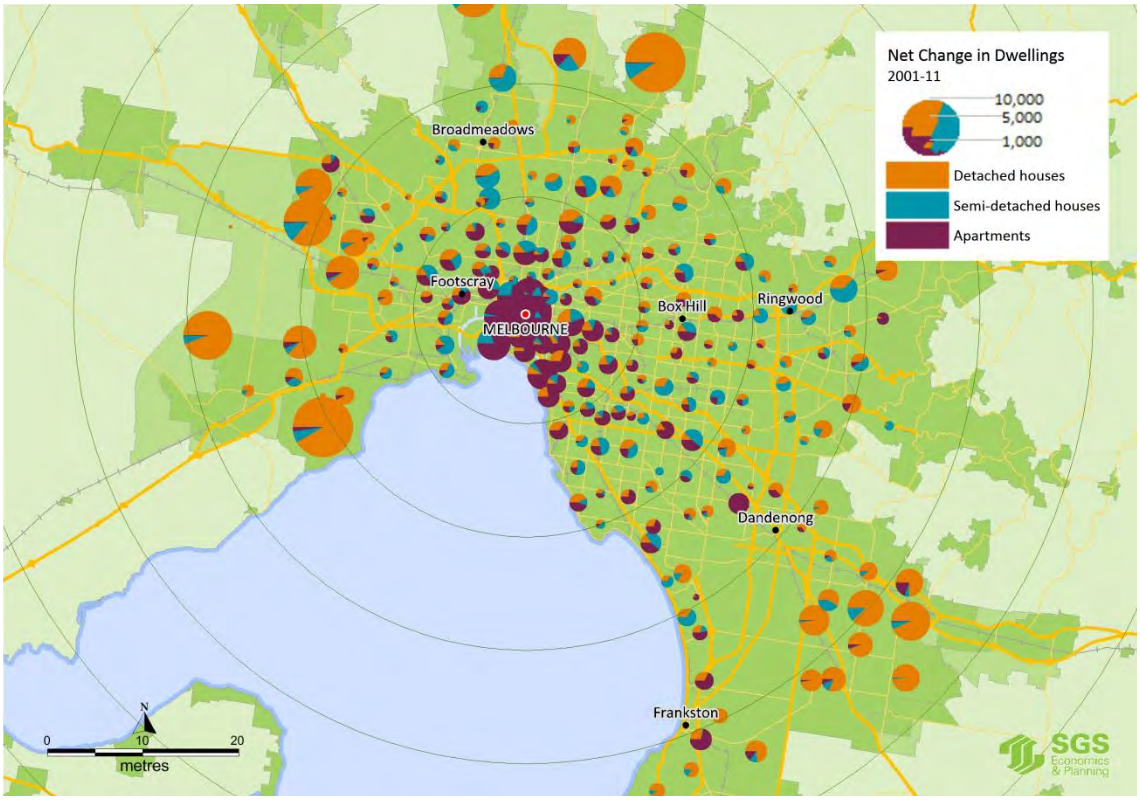
Figure 4 and Figure 5 present the spatial distribution of the net change in the housing stock by development types in Melbourne and Sydney. The size of each circle represents the amount of change and the segments represent the type of housing development. From this, two broad trends can be seen:

- There has been a significant amount of development in the outer growth corridors. This development has predominately been in the form of detached housing.
- There has also been significant development in the inner core of Melbourne and Sydney. This development has predominantly been apartments.

Comparison of the two maps also shows the dominance of apartments in Sydney versus the situation in Melbourne, and Sydney's more accentuated polycentric nature, with particular centres such as Parramatta containing a significant number of apartments.

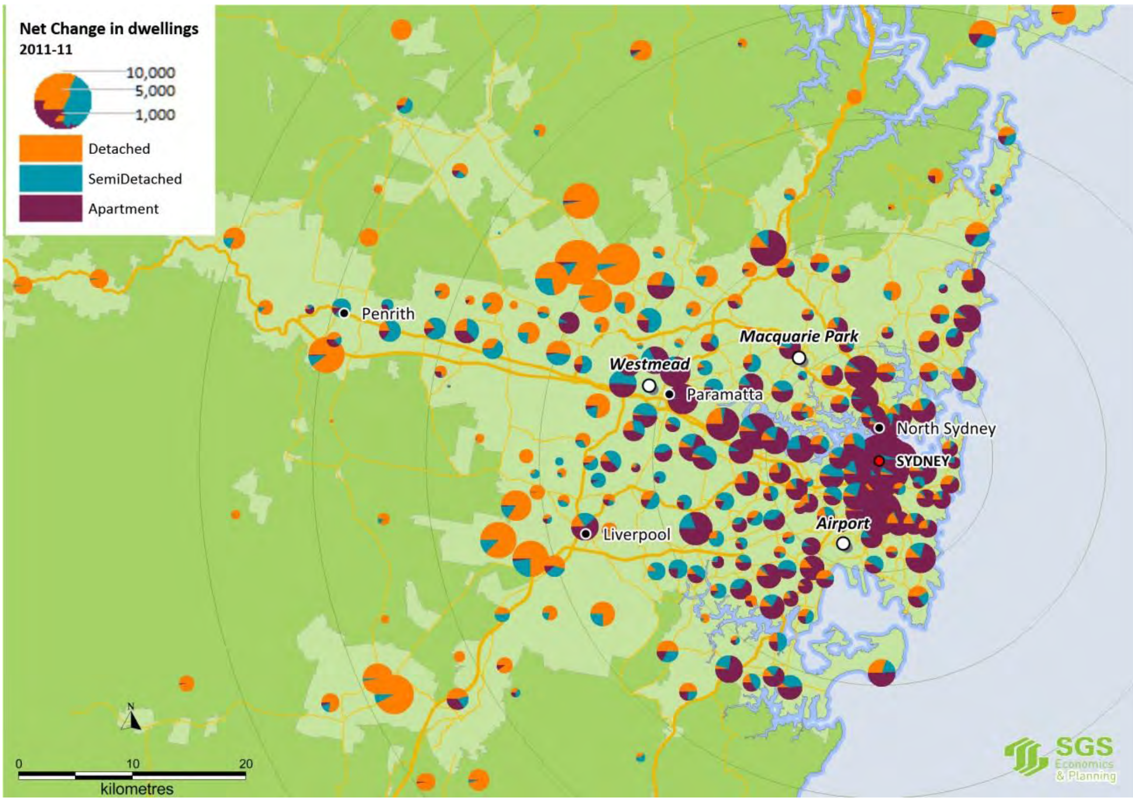
[4] For the purposes of this analysis "Sydney" is defined based on its urban extent. Surrounding peri-urban and rural areas have been excluded even if within the Greater Sydney SD/GCCSA. Refer to Figure **13**.

FIGURE 4. **DISTRIBUTION OF DWELLING NET CHANGE, MELBOURNE 2001-11**



Source: 2001 to 2011 ABS Census

FIGURE 5. **DISTRIBUTION OF DWELLING NET CHANGE, SYDNEY 2001-11**



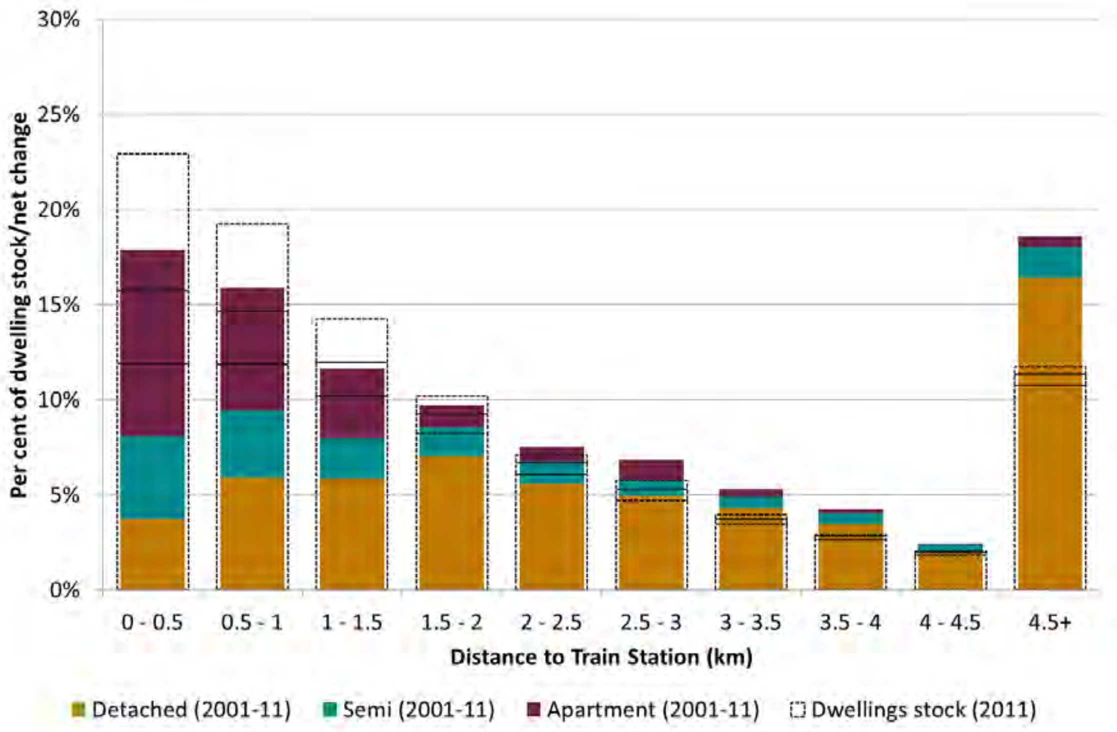
Source: 2001 to 2011 ABS Census

Further analysis of this recent change in housing by access to public transport infrastructure (measured through the distance to a train station) and general accessibility to jobs and services (measured through Effective Job Density) suggest there is a correlation. The following figures present the distribution of the net change in housing by three housing development types. The distribution of the existing housing stock has also been included as a dotted line for comparison.

Effective Job Density
EJD is a measure of agglomeration based on the number of jobs within all of Melbourne discounted by the time taken to access them by car or public transport. It is an index measure where the higher score represents a more agglomerated area. An area can be highly agglomerated either by having a high concentration of jobs (i.e. the CBD) or by having strong transport connections to lots of jobs, or a combination of both.

From Figure 6 it can be seen that compared to the existing housing stock there is relatively less development occurring within close proximity to a train station in Melbourne. 20 per cent of new housing was over 4.5 km from a train station and this was predominantly detached housing. The vast majority of development occurring near train stations is either apartment or semi-detached housing. This reflects the intensification and urban renewal development activity occurring around many stations within the existing urban areas of Melbourne.

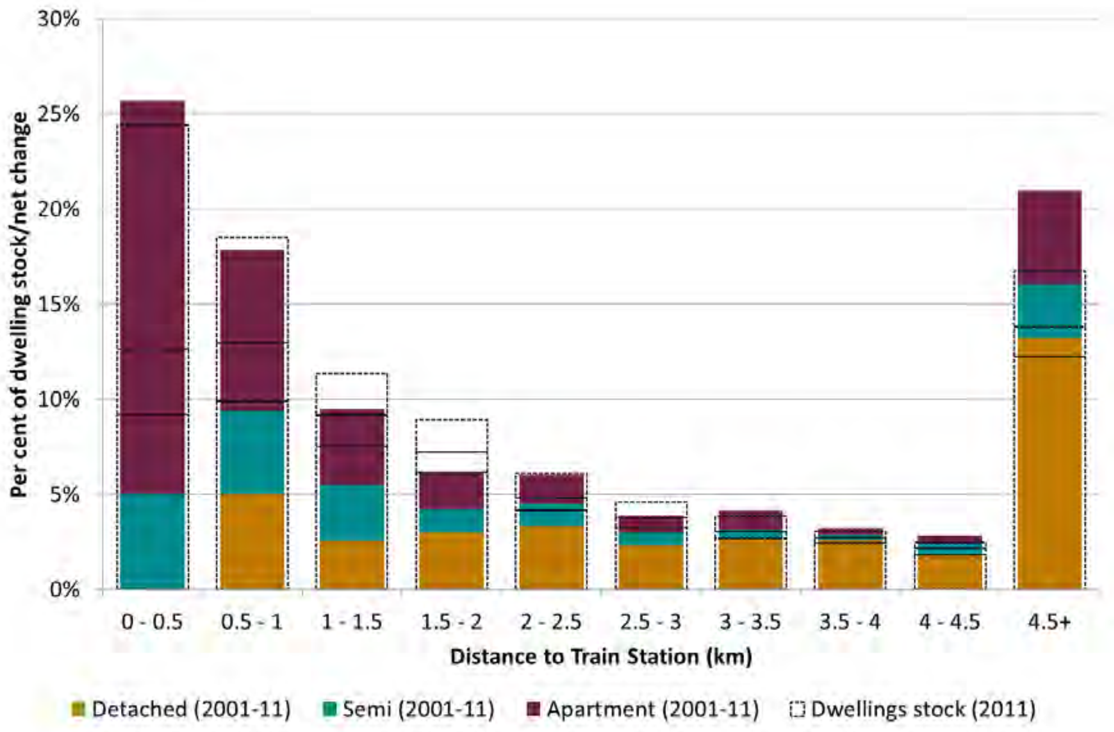
FIGURE 6. **DWELLING NET CHANGE BY DISTANCE FROM A TRAIN STATION, MELBOURNE 2001-11**



Source: 2001 to 2011 ABS Census

In Sydney however, there was significantly more housing growth occurring within 1 km of a train station (see Figure 7), which was predominantly apartments and semi-detached housing. There was still approximately 16 per cent of new housing occurring outside of a 4.5 km radius of a train station in Sydney, mostly as separate houses.

FIGURE 7. **DWELLING NET CHANGE BY DISTANCE FROM A TRAIN STATION, SYDNEY 2001-11**

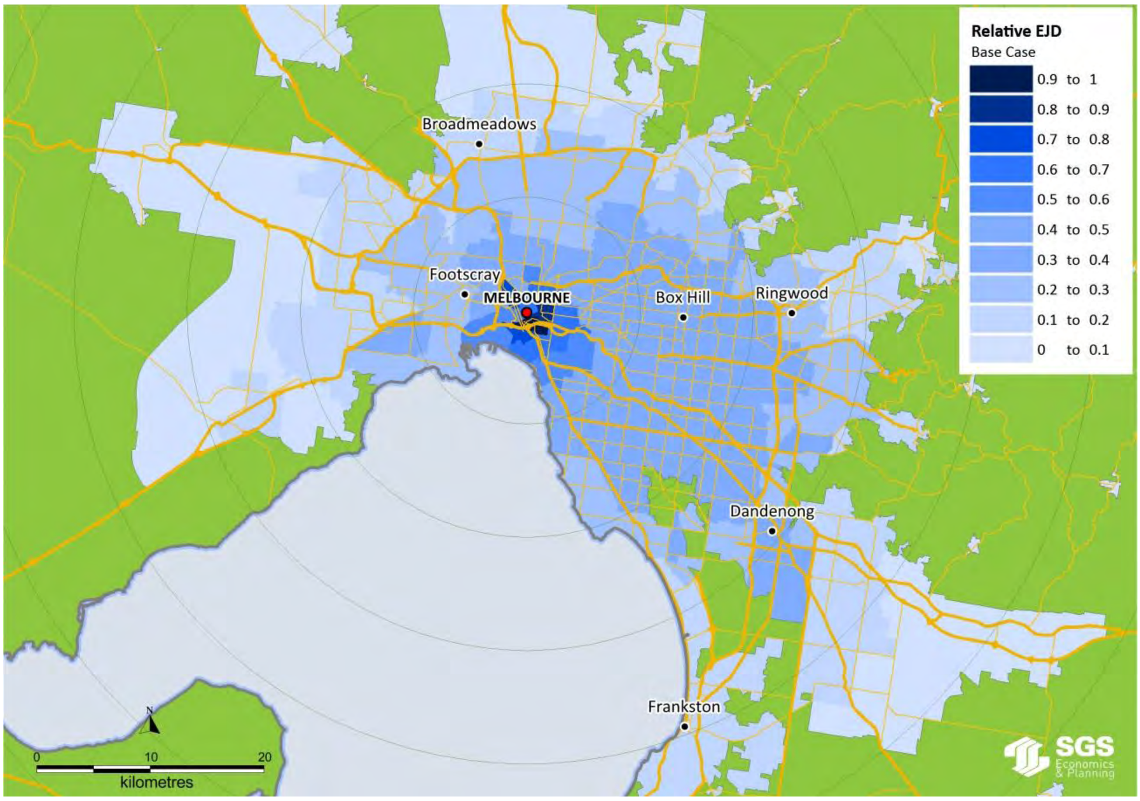


Source: 2001 to 2011 ABS Census

Figure 9 presents the change in housing stock by relative Effective Job Density (EJD)(see Figure 8). From this it can be seen that within those locations with a very high level of agglomeration (relative EJD closer to 1) there has been a greater proportion of development compared to the existing housing stock. This has been predominantly apartment type housing. Locations with lower levels of relative EJD experienced strong growth in detached housing.

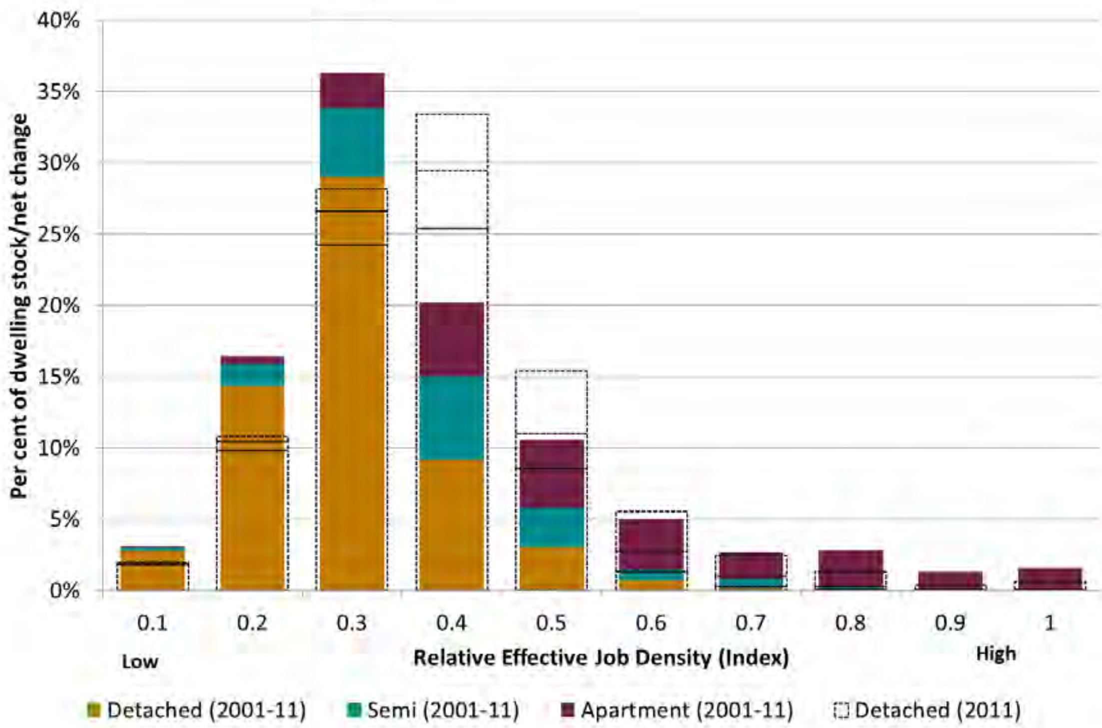
For Sydney, housing development was more dispersed across the levels of relative EJD, see Figure 10 and Figure 11. A greater proportion of new development compared to the existing stock occurred at high levels of agglomeration. In Sydney, there was also significant apartment growth at lower levels of relative EJD (between 0.3 and 0.5) which was not the case for Melbourne.

FIGURE 8. **RELATIVE EFFECTIVE JOB DENSITY, MELBOURNE**



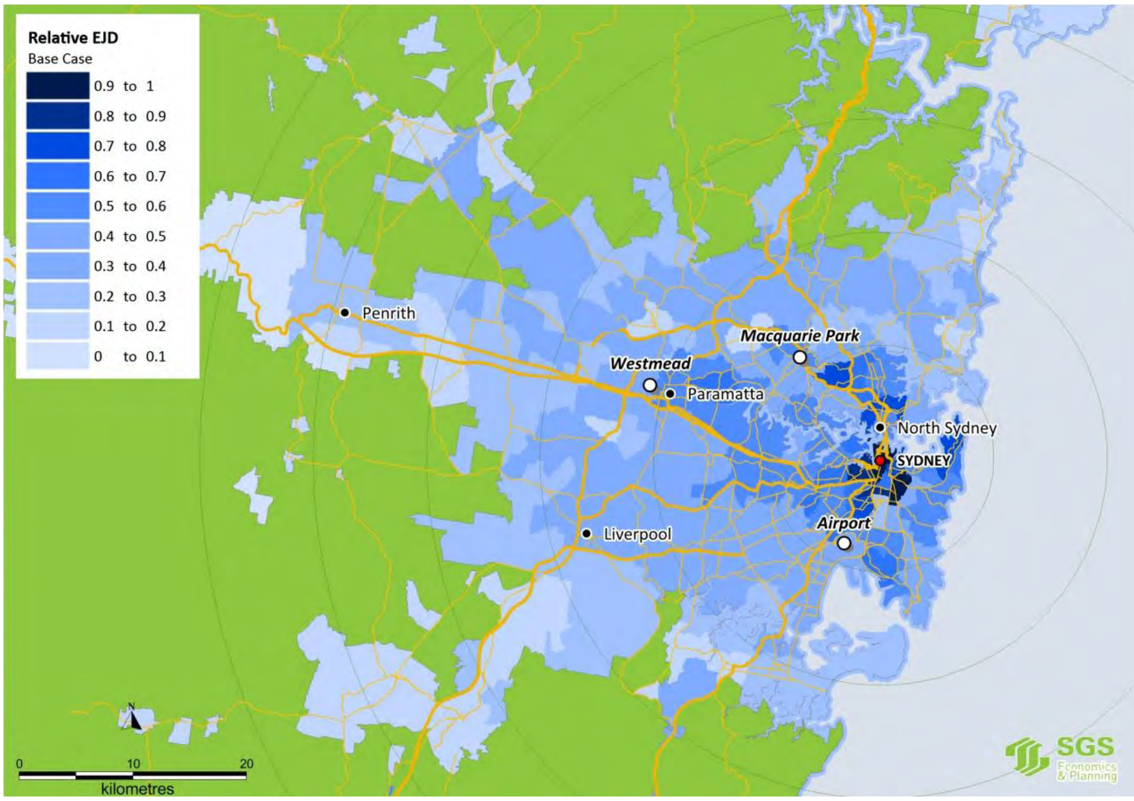
Source: SGS Economics and Planning

FIGURE 9. **DWELLING NET CHANGE BY RELATIVE EFFECTIVE JOB DENSITY, MELBOURNE 2001-11**



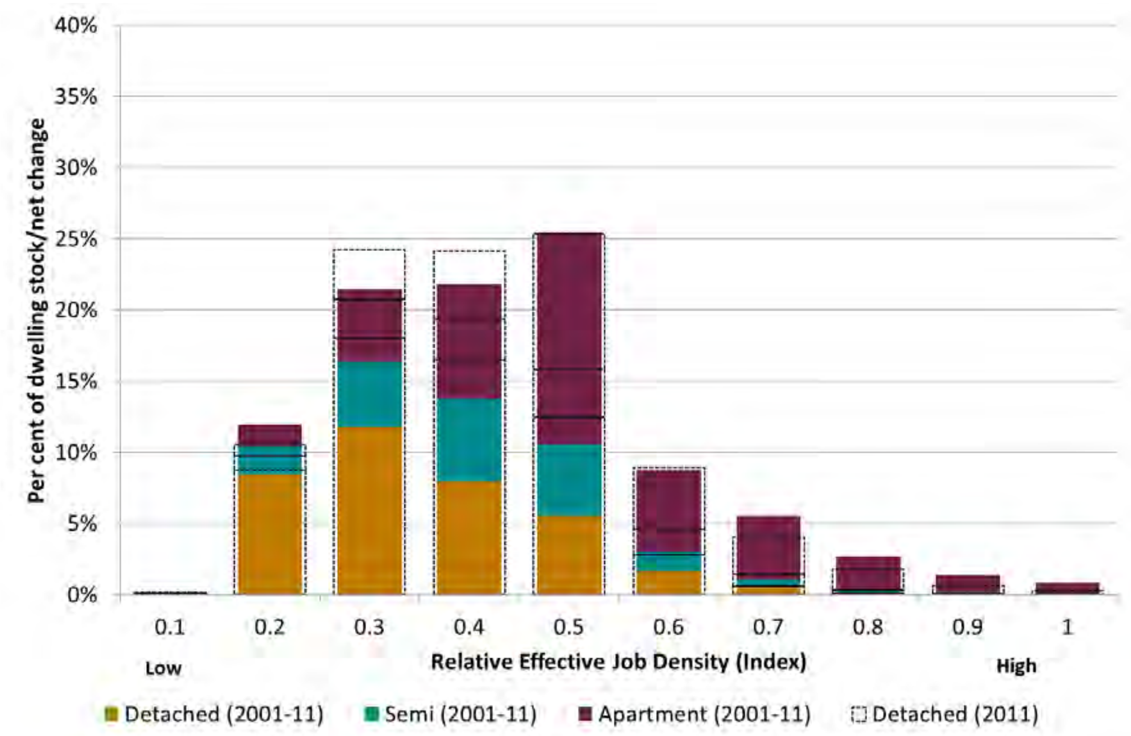
Source: 2001 to 2011 ABS Census and SGS Economics and Planning

FIGURE 10. **RELATIVE EFFECTIVE JOB DENSITY, SYDNEY**



Source: SGS Economics and Planning

FIGURE 11. **DWELLING NET CHANGE BY RELATIVE EFFECTIVE JOB DENSITY, SYDNEY 2001-11**



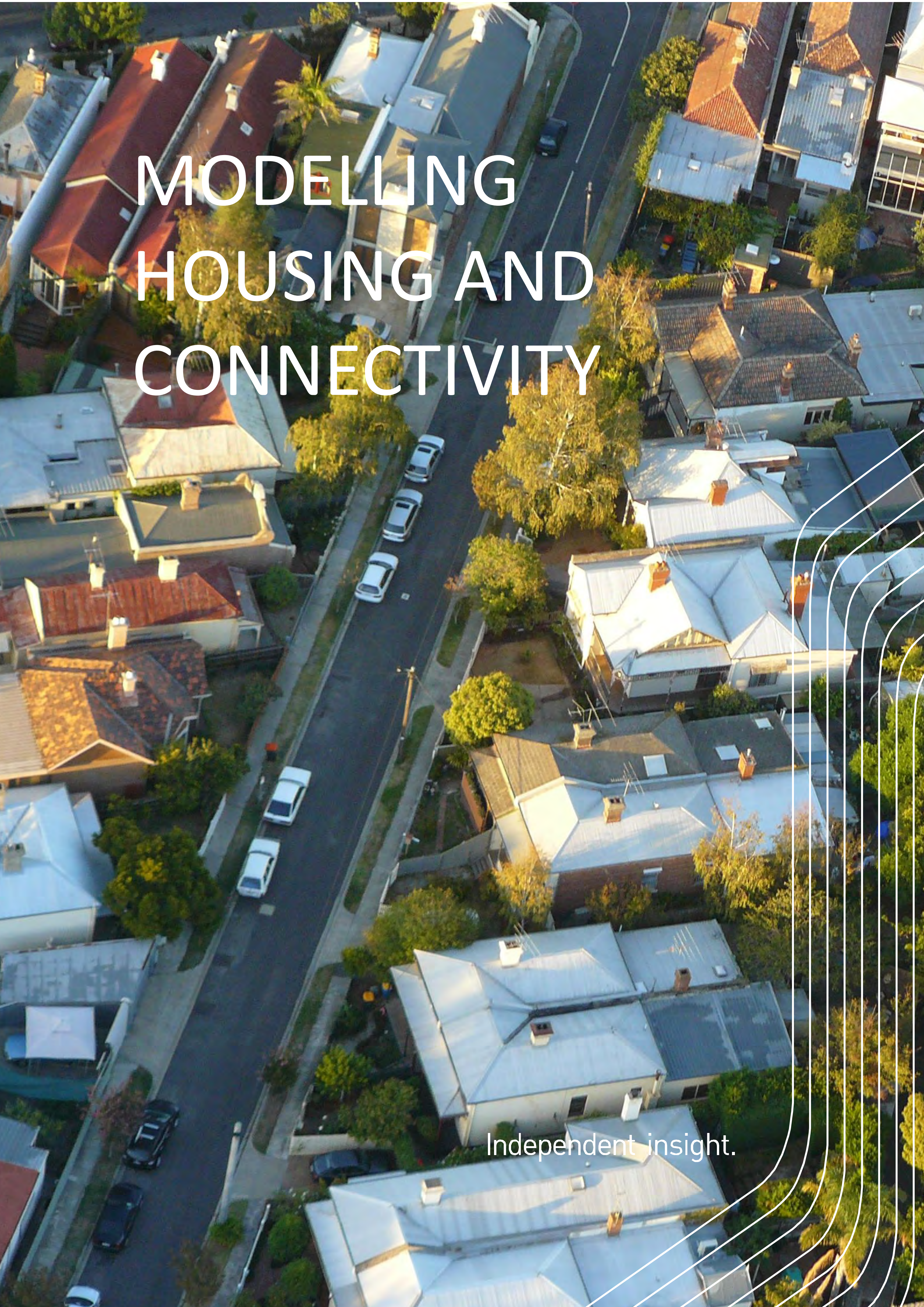
Source: 2001 to 2011 ABS Census and SGS Economics and Planning

2.2 Chapter conclusions

From this analysis of recent housing trends in Melbourne and Sydney the following key findings were identified:

- New housing development in both Melbourne and Sydney has been of a denser form than the existing stock. This is particularly evident in Sydney.
- Apartment growth has been focused in inner locations and near public transport.
- Detached housing growth has been focused in outer growth corridors.
- In general housing development in Melbourne has been more polarised than Sydney.

MODELLING HOUSING AND CONNECTIVITY



Independent insight.

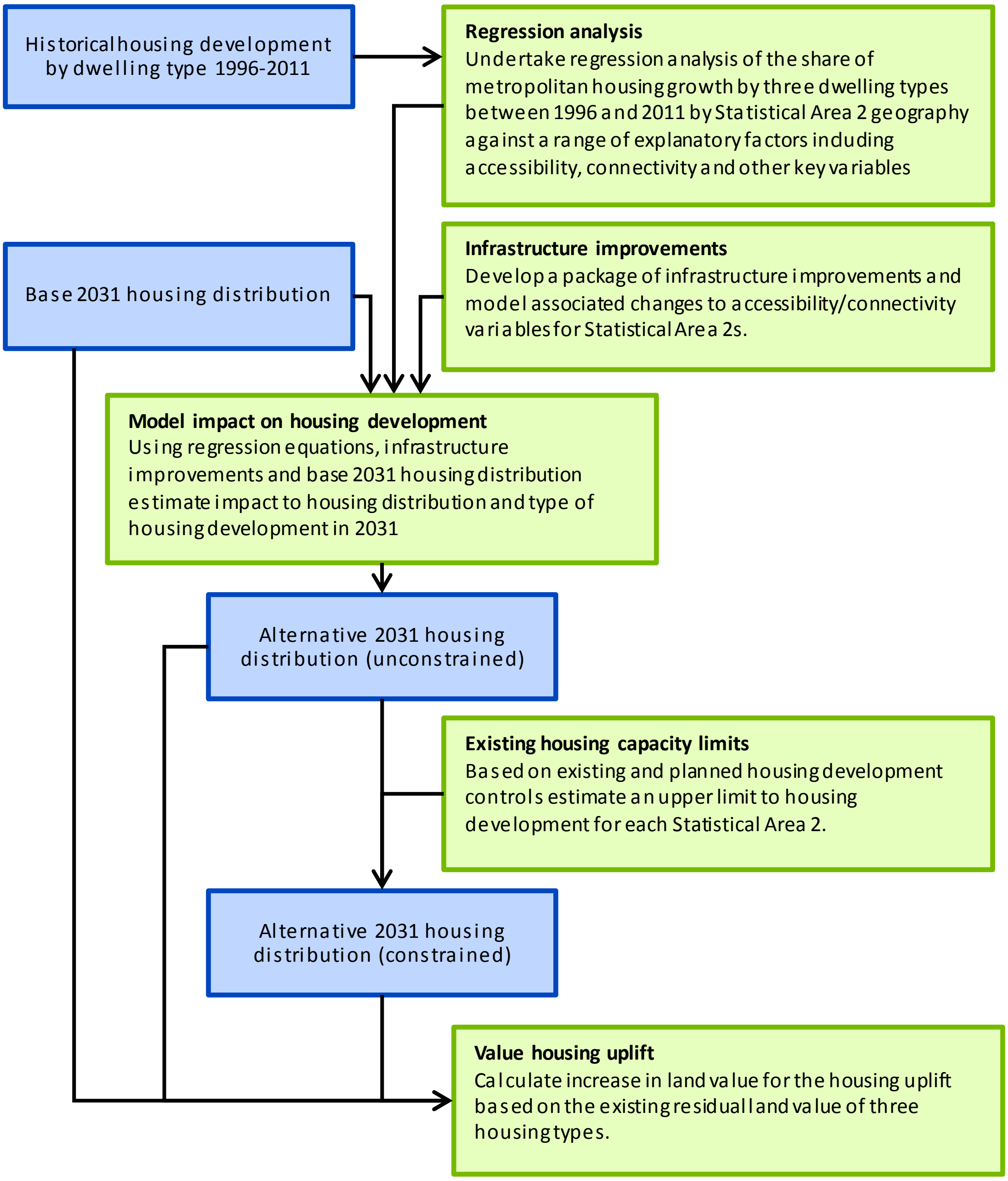
3 MODELLING HOUSING AND CONNECTIVITY

3.1 Conceptual Framework

The following statistical analysis seeks to estimate the extent to which infrastructure investment that improves connectivity and accessibility influences housing development. The model operates at a metropolitan wide level given the strong inter-relationships between localised housing markets. That is, an increase in supply in one location is likely to impact supply in another.

The figure overleaf provides an overview of the approach, key inputs/outputs and analytical tasks competed during this stage of the project. The remainder of this section provides details regarding the data variables collected, statistical techniques used, re-distribution model approach and results from the analysis.

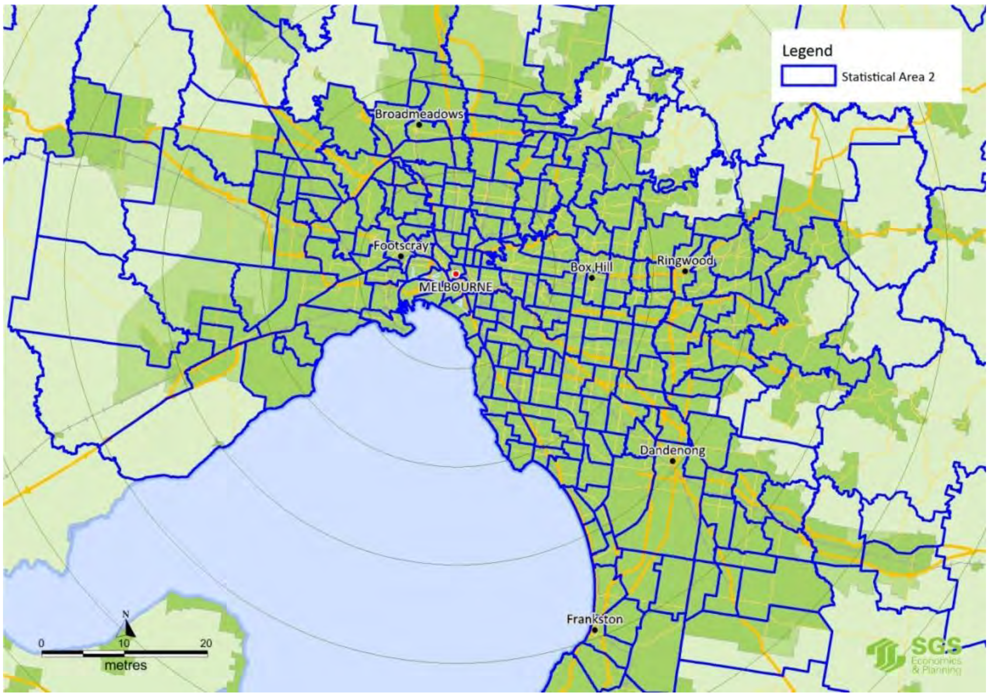
FIGURE 12. **ANALYSIS PROCESS OVERVIEW**



3.2 Data Preparation

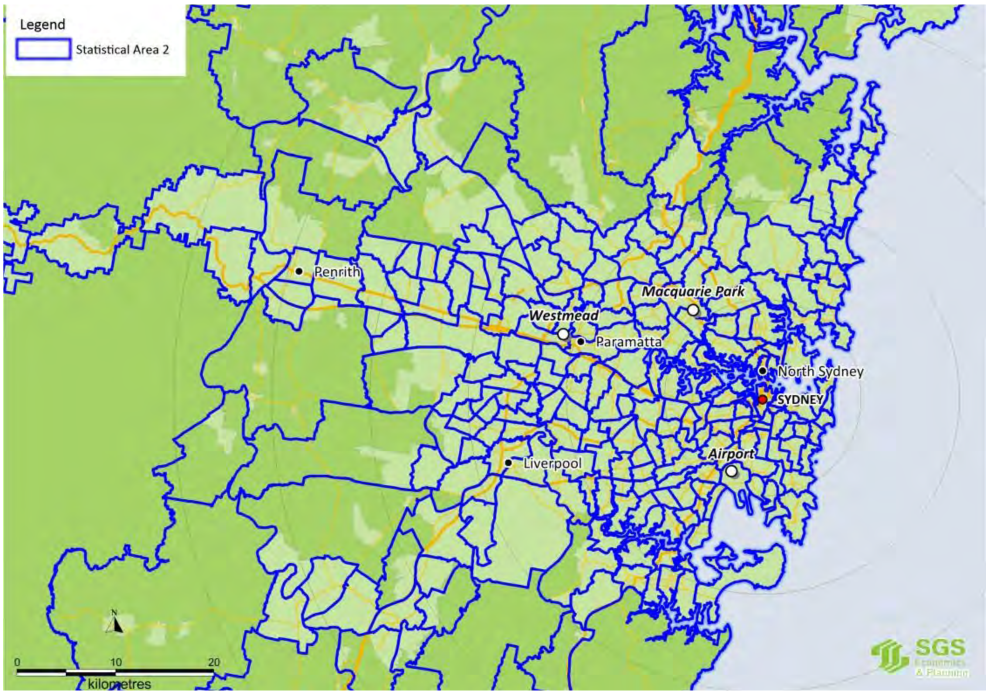
The statistical analysis and subsequent redistribution model has been created based on the ABS Statistical Area 2 (SA2) geography (see Figure 13 and Figure 14 below). There are approximately 250 SA2s across each of the Melbourne and Sydney metropolitan areas. These are similar in size to a suburb; an SA2 typically has between 4,000 and 7,000 dwellings.

FIGURE 13. **STATISTICAL AREA 2 GEOGRAPHY, MELBOURNE**



Source: SGS Economics and Planning

FIGURE 14. **STATISTICAL AREA 2 GEOGRAPHY, SYDNEY**



Source: SGS Economics and Planning

A total of 64 SA2s from the Melbourne area and 5 from Sydney have been excluded from the analysis because they represented:

- **Non-residential areas** such as the port and airport.
- **Non-urban areas** which are situated within the metropolitan areas such as the Mornington Peninsula in Melbourne and Bilpin in Sydney. These areas exhibit quite different development patterns than existing urban areas and are likely to distort the results.

A range of datasets and spatial attributes were aligned to the SA2 geography for use in the regression analysis stage. They were grouped into variables sets based on what real world phenomena they were illustrating. Figure 15 below lists each variable, the data sources and any additional information regarding how it was created.

While many of the attributes were only developed for a single point in time (i.e. cross-sectional data), the change in housing, housing stock and EJD were all developed as panel datasets for the period 1996-2011 for Melbourne. Given the limited availability of data in Sydney, the change in housing, housing stock and EJD were produced for only 1 cross-sectional time period, 2006-2011.

Maps of the regional indicator variables are also presented after the table.

Cross-sectional data
Is a one-dimensional dataset which varies between subjects (i.e. different locations) at the same point in time.

Time series data
Is a one-dimensional dataset which varies over time (i.e. 1996 – 2011) for a still subject (i.e. population).

Panel data
Is a two-dimensional dataset which varies between subjects (i.e. different locations) and over time (i.e. 1996-2011)

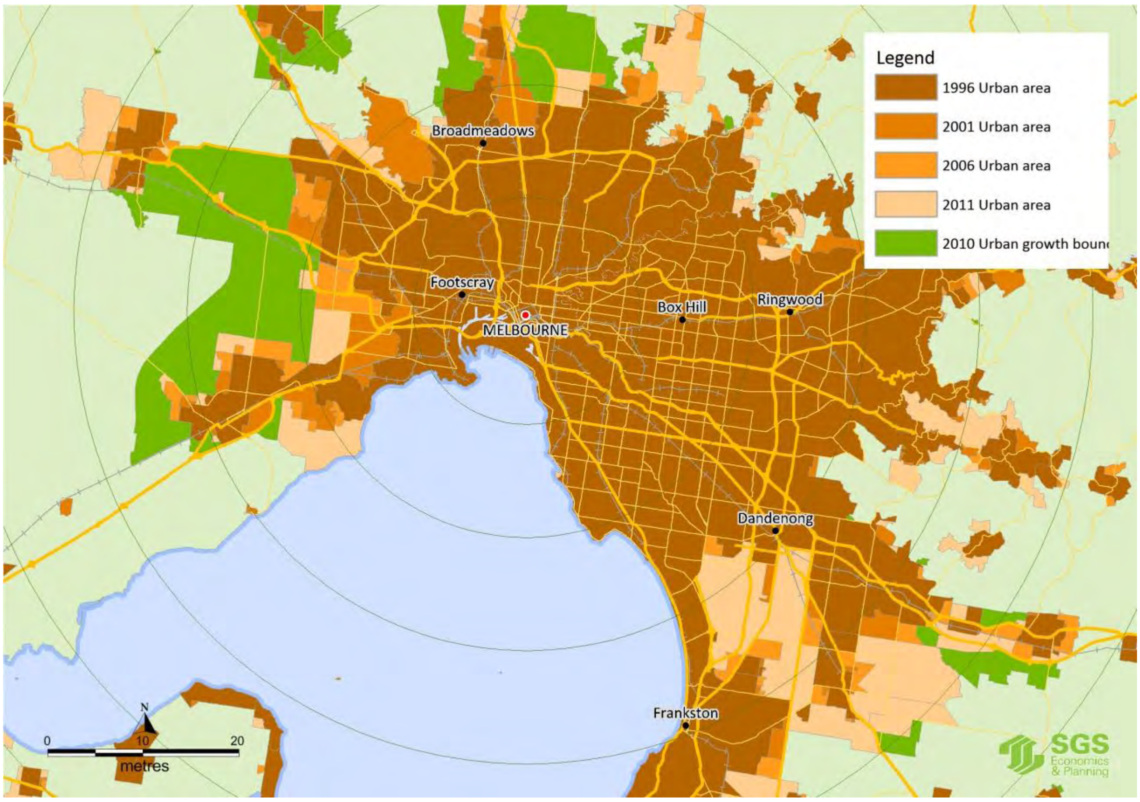
FIGURE 15. **REGRESSION DATASET**

Set	Name	Source and notes
Independent Variables		
Share of housing development	Share of net change in total dwellings - 1996-01 - 2001-06 - 2006-11	Source: ABS Census and SGS SGS used GIS analysis to align historical small area (Collection District/Statistical Area 1) Census data to a consistent Statistical Area 2 geography. Where boundary conflicts occurred a land area proportion split was used to redistribute data.
	Share of net change in detached dwellings - 1996-01 - 2001-06 - 2006-11	
	Share of net change in semi-detached dwellings - 1996-01 - 2001-06 - 2006-11	
	Share of net change in apartments dwellings - 1996-01 - 2001-06 - 2006-11	
Explanatory Variables		
Existing Stock/Land	Share of total dwellings - 1996 - 2001 - 2006	Source: ABS Census and SGS
	Share of detached dwellings - 1996 - 2001 - 2006 - 2011	Source: ABS Census and SGS

Set	Name	Source and notes
	Share of semi-detached dwellings - 1996 - 2001 - 2006 -2011	Source: ABS Census and SGS
	Share of apartment dwellings - 1996 - 2001 - 2006 - 2011	Source: ABS Census and SGS
	Share of urban land - 1996 - 2001 - 2006 - 2011	Source: Urban Centre/Locality from the Australian Standard Geographic Classifications (ASGC) - ABS (see Figure x)
Land Supply	Share of change in urban land - 1996-01 - 2001-06 - 2006-11	Source: Urban Centre/Locality from the Australian Standard Geographic Classifications (ASGC) - ABS (see Figure x)
Connectivity and accessibility measures	Effective Job Density - 1996 - 2001 - 2006 - 2011	Source: SGS based on Total employment data - ABS Census AM peak car and public transport travel times - Melbourne Integrated Transport Model (MITM) - Department of Transport
	Public Transport Access Levels (Train)	Source: SGS A measure of a locations public transport access as of 2010 based on the walk distance to stops and the number, frequency and type of services available.
	Public Transport Access Levels (Tram)	
	Public Transport Access Levels (Bus)	
	Public Transport Access Levels (Combined)	
	Distance to Train	Based on crow fly distance to closest train station (km)
	Distance to Tram	Based on crow fly distance to closest tram stops (km)
	Distance to Fixed Public Transport	Based on crow fly distance to closest train/tram stops (km)
	Distance to Public Transport	Based on crow fly distance to closest train/tram/bust stop (km)
Other explanatory factors	Distance to CBD	Based on crow fly distance to CBD (km)
	Distance to Central Activity Area	Based on crow fly distance to a CAA (km)
	Distance to principal activity area	Based on crow fly distance to a PAA (km)
	Distance to major activity area	Based on crow fly distance to a MAA (km)
	Distance to industrial node	Source: Designated industrial nodes - 2010 Urban Development Program - Department of Planning and Community Development Based on crow fly distance to industrial node (km)
	Near an industrial node	
	Distance to coast	Based on crow fly distance to coastline (km)
	Near the coast	
	Distance to coast/Yarra	Based on crow fly distance to coastline or Yarra river (km)
	Near to the coast/Yarra	
	Distance to coast/Yarra/major park	Based on crow fly distance to coastline, Yarra river or metropolitan level park(km)
	Near to the coast/yarra/major park	
	Distance to a university	Based on crow fly distance to university (km)

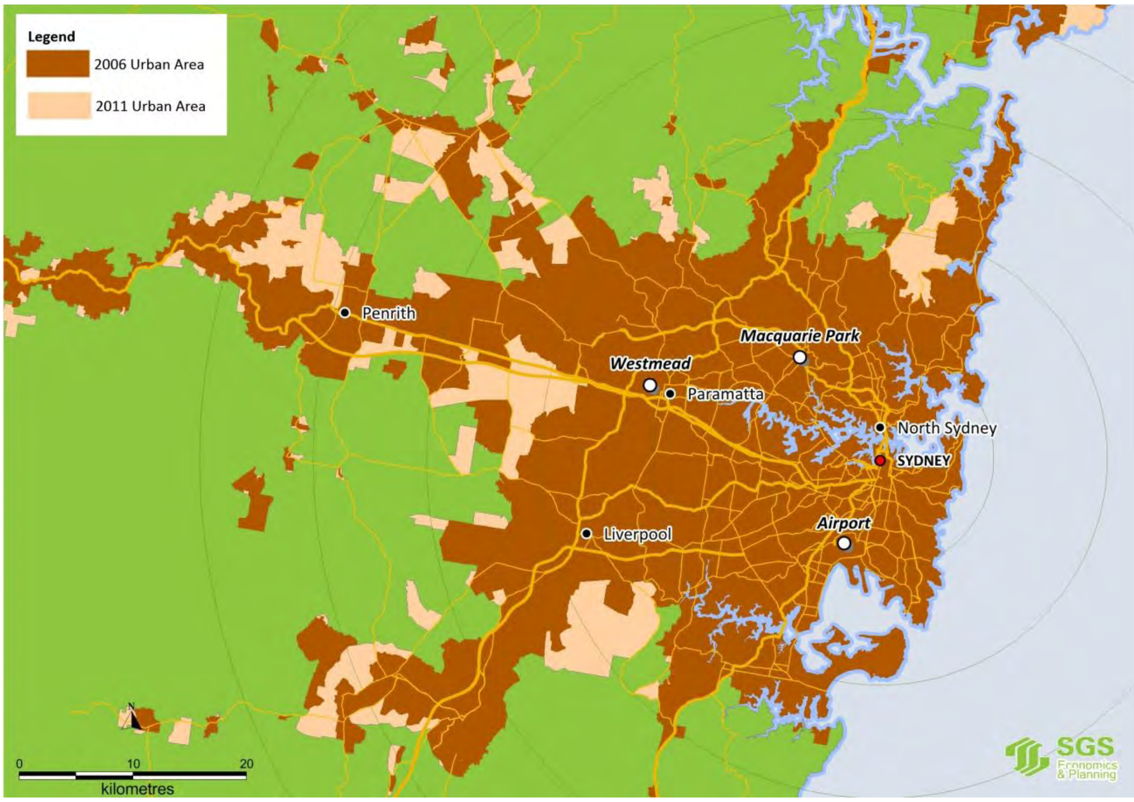
Set	Name	Source and notes
	Near a university	
	Targeted Urban Renewal Location	Based on metropolitan strategic planning documents.
Region identifiers	Development Rings	Based on historical development patterns. Inner established areas, middle established areas, outer established areas, remnant broad hectare, growth areas (See Figure X)
	Self-contained housing markets	Source: SGS based on ABS data Using migration patterns from 2006 to 2011 eight sub-markets for Melbourne have been defined: Inner South-East, West-South, West, North-West, North-East, East, Outer South-East and Mornington Peninsula (See Figure X).
	Self-contained labour markets	Source: SGS based on ABS data Using 2011 journey to work patterns six sub-markets for Melbourne have been defined: Inner, West, North, East, South-East and Mornington Peninsula (See Figure X).

FIGURE 16. **URBAN AREA, MELBOURNE 1996, 2001, 2006 AND 2011**



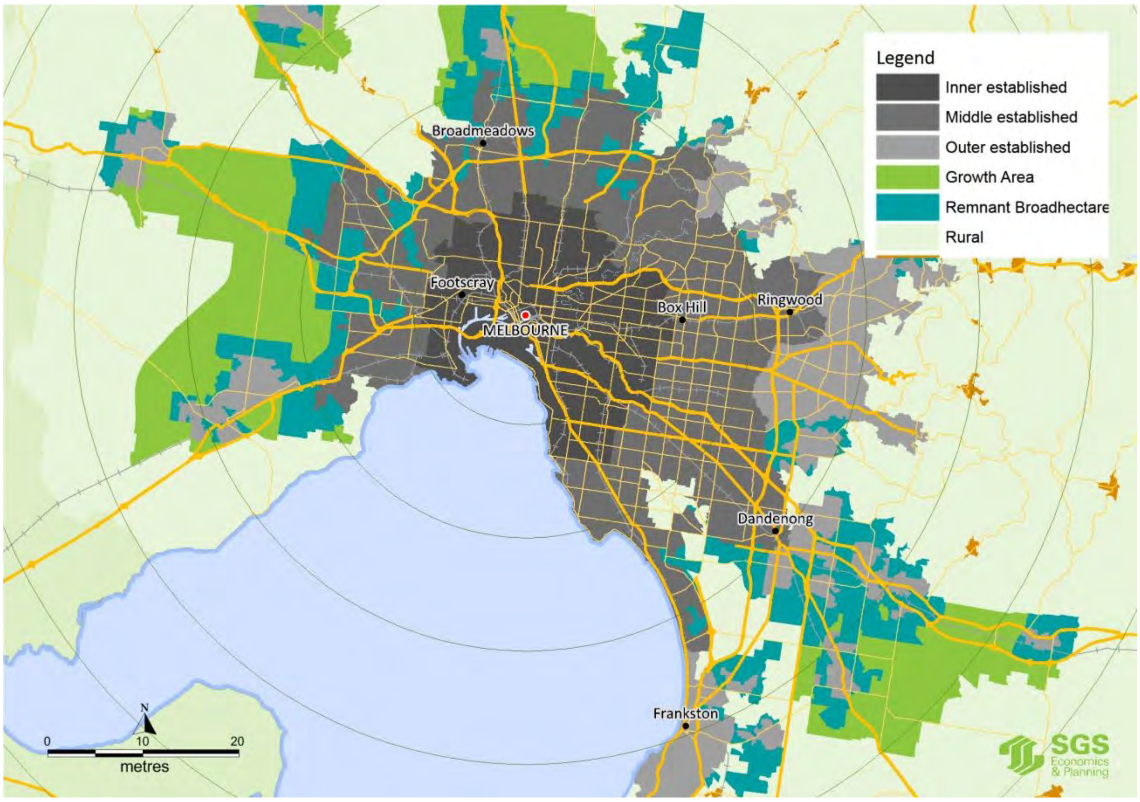
Source: ABS – ASGC

FIGURE 17. **URBAN AREA, SYDNEY 2006 AND 2011**



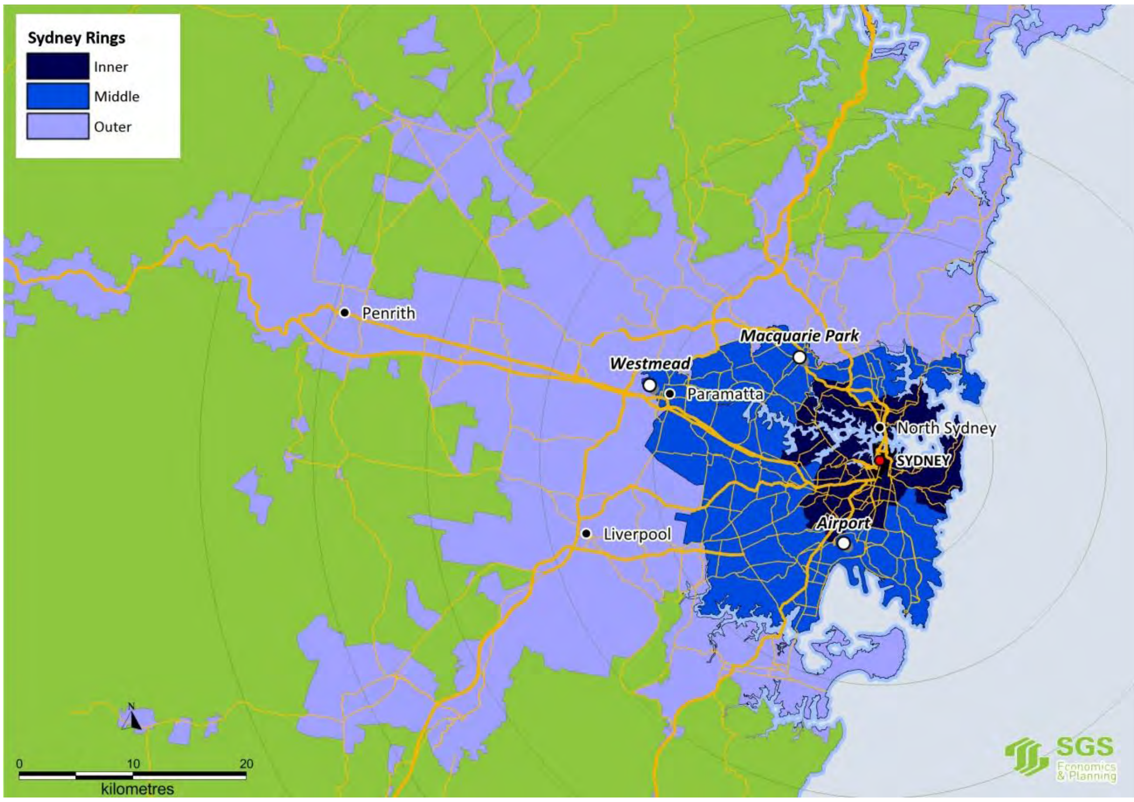
Source: ABS - ASGC

FIGURE 18. **DEVELOPMENT RINGS, MELBOURNE**



Source: SGS Economics and Planning

FIGURE 19. **DEVELOPMENT RINGS, SYDNEY**



Source: SGS Economics and Planning

3.3 Regression analysis

To estimate the induced change in housing development resulting from changes to connectivity/ accessibility a regression analysis of historical changes in the share of housing development by type compared to a range of explanatory variables was completed.

That is, the share of a location's change in dwellings is a function of:

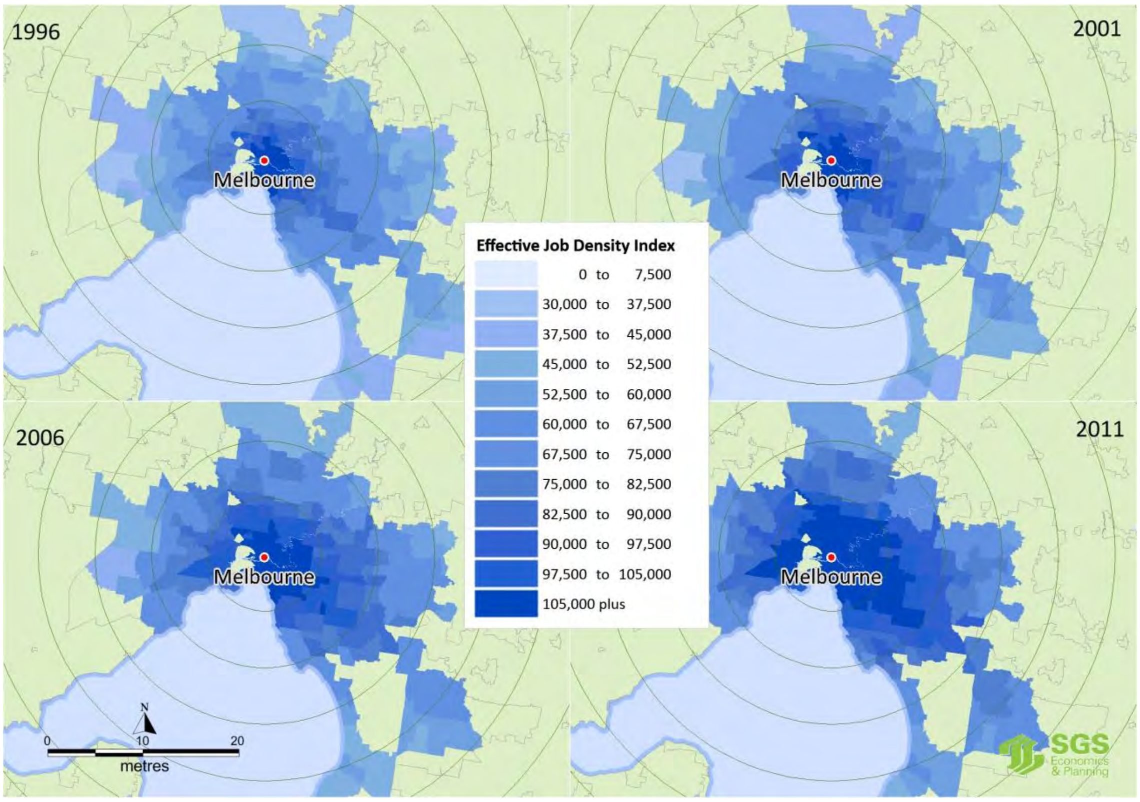
- **Size of the location**. Based on the share of existing dwellings or urban land within that zone.
- **Amount of new land supply**. Based on the share of the change in the urban land.
- Connectivity or accessibility of the location. Based on an appropriate indicator
- **Other locational attributes** such as, amenities, dis-amenities, regional/market differences, etc.

Of particular relevance is EJD which is used as a measure of accessibility. Over the past 15 years there have been several major road infrastructure projects that have had a significant impact on the accessibility rating of certain locations across metropolitan Melbourne, such as:

- 1996 to 2001 – Western Ring Road
- 2001 to 2006 – Citylink
- 2006 to 2011 – Eastlink and major improvements to the Monash Freeway and the West Gate Bridge

These have been captured in the EJD index through changes in travel times and employment distribution (See Figure 20). While the overall level of EJD has increased over the period there have been changes in the spatial distribution of the index. For example, projects such as the Western Ring Road and Citylink have increased the accessibility of the western suburbs, relative to the eastern.

FIGURE 20. **EFFECTIVE JOB DENSITY, MELBOURNE 1996-11**

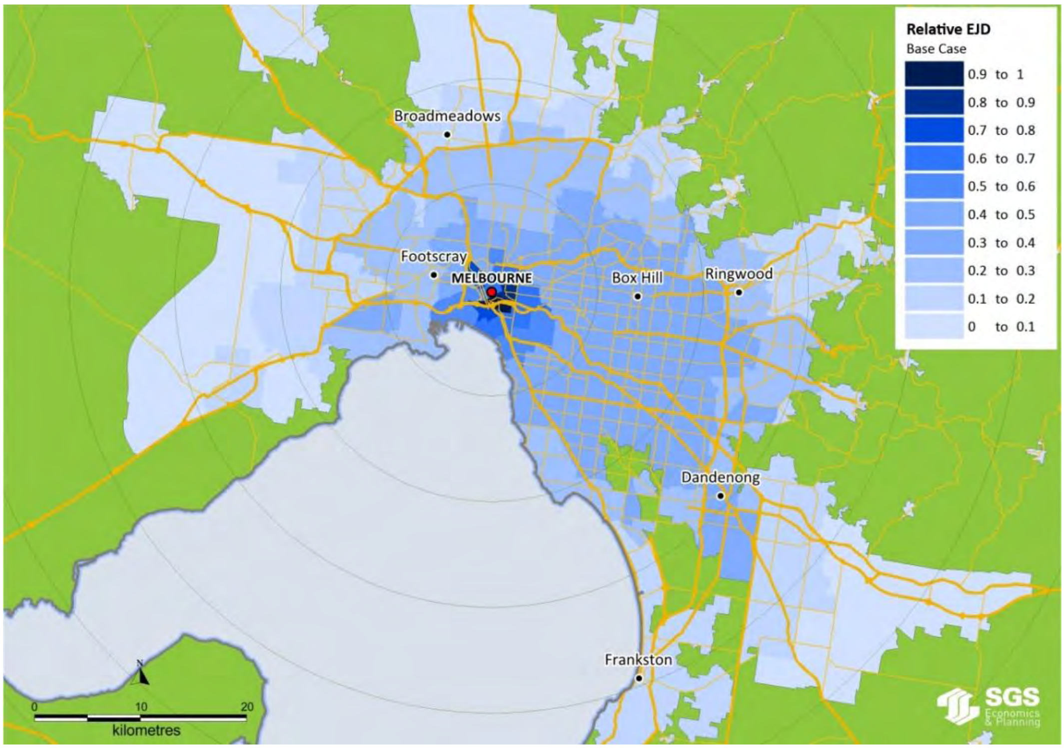


Source: SGS Economics and Planning

A measure of relative accessibility is useful in comparing the EJD index between Melbourne and Sydney. This is calculated by ranking each SA2 value between 0 and 1, where 1 is the most accessible location (typically the CBD) and 0 is the least accessible location. The relativities between the various locations are maintained on this scale.

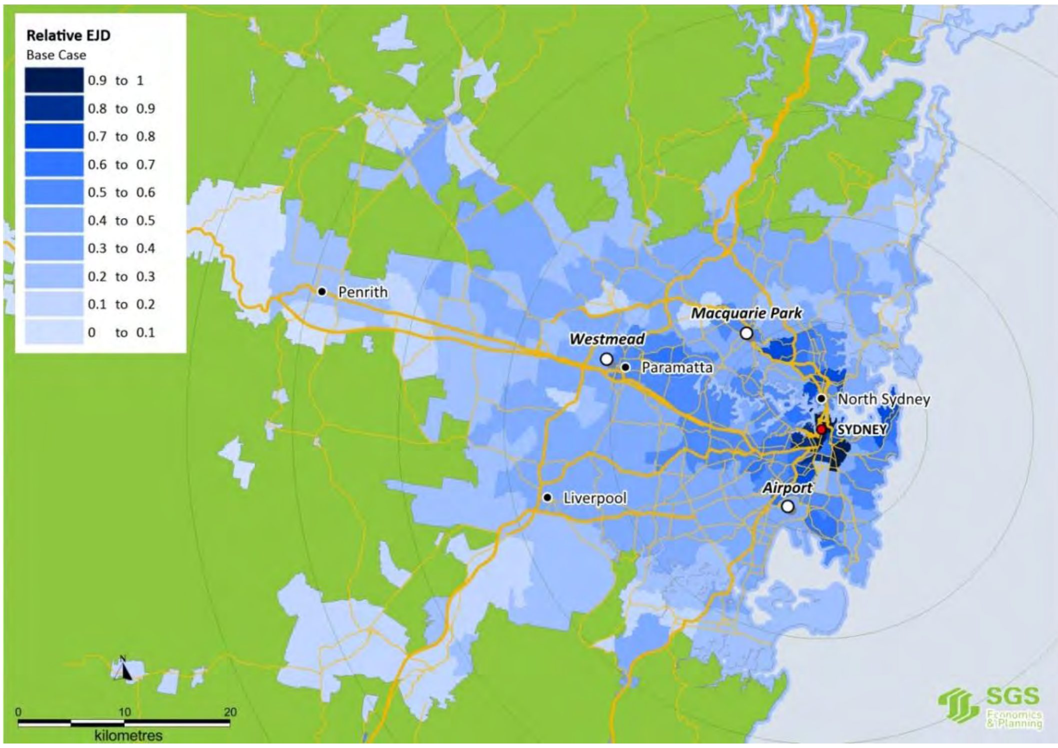
The maps in Figure 21 and Figure 22 show the relative EJD by SA2 for Melbourne and Sydney respectively. Melbourne's EJD shows it is highly monocentric characteristics, whilst Sydney is more polycentric.

FIGURE 21. **RELATIVE EFFECTIVE JOB DENSITY, MELBOURNE**



Source: SGS Economics and Planning

FIGURE 22. **RELATIVE EFFECTIVE JOB DENSITY, SYDNEY**



Source: SGS Economics and Planning

Regression analysis techniques

During the preliminary analysis it was discovered that there were quite different development patterns between the three broad housing types. For this reason four separate multiple linear regressions were completed for the following dependent variables:

- Share of net change in **total dwelling stock**;
- Share of net change in **detached dwelling stock**;
- Share of net change in semi-detached dwelling stock;
- Share of net change in **apartment dwelling stock**;

For Melbourne a panel data regression was completed for three time periods (1996-01, 2001-06 and 2006-11) and 216 cross-sections (SA2s) with weighting to control for time-series variations. Variables that were not available across time were left static across all time periods. For Sydney only a single time period was available (2006-11); therefore only a cross-sectional analysis was completed.

A range of descriptive statistics and sequential testing processes were used to select a preferred equation.

- **Correlation Matrix**. A matrix was used to assess how correlated (or similar) one variable is to another. The correlation coefficients within this matrix range from -1 to 1. Where two variables have a coefficient of 1 (or -1), this means they are perfectly related. A coefficient of 0 means there is no relationship between the two variables at all. A negative coefficient signifies there is an inverse relationship, that is, as one value increases, the other value decreases. An analysis of the correlation matrix determines which variables are closely related and therefore may essentially be representing the same concept (i.e. distance to the CBD and EJD may both be representing a similar concept of a locations proximity to the city 'core'). If two correlated variables that represent the same thing are included in a regression equation it is difficult to mathematically attribute change/effect to one or the other and both can appear statistically insignificant or can adversely affect the robustness of the equation. Figure 23 overleaf presents the correlation matrix for all the variables tested during the regression analysis phase. Any variables with a coefficient greater than |0.8| are typically considered to be 'highly' correlated and are highlighted in red below. Coefficients greater than |0.5| exhibit some degree of correlation and have been highlighted yellow.

- **Conceptual framework.** Variables were tested in line with the conceptual framework. That is variables were sequentially tested in sets related to the phenomena that they were deemed to represent. Preferred variable(s) for each set would then remain in the equation awaiting testing of the following set of variables. Higher level variables such as existing share were included first with lower level attributes tested later.

- **Step-wise selection.** This is an automated statistical procedure for choosing a preferred variable or set of variables from a longer list of variables. This is done by continually swapping variables in and out of an equation until the highest adjusted coefficient of multiple determination (adjusted R squared) is found and all variables are statistically significant. This procedure was one of the techniques used to select the preferred variable from a set of similar variables (i.e. all public transport variables were included and the step-wise variable selection procedure choose the variable that best explained the variation in resultant density).

- **Descriptive Statistics.** A range of descriptive statistics were analysed to determine the appropriateness of the regression equation. This included the adjusted R squared and individual variable significance.

FIGURE 23. **CO-VARIANCE MATRIX FOR MELBOURNE**

	SHARE_DW	SHARE_DWSEP	SHARE_DWSEMI	SHARE_DWAPT	SHARE_UCL	SHARE_CHUCL	REL_EJD_ALLYRS	PTAI_TRAIN	PTAI_TRAM	PTAI_BUS	PTAI_COMBO	TRAIN_DIST	TRAM_DIST	FIXEDPT_DIST	PT_DIST	CBD_DIST	DIST_CAD	DIST_PAC	DIST_MAC	INDNODE_DIST	COAST_DIST	COASTYARRA_DIST	PARKWATER_DIST	UNI_DIST
SHARE_DW	1.00	0.74	0.47	0.48	0.46	-0.19	0.09	0.19	0.10	0.20	0.20	-0.26	-0.12	-0.23	-0.33	-0.05	-0.14	-0.10	-0.34	0.26	-0.03	-0.15	-0.12	-0.09
SHARE_DWSEP	0.74	1.00	-0.04	-0.20	0.73	-0.08	-0.41	-0.02	-0.33	0.00	-0.18	0.03	0.17	0.12	-0.20	0.34	-0.11	0.09	-0.02	0.04	0.32	0.22	0.16	0.20
SHARE_DWSEMI	0.47	-0.04	1.00	0.53	-0.14	-0.17	0.47	0.21	0.31	0.15	0.29	-0.34	-0.33	-0.41	-0.23	-0.40	-0.12	-0.16	-0.40	0.36	-0.33	-0.44	-0.35	-0.33
SHARE_DWAPT	0.48	-0.20	0.53	1.00	-0.25	-0.14	0.62	0.31	0.58	0.30	0.53	-0.39	-0.35	-0.43	-0.21	-0.46	-0.04	-0.28	-0.44	0.27	-0.43	-0.43	-0.33	-0.36
SHARE_UCL	0.46	0.73	-0.14	-0.25	1.00	0.02	-0.45	-0.18	-0.30	-0.11	-0.27	0.24	0.39	0.33	-0.07	0.48	-0.09	0.32	0.12	-0.05	0.31	0.23	0.19	0.40
SHARE_CHUCL	-0.19	-0.08	-0.17	-0.14	0.02	1.00	-0.21	-0.14	-0.09	-0.17	-0.17	0.31	0.28	0.36	0.46	0.18	0.26	0.21	0.25	-0.24	0.08	0.18	0.30	0.28
REL_EJD_ALLYRS	0.09	-0.41	0.47	0.62	-0.45	-0.21	1.00	0.35	0.69	0.38	0.66	-0.40	-0.61	-0.51	-0.28	-0.73	-0.23	-0.43	-0.48	0.27	-0.47	-0.49	-0.48	-0.66
PTAI_TRAIN	0.19	-0.02	0.21	0.31	-0.18	-0.14	0.35	1.00	0.21	0.30	0.53	-0.57	-0.26	-0.47	-0.19	-0.29	-0.19	-0.20	-0.29	0.20	-0.14	-0.18	-0.13	-0.27
PTAI_TRAM	0.10	-0.33	0.31	0.58	-0.30	-0.09	0.69	0.21	1.00	0.44	0.84	-0.23	-0.33	-0.35	-0.14	-0.46	-0.08	-0.24	-0.28	0.19	-0.29	-0.33	-0.27	-0.35
PTAI_BUS	0.20	0.00	0.15	0.30	-0.11	-0.17	0.38	0.30	0.44	1.00	0.77	-0.29	-0.32	-0.32	-0.36	-0.31	-0.23	-0.30	-0.27	0.16	-0.07	-0.16	-0.20	-0.34
PTAI_COMBO	0.20	-0.18	0.29	0.53	-0.27	-0.17	0.66	0.53	0.84	0.77	1.00	-0.40	-0.42	-0.45	-0.29	-0.49	-0.20	-0.33	-0.35	0.25	-0.22	-0.31	-0.28	-0.44
TRAIN_DIST	-0.26	0.03	-0.34	-0.39	0.24	0.31	-0.40	-0.57	-0.23	-0.29	-0.40	1.00	0.35	0.89	0.47	0.39	0.24	0.31	0.48	-0.18	0.28	0.34	0.22	0.37
TRAM_DIST	-0.12	0.17	-0.33	-0.35	0.39	0.28	-0.61	-0.26	-0.33	-0.32	-0.42	0.35	1.00	0.51	0.39	0.89	0.23	0.59	0.43	-0.33	0.08	0.33	0.49	0.92
FIXEDPT_DIST	-0.23	0.12	-0.41	-0.43	0.33	0.36	-0.51	-0.47	-0.35	-0.32	-0.45	0.89	0.51	1.00	0.53	0.52	0.27	0.41	0.49	-0.20	0.29	0.39	0.30	0.51
PT_DIST	-0.33	-0.20	-0.23	-0.21	-0.07	0.46	-0.28	-0.19	-0.14	-0.36	-0.29	0.47	0.39	0.53	1.00	0.25	0.40	0.32	0.49	-0.26	0.11	0.25	0.42	0.38
CBD_DIST	-0.05	0.34	-0.40	-0.46	0.48	0.18	-0.73	-0.29	-0.46	-0.31	-0.49	0.39	0.89	0.52	0.25	1.00	0.14	0.52	0.44	-0.17	0.35	0.52	0.54	0.85
DIST_CAD	-0.14	-0.11	-0.12	-0.04	-0.09	0.26	-0.23	-0.19	-0.08	-0.23	-0.20	0.24	0.23	0.27	0.40	0.14	1.00	-0.01	0.12	-0.16	-0.05	0.09	0.28	0.24
DIST_PAC	-0.10	0.09	-0.16	-0.28	0.32	0.21	-0.43	-0.20	-0.24	-0.30	-0.33	0.31	0.59	0.41	0.32	0.52	-0.01	1.00	0.28	-0.07	0.05	0.03	0.16	0.56
DIST_MAC	-0.34	-0.02	-0.40	-0.44	0.12	0.25	-0.48	-0.29	-0.28	-0.27	-0.35	0.48	0.43	0.49	0.49	0.44	0.12	0.28	1.00	-0.18	0.26	0.23	0.32	0.43
INDNODE_DIST	0.26	0.04	0.36	0.27	-0.05	-0.24	0.27	0.20	0.19	0.16	0.25	-0.18	-0.33	-0.20	-0.26	-0.17	-0.16	-0.07	-0.18	1.00	0.07	-0.37	-0.29	-0.27
COAST_DIST	-0.03	0.32	-0.33	-0.43	0.31	0.08	-0.47	-0.14	-0.29	-0.07	-0.22	0.28	0.08	0.29	0.11	0.35	-0.05	0.05	0.26	0.07	1.00	0.66	0.50	0.23
COASTYARRA_DIST	-0.15	0.22	-0.44	-0.43	0.23	0.18	-0.49	-0.18	-0.33	-0.16	-0.31	0.34	0.33	0.39	0.25	0.52	0.09	0.03	0.23	-0.37	0.66	1.00	0.67	0.40
PARKWATER_DIST	-0.12	0.16	-0.35	-0.33	0.19	0.30	-0.48	-0.13	-0.27	-0.20	-0.28	0.22	0.49	0.30	0.42	0.54	0.28	0.16	0.32	-0.29	0.50	0.67	1.00	0.49
UNI_DIST	-0.09	0.20	-0.33	-0.36	0.40	0.28	-0.66	-0.27	-0.35	-0.34	-0.44	0.37	0.92	0.51	0.38	0.85	0.24	0.56	0.43	-0.27	0.23	0.40	0.49	1.00

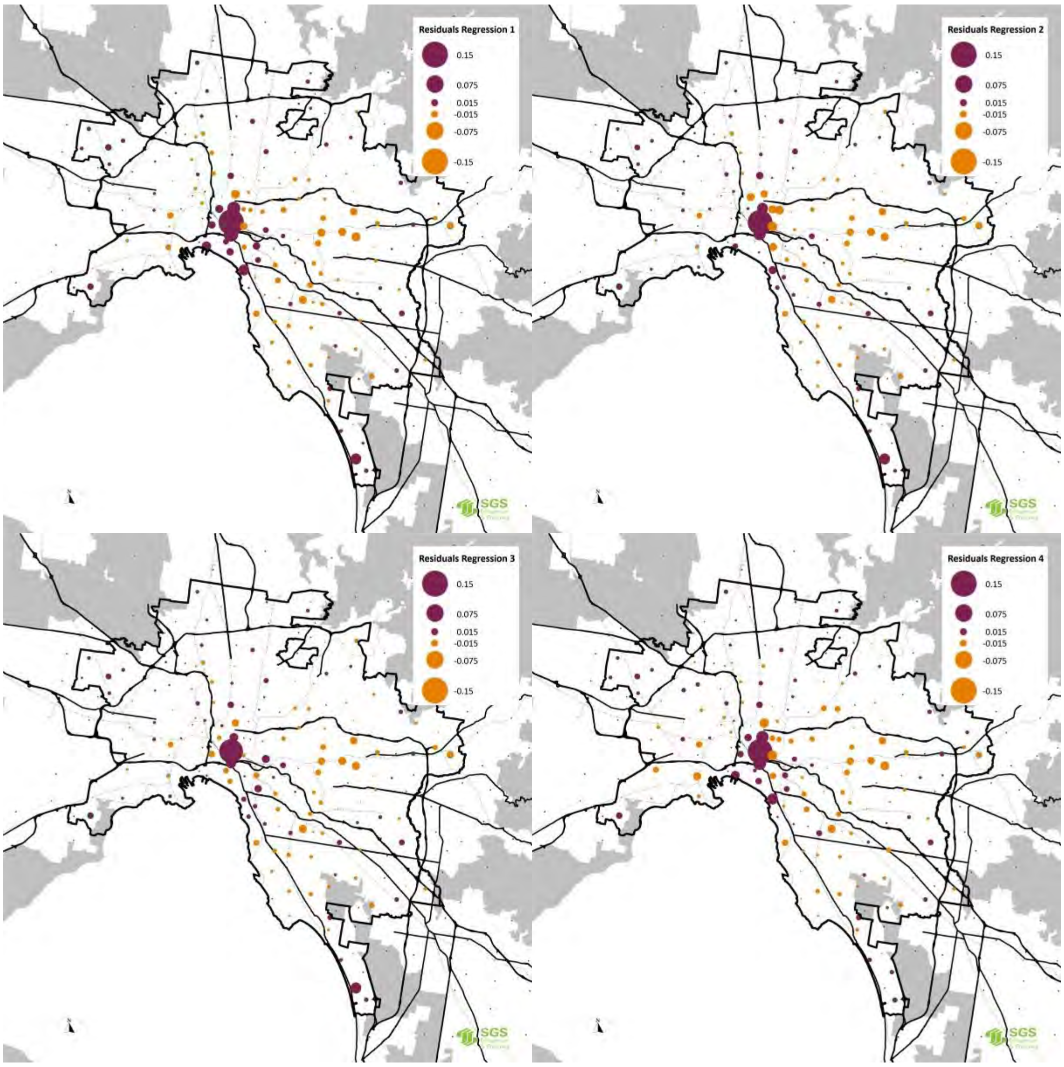
Source: SGS Economics and Planning

The regression results were also further refined by mapping the regression residuals (or errors) to identify spatial patterns which may indicate where the equation is over or under estimating the change in housing development. The location of these residuals could highlight additional factors to be included or outliers that were not already identified.

Figure 24 presents four maps of the residuals from the Melbourne regression, with purple dots representing positive errors where the model has under estimated the share of dwelling development, and orange dots representing negative errors where the model has overestimated the share of dwelling development. The following steps were taken. The regression used in each was the preferred equation displayed in Figure 26, without any region dummies.

- *Regression 1* No region dummies: There were significant residuals around the CBD and inner core of Melbourne
- *Regression 2* Added an inner core dummy: The residuals decreased slightly, however the negative residuals increased in magnitude.
- *Regression 3* Adjusted inner core dummy (covering a smaller area): The residuals decreased slightly again.
- *Regression 4* Removed outlier in the south east on the coast and added north west and east/south east dummy: The residuals increased slightly, however the R squared increased significantly between regression 3 and 4 so regression 4 was selected as the preferred equation.

FIGURE 24. **MAPS OF RESIDUALS, MELBOURNE REGRESSION**

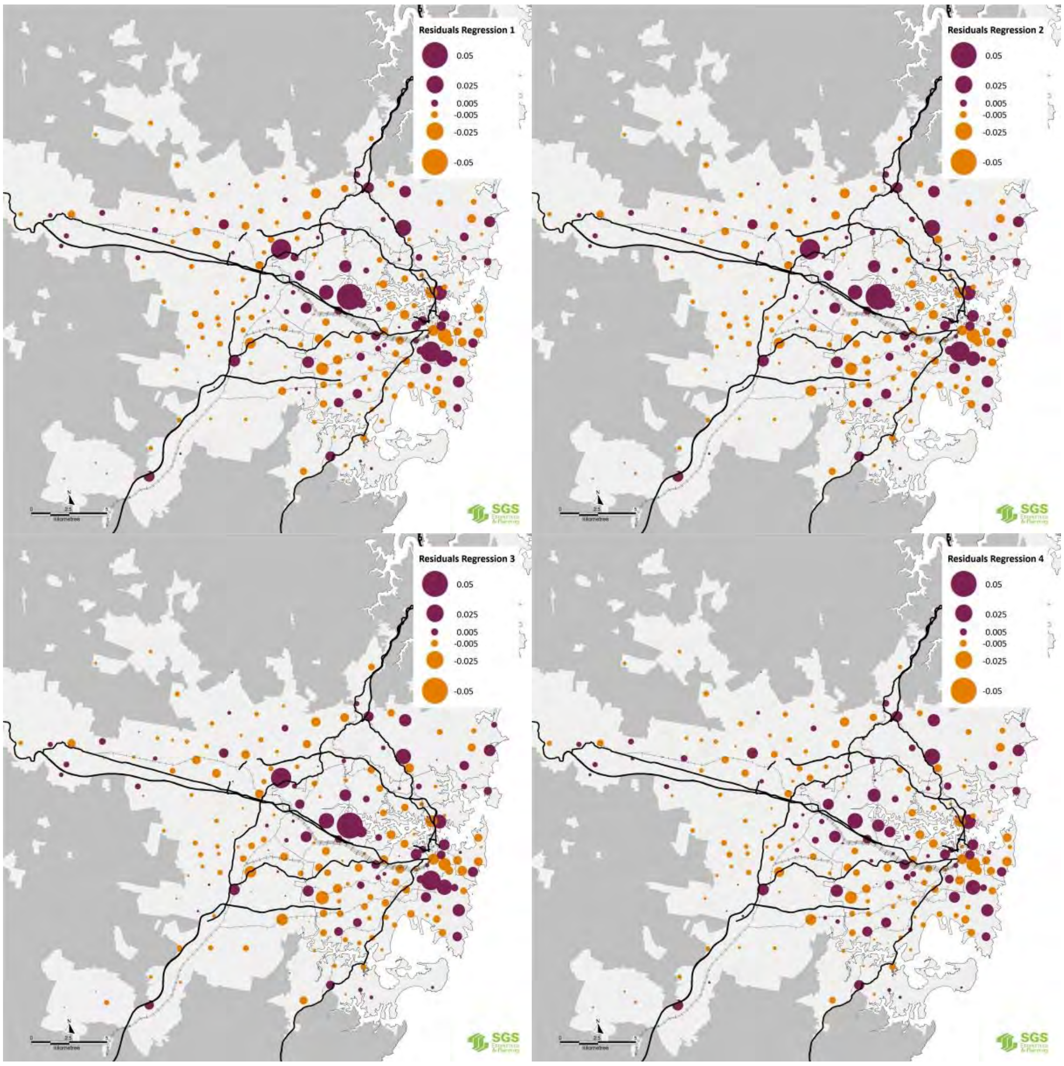


Source: SGS Economics & Planning

Figure 25 shows four maps of the residuals for the Sydney regression, with purple dots representing positive errors where the model has under estimated the share of dwelling development, and orange dots representing negative errors where the model has overestimated the share of dwelling development. The following steps were taken. The regression used in each was the preferred equation displayed in above in Figure 27, without any dummies.

- *Regression 1* CBD dummy: There were significant residuals around the CBD and inner core of Sydney
- *Regression 2* Added a university dummy (keeping CBD dummy): The residuals decreased slightly, however the negative residuals increased in magnitude.
- *Regression 3* Added an on rail line dummy (keeping CBD and University dummy): The residuals decreased slightly again, but were still widespread.
- *Regression 4* Added a targeted urban renewal dummy (keeping only the university dummy): The residuals decreased particularly around the urban renewal sites (Rhodes and inner Sydney), so regression 4 was selected as the preferred equation.

FIGURE 25. **MAPS OF RESIDUALS, SYDNEY REGRESSION**



Source: SGS Economics & Planning

Additional refinement around the connectivity variable was undertaken, firstly by separating the combined EJD variable by car and public transport. It was found that both the public transport EJD and car EJD variables did not improve the explanatory power of the regression in estimating the variation in the share of dwelling change for all development types in both Melbourne and Sydney. The public transport EJD only includes trips and travel time on public transport which are on average much longer than car trips. The car EJD includes trips made only by private vehicle. The relationship between apartment growth and public transport EJD was much weaker than car EJD.

There are varying proportions of public transport use across the metropolitan areas. In Melbourne, for example, 68 per cent of people with jobs in the CBD travel to work on public transport, whilst only 2 per cent of workers in outer urban Cranbourne travel on public transport. Given this, it was decided to use the combined public transport and car measure to generate a more real life representation of accessibility.

Preferred regression equations

From the regression analysis it was found that as connectivity (via EJD) increases there is likely to be an increase in the share of housing developed in that location. In addition, there is likely to be a shift in the mix of housing types which will be developed:

- Separate houses are less likely to be developed;
- Semi-detached houses will remain relatively the same; and
- Apartments are more likely to be developed.

The strength of this relationship was found to vary by the different development types. It was found that apartment development exhibited the strongest relationship with connectivity. For this reason only the apartment regression equation was used in the redistribution model. Detached and semi-detached had a very weak relationship, with most of the variation being explained by other factors such as land supply.

To further improve the strength of the apartment regression equation the analysis was focused on the inner and middle rings for Melbourne only, with the outer and growth area SA2s being excluded. This reduced the number of observations from 216 to 163 for Melbourne.

The following presents the preferred equations for apartment development in Melbourne and Sydney. The regression results for the other development types can be found in the technical appendix.

FIGURE 26. **APARTMENT DWELLINGS PREFERRED REGRESSION RESULTS, MELBOURNE**

Periods:	3			
Cross-sections:	163			
Dependent Variable:	Share of apartment dwelling change			
Independent variables				
	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.020	0.003	-7.146	0.000
Relative EJD	0.081	0.008	9.654	0.000
Coast indicator (dummy)	0.005	0.001	7.101	0.000
University indicator (dummy)	0.006	0.002	3.187	0.002
Labour market region (dummy)				
- North/West	0.008	0.002	4.189	0.000
- East/South-East	0.004	0.001	5.537	0.000
Adjusted R-squared:	0.434			

In summary, these results indicate that in Melbourne the share of net change in apartments is based on:

- The **relative EJD**. With a location having a higher EJD likely to have a greater share of the net change.
- Coastal areas are likely to have a higher share than other locations.
- Locations near Universities are likely to have a higher share than other locations.

- Compared to the East/South East the North/West is likely to have a slightly higher share of the net change[5].

Compared to total dwellings, apartments showed a stronger correlation with EJD along with some other key amenity variables (such as Coast and Universities). Also the existing housing stock or amount of existing urban land was not found to be significant.

FIGURE 27. **APARTMENT DWELLINGS PREFERRED REGRESSION RESULTS, SYDNEY**

Periods:	1			
Included Observations:	279			
Dependent Variable:	Share of apartment dwelling change			
Independent variables				
	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.001	0.001	-1.143	0.254
Relative EJD	0.010	0.002	5.916	0.000
Targeted Urban Renewal Site (dummy)	0.039	0.003	14.211	0.000
University indicator (dummy)	0.006	0.002	2.700	0.007
Adjusted R-squared:	0.497			

In summary, these results indicate that in Sydney the share of net change in apartments is based on:

- The **relative EJD**. With a location having a higher EJD likely to have a greater share of the net change.
- **Targeted urban renewal sites** are likely to have a higher share than other locations, given planning policy to increase development in specific locations.
- Locations **near Universities** are likely to have a higher share than other locations.

3.4 Application of regression results

Using the statistical relationships found in the preceding section a model was developed to re-distribute housing development across the metropolitan areas from one SA2 to another and between housing types. This was done by comparing the level of EJD under the base case and proposed alternative scenario. All other variables were assumed to be constant across both the base and proposed alternative scenario. That is, if there is no impact to EJD then the location's housing development remains as per the base case. If EJD is increased/decreased then the amount and mix of housing is adjusted in line with the regression coefficients.

This was undertaken in a two-step approach, with apartment growth first increased by SA2 in line with the regression coefficients, and then detached housing growth decreased using a density equivalence ratio[6]. Detached housing growth is then shifted out of areas with low levels of connectivity and significant amounts of growth projected. It was assumed there would be no net change to semi-detached housing from changes in accessibility. In reality, a "shuffling" of preferences would occur through semi-detached housing (i.e. some people living in detached housing would now live in semi-detached houses and some people in semi-detached houses would now live in apartments)

[5] Reflecting perhaps a more accommodating Council posture towards infill development in the North/West versus the East/South regions of Melbourne.

[6] A density equivalence ratio estimates the number of detached houses that are replaced by new apartment development (i.e. increased density). Using historical trends in housing demolition and apartment construction the ratio was estimated to be 1:9, i.e. 1 house to 9 apartments.

A series of constraints were placed on the amount of redistribution that could occur.

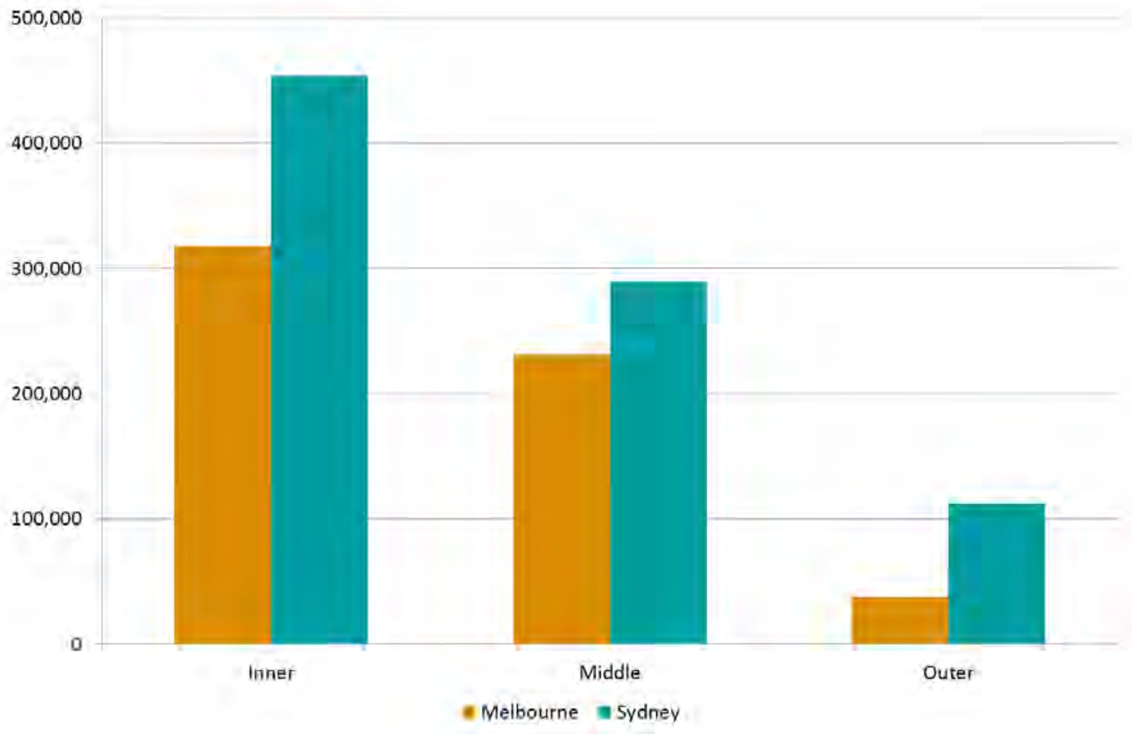
- Development relocating away from a location is limited to within 1 per cent per year of the base case. That is, over a 5 year period only 5 per cent could be relocated away.
- Existing housing is only removed if there is sufficient new development moving in. That is, if EJD increases the existing detached housing stock will only decline if there is sufficient increase in apartment housing to replace it.
- A notional capacity constraint was placed on how much development can be relocated into an area. This was derived from an assessment of planning controls, past housing development trends and common housing typologies.

Finally, a broad residual land value analysis by location and development type was completed to illustrate the potential value uplift from this redistribution. In summary, this approach using average sales prices by suburb and development type (houses and apartments) and subtracts the average development costs for construction (including financing expenses and an allowance for profit). Figure 28 presents the estimated residual land value for Sydney and Melbourne by the inner, middle and outer rings. Sales prices for apartments were much higher in Sydney compared to Melbourne, and construction costs were marginally cheaper.

Residual Land Value *By ring*	=	Sales price *By ring* *By type*	-	Cost of development *By type* *By Ring*

The change in housing development by type is then multiplied by the raw residual land value estimate.

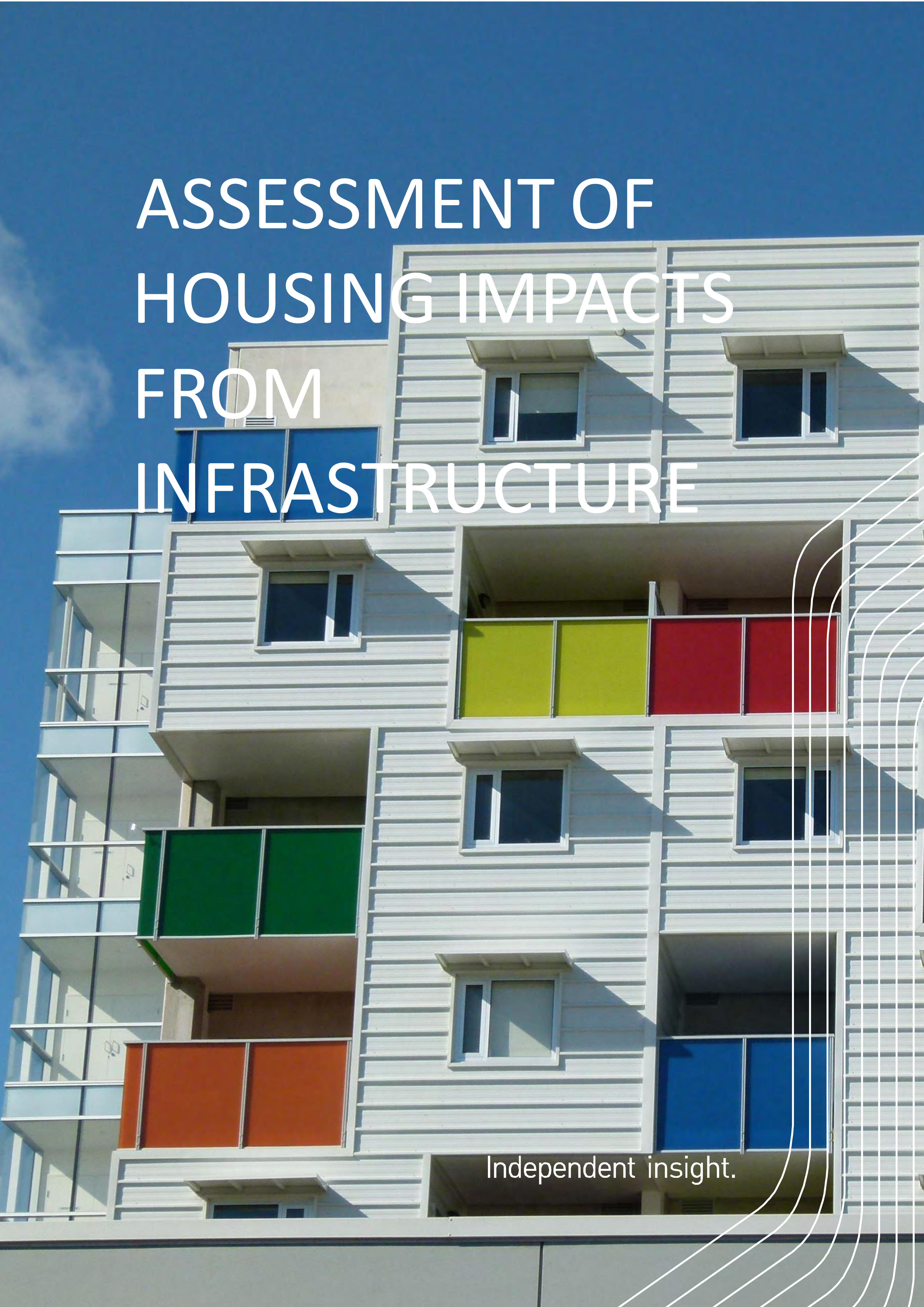
FIGURE 28. **RESIDUAL LAND VALUE FOR SYDNEY & MELBOURNE**



Source: SGS Economics & Planning

While this is a somewhat crude approach, it provides a broad indication of the magnitude of land value changes under different scenarios.

ASSESSMENT OF HOUSING IMPACTS FROM INFRASTRUCTURE



Independent insight.

4 ASSESSMENT OF HOUSING IMPACTS FROM INFRASTRUCTURE

4.1 Introduction

This section takes a scenario approach in appraising the implications of the 'housing to infrastructure' elasticities estimated previously for the pattern of urban development in metropolitan Melbourne and Sydney.

The following analysis contemplates investment in 'major' or 'city-shaping' rail and road projects in both metropolises. The projects are not specified in terms of route, service levels and cost but, rather, in terms of their assumed impacts on EJD in different parts of the city.

Implicitly, the projects in question are deemed to be of the same scale and scope as investments such as CityLink or the metropolitan Rail Loop in Melbourne, and the M7 Orbital in Sydney. That is, they are assumed to substantially shift accessibility contours across these cities.

Thus, the scenarios are 'realistic' in the sense that assumed impacts are benchmarked against those achieved in earlier, similar projects.

4.2 Approach

The Sydney and Melbourne metropolitan areas were divided into three broadly comparable concentric rings covering inner, middle and outer suburbs. The inner and middle suburbs contained approximately the same proportion of metropolitan dwellings in 2011. Each ring was applied an assumed percentage uplift in relative effective job density (EJD) arising from the notional transport projects. As noted, these uplifts were based on previous work completed by SGS on major transport infrastructure projects. However, they should be interpreted as hypothetical scenarios, devised for analytical purposes only.

The percentage uplifts applied to Sydney and Melbourne are shown in Figure 29. They are set at slightly higher levels for Melbourne reflecting the less fragmented structure of that metropolis. That is, for a given investment quantum, a transport project in Melbourne will face less 'friction' or fewer barriers in connecting up major concentrations of employment.

FIGURE 29 ASSUMED PERCENTAGE UPLIFTS TO RELATIVE EJD BY RING

Ring	Melbourne	Sydney
Inner	14%	10%
Middle	7%	5%
Outer	2%	1%

Source: SGS Economics & Planning

Figure 30 presents the outcomes from four hypothetical scenarios regarding increases in apartment activity and land values, and the reduction in land required for urban fringe expansion, assuming that the EJD uplifts shown above have taken full effect over the period 2011-2031. The four scenarios are as follows:

- Outcomes in Sydney with Sydney equation and EJD coefficient
- Outcomes in Sydney with Sydney equation and Melbourne EJD coefficient
- Outcomes in Melbourne with Melbourne equation and Sydney EJD coefficient
- Outcomes in Melbourne with Melbourne equation and Melbourne EJD coefficient.

This approach tests the impact of a Melbourne specific transport investment under a metropolitan Melbourne context and a metropolitan Sydney context, and repeats this for a Sydney specific investment program. The purpose in this procedure was a form of sensitivity testing, recognising that the estimated Sydney elasticities were beset with data limitations. By cross-deploying the city elasticities, the broad range of possible outcomes in urban development could be explored.

The impacts using the Melbourne EJD coefficient are much larger than those where the Sydney EJD coefficient is used, given the stronger statistical relationship that was observed between accessibility (EJD) and higher density housing development in Melbourne. However, the land value uplift is shown to be higher in Sydney than in Melbourne due to the higher residual land values that occur in Sydney.

As a result of the transport investment increasing housing density in the existing urban area, the amount of land that would be required on the urban fringe for detached housing is reduced in both cities. This land area was estimated using an average dwelling density of 15 dwellings per hectare (gross). In Melbourne, the reduction in land required for urban fringe expansion resulting from this hypothetical scenario was estimated to be 7,500 hectares. This represents 3% of the existing urban area of Melbourne. In Sydney using the Sydney EJD coefficient scenario the reduction in urban fringe land was estimated to be 933 hectares, equivalent to 0.2% of the existing urban area.

FIGURE 30 SYDNEY AND MELBOURNE SCENARIO OUTCOMES

	Sydney Metropolitan Outcomes		Melbourne Metropolitan Outcomes	
	Sydney EJD coefficient	**Melbourne EJD Coefficient**	**Sydney EJD coefficient**	**Melbourne EJD Coefficient**
Additional Apartments	14,000	109,100	14,400	112,700
Proportion of Stock	9%	72%	13%	101%
Land value uplift ($millions)	3,958	28,037	2,879	22,130
Reduction in land required in urban fringe expansion (Ha)	933	7,273	960	7,513
Share of existing urban area	0.2%	1.8%	0.4%	3.0%

Source: SGS Economics & Planning

These results are explored in more detail in the following pages.

4.3 Melbourne

Housing impacts – dwelling composition and location

The housing impacts from the transport investment scenario in Melbourne using the Melbourne EJD coefficient are projected to include a significant increase in apartment growth and a decrease in detached housing growth, and thus decrease in land required on the urban fringe. Figure 31 presents the high level impacts across greater Melbourne under this scenario, for the three dwelling types using the Melbourne EJD coefficient. Under the base case an additional 112,000 apartments are forecast between 2011 and 2031, and an additional 197,800 detached houses. The impact of this scenario is to increase apartment growth by 112,700 dwellings (101% of the base case apartment growth) and decrease detached houses by the same amount (57% of base case detached housing growth).

It should be noted that in these calculations, the total stock of dwellings across Melbourne in 2031 is fixed; the effect of the EJD uplift is a redistribution of dwellings by type and geography.

The chart in Figure 32 shows the base and project case growth in number of dwellings (by detached, semi-detached and apartments) in 2031 for the inner, middle and outer rings of Melbourne using the Melbourne EJD coefficient. This highlights that the number of apartments across Melbourne is increasing, more so in the inner and middle rings. The number of semi-detached houses does not change between the base and project case. The number of detached houses falls between the base and project case, more so in the middle ring which contained the greatest proportion of dwellings in 2031.

FIGURE 31. **SUMMARY RESULTS FOR MELBOURNE SCENARIO**

		Detached	Semi-Detached	Apartments	Total Dwellings
Base Case	2011	903,700	178,200	258,000	1,339,900
	2031	1,101,500	292,500	370,000	1,764,000
	2011 - 2031 Growth	197,800	114,300	112,000	424,100
Project Case	2031	988,800	292,500	482,700	1,764,000
	2011 - 2031 Growth	85,100	114,300	224,700	424,100
Change	Growth	-112,700	0	112,700	0
	Percentage	-57%	0%	101%	0%

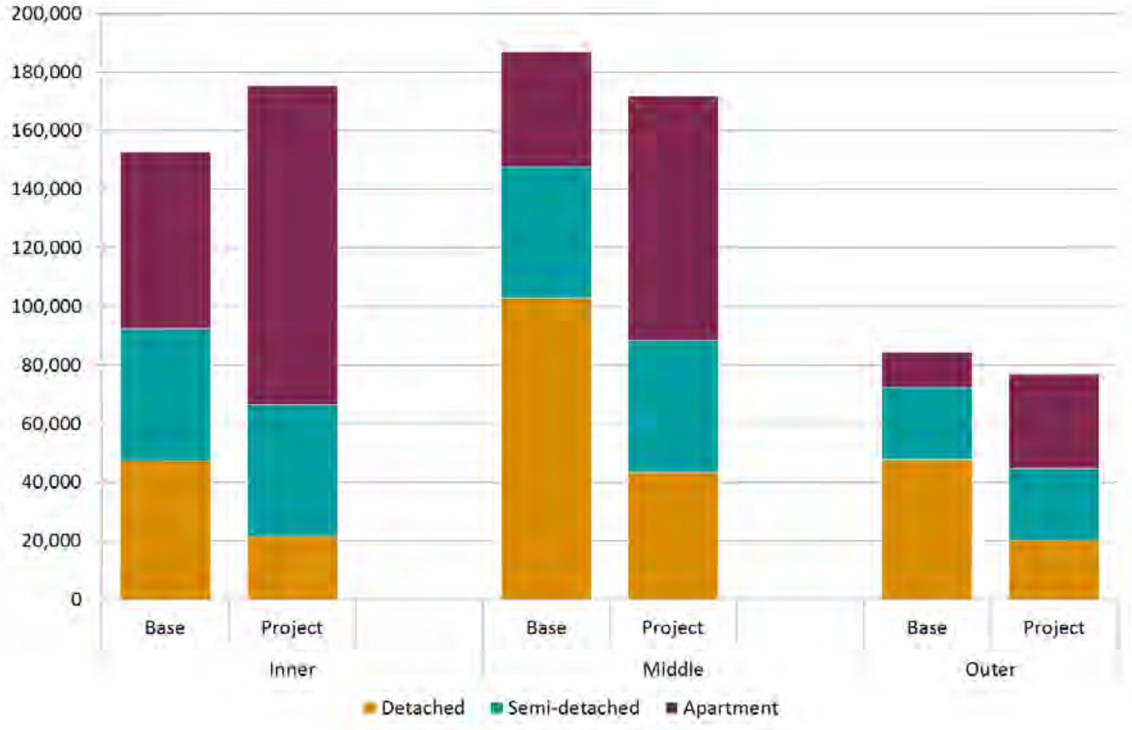
Source: ABS 2011 Census and SGS Economics & Planning

Figure 33 maps the percentage impacts on EJD under the transport investment scenario. This highlights the varying benefits to the inner, middle and outer rings of Melbourne.

The unconstrained housing impacts using the Melbourne EJD coefficient are shown in Figure 34 and Figure 35. This highlights that the largest impacts include apartment growth occur in the inner ring, with detached housing growth being pulled away from the urban fringe areas.

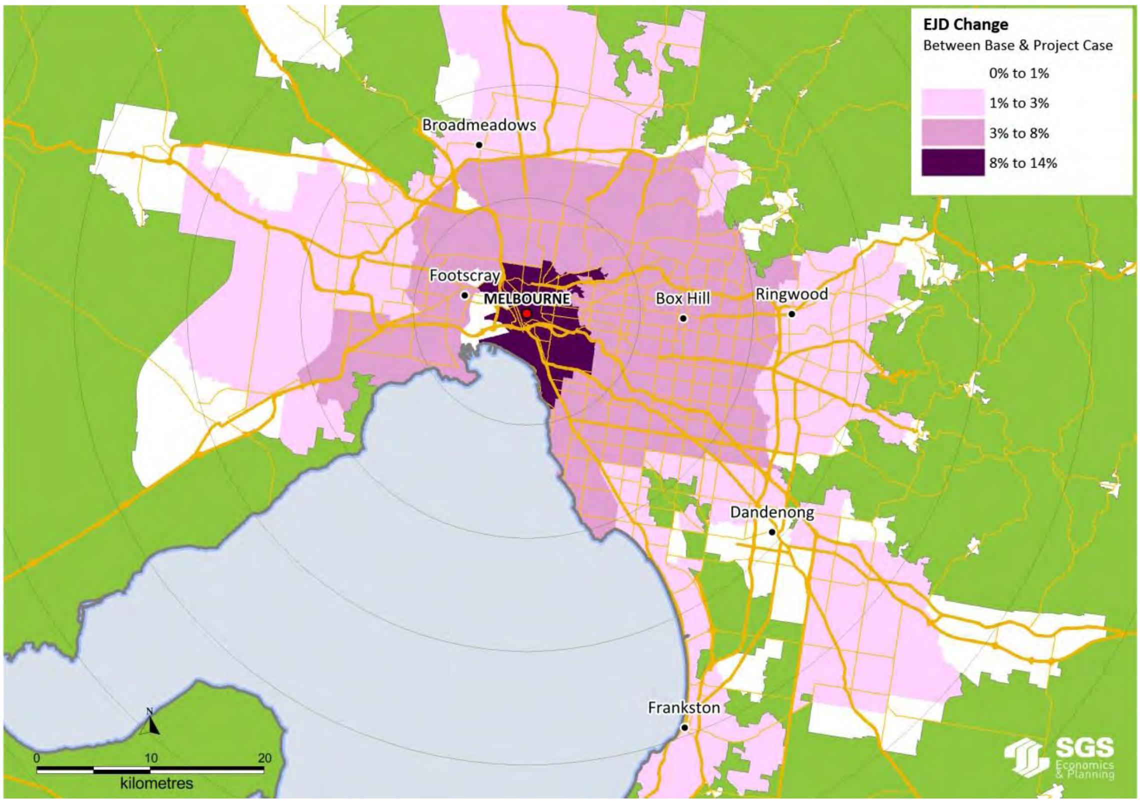
The unconstrained impacts under the Melbourne scenario using the Sydney EJD coefficient are shown in Figure 36 and Figure 37. In this scenario the impacts across the metropolitan area are much smaller, with a maximum change of 200 apartments.

FIGURE 32. **SUMMARY RESULTS BY RING AND DWELLING TYPE, MELBOURNE**



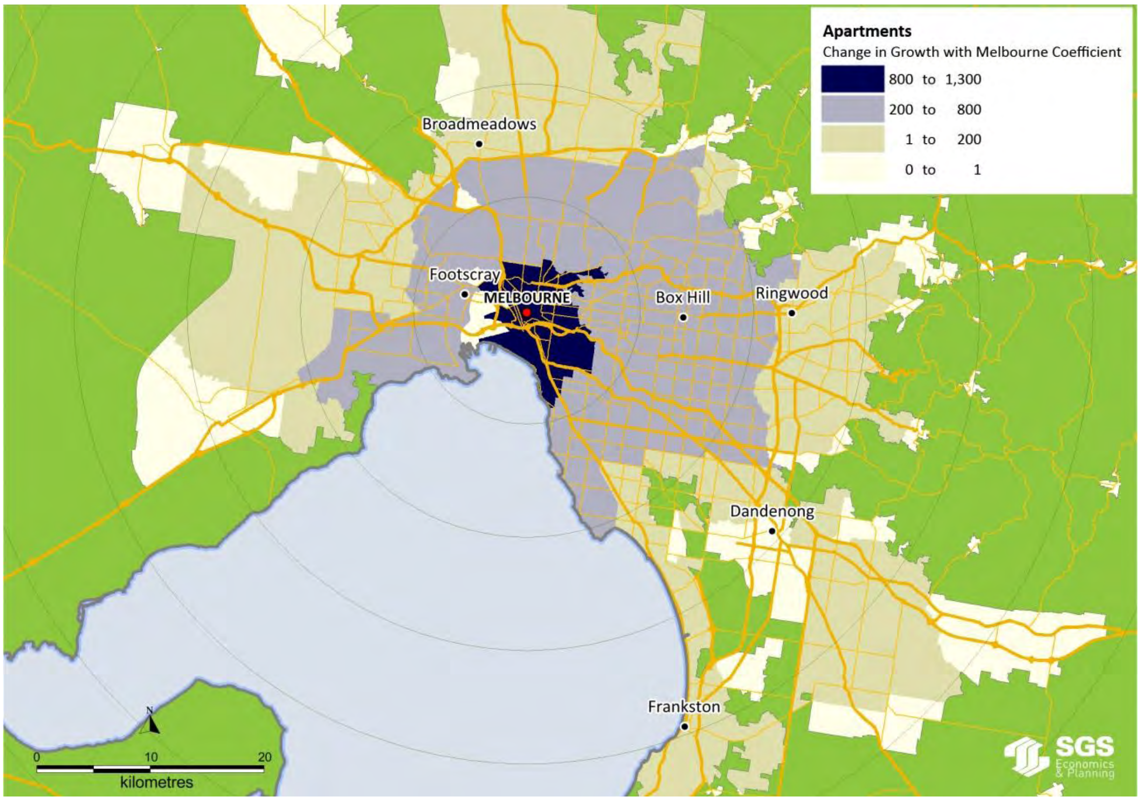
Source: SGS Economics & Planning

FIGURE 33. **PERCENTAGE IMPACT ON EJD, MELBOURNE**



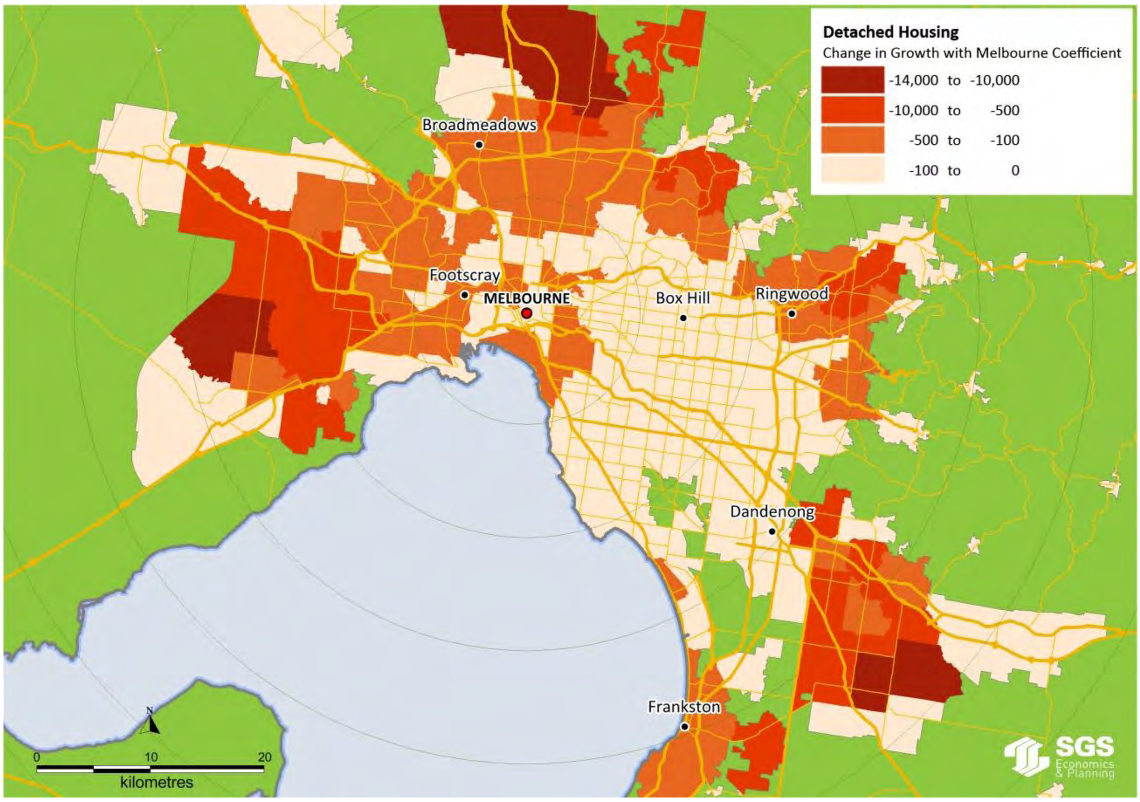
Source: SGS Economics & Planning

FIGURE 34. **MAP OF IMPACT ON APARTMENT GROWTH, MELBOURNE**



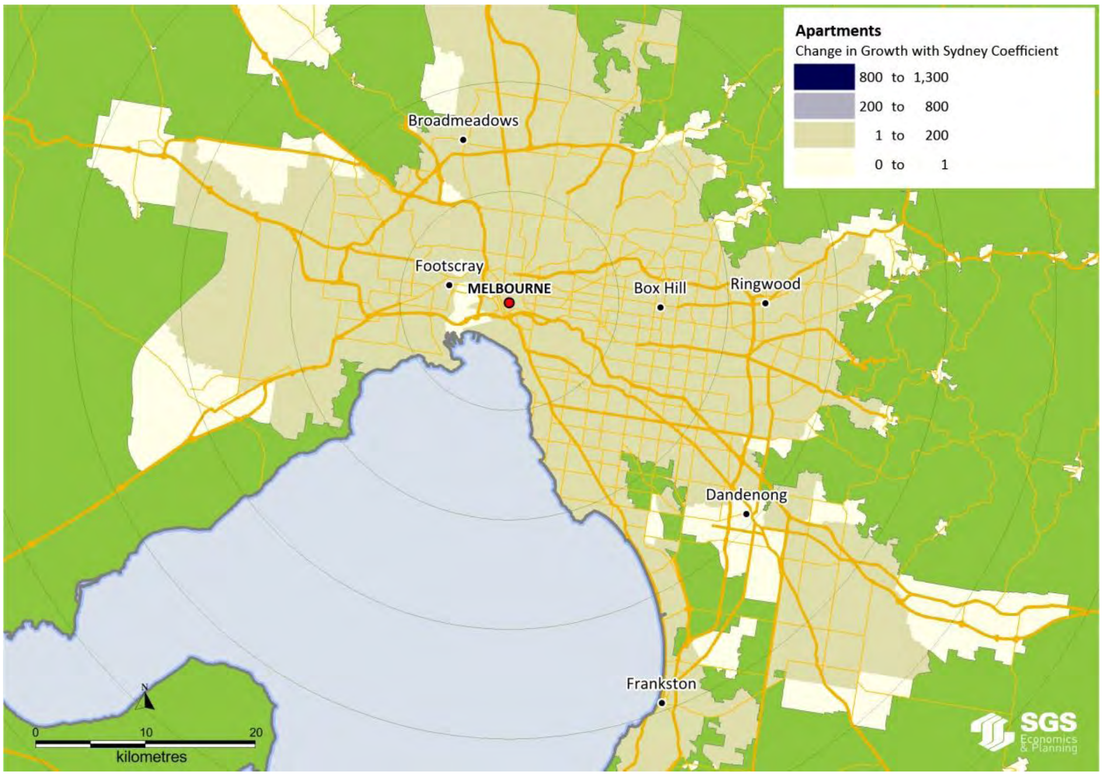
Source: SGS Economics & Planning

FIGURE 35. **MAP OF IMPACT ON DETACHED HOUSING GROWTH, MELBOURNE**



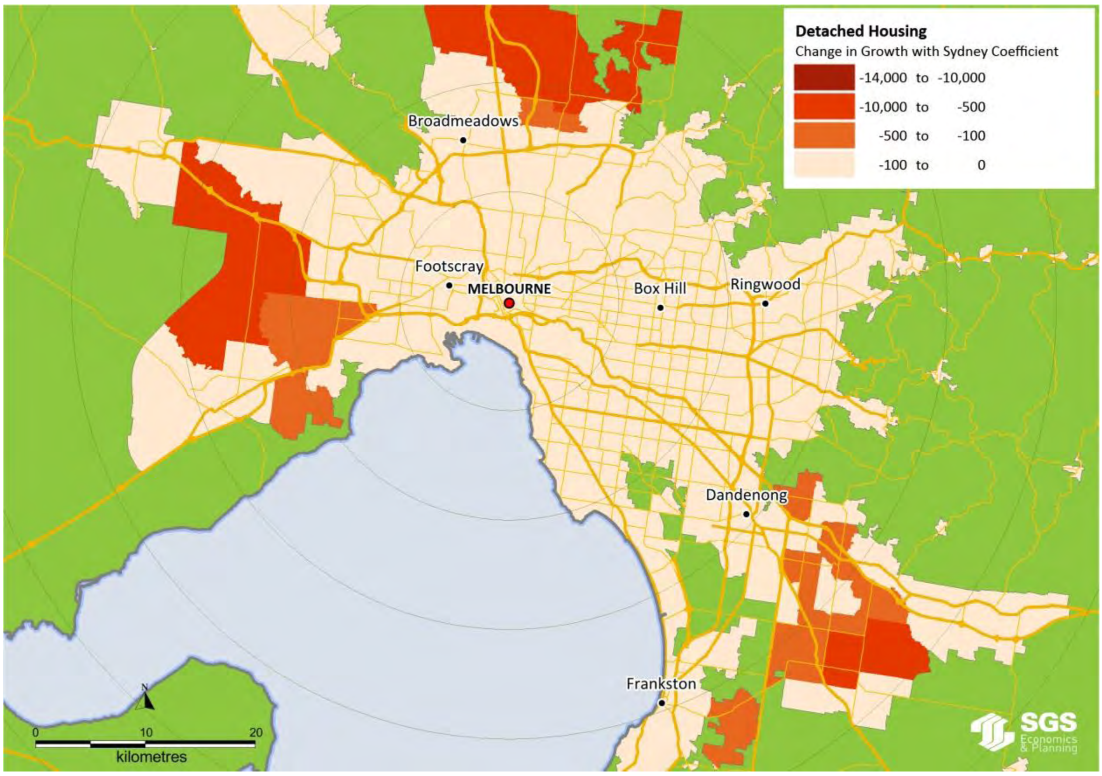
Source: SGS Economics & Planning

FIGURE 36. **MAP OF IMPACT ON APARTMENT GROWTH, MELBOURNE WITH SYDNEY EJD COEFFICIENT**



Source: SGS Economics & Planning

FIGURE 37. **MAP OF IMPACT ON DETACHED HOUSING GROWTH, MELBOURNE WITH SYDNEY EJD COEFFICIENT**



Source: SGS Economics & Planning

Housing impacts – land value

The impacts with respect to land values were gauged as the number of additional dwellings multiplied by an estimated residual land value. The impacts on the three broad rings in Melbourne are presented in Figure 38 for both the Melbourne and Sydney EJD coefficients. Across Melbourne the total dollar impact from the construction of the additional apartments is estimated to be $22.1 billion (in 2013 dollars). This is split mainly between the inner and middle rings, which were estimated to produce $10.7 billion and $8.2 billion respectively. The land value impacts from the Sydney EJD coefficient scenario were much smaller, with only $2.9 billion across metropolitan Melbourne.

FIGURE 38 LAND VALUE IMPACTS, MELBOURNE

Ring	Residual Land Value Impact ($millions)	
	Melbourne EJD coefficient	Sydney EJD Coefficient
Inner	$10,777	$1,422
Middle	$8,169	$1,057
Outer	$3,184	$400
Total	$22,130	$2,879

Source: SGS Economics & Planning

4.4 Sydney

Housing impacts – dwelling composition and location

The housing impacts from the transport investment scenario in Sydney are projected to be considerably smaller compared to those for Melbourne. This is due to the weaker relationship between EJD and housing development in Sydney. Figure 39 presents the high level impacts across greater Sydney under this scenario, for the three dwelling types using the Sydney EJD coefficients. Under the base case an additional 150,800 apartments are forecast between 2011 and 2031, and an additional 270,700 detached houses. The impact of this scenario is to increase apartment growth by 14,000 dwellings (9% of the base case apartment growth) and decrease detached houses by the same amount (5% of base case detached housing growth).

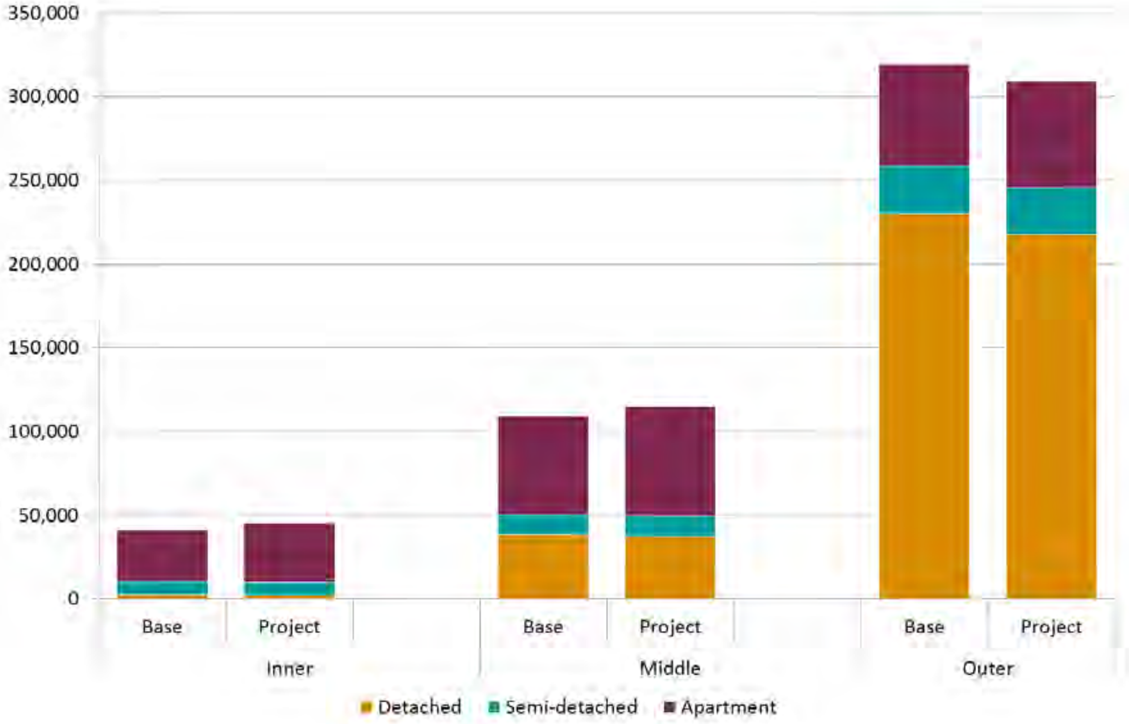
The chart in Figure 40 shows the base and project case growth in number of dwellings (by detached, semi-detached and apartments) in 2031 for the inner, middle and outer rings of Sydney using the Sydney EJD coefficient. This highlights that the number of apartments across Sydney is increasing. The number of semi-detached houses across Sydney is very small and does not change between the base and project case. The outer region contains the most significant number of detached houses which falls slightly between the base and project case.

FIGURE 39 SUMMARY RESULTS FOR SYDNEY SCENARIO

		Detached	Semi-Detached	Apartments	Total Dwellings
Base Case	2011	1,013,200	220,400	474,400	1,013,200
	2031	1,283,900	268,300	625,200	1,283,900
	2011 - 2031 Growth	270,700	47,900	150,800	270,700
Project Case	2031	1,269,900	268,300	639,200	1,269,900
	2011 - 2031 Growth	256,700	47,900	164,800	256,700
Change	Growth	-14,000	0	14,000	-14,000
	Percentage	-5%	0%	9%	-5%

Source: ABS 2011 Census and SGS Economics & Planning

FIGURE 40. **SUMMARY RESULTS BY RING AND DWELLING TYPE, SYDNEY**



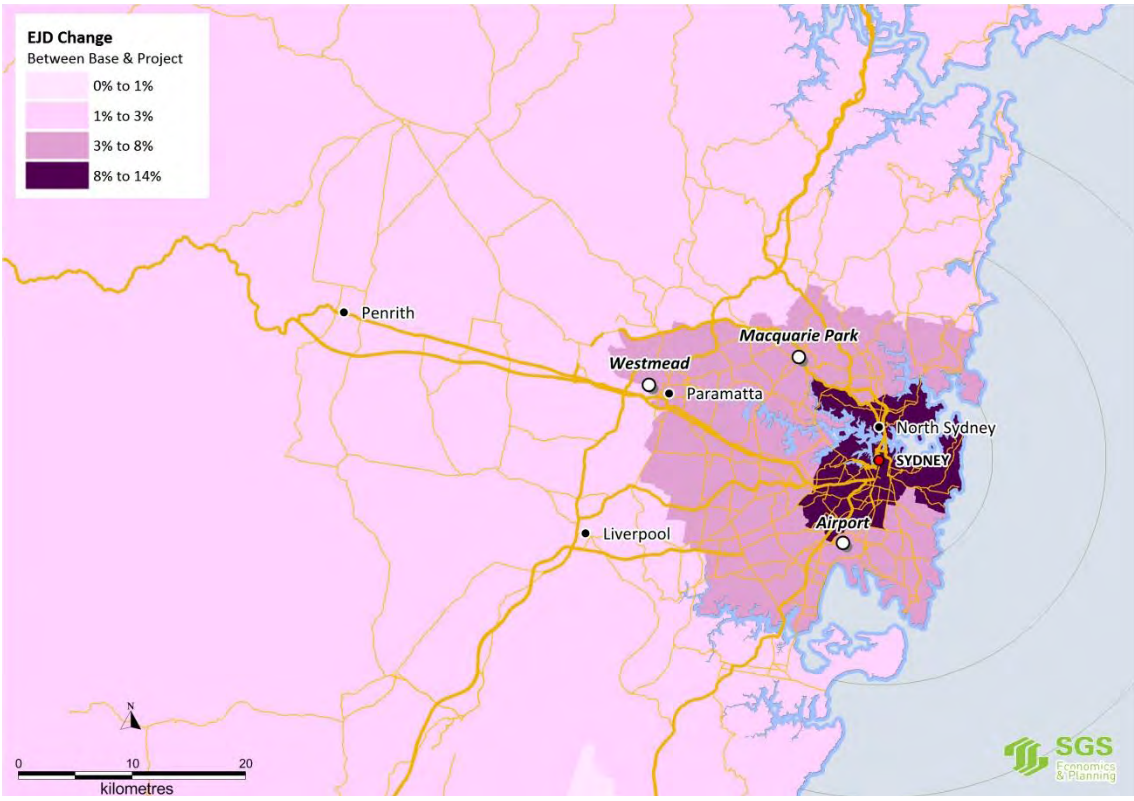
Source: SGS Economics & Planning

Figure 41 maps of the percentage impact on EJD under the assumed transport investment program. This reflects the greater benefit to the inner ring compared to outer regions.

The impact on dwellings across Sydney using the Sydney EJD coefficient is shown in Figure 42 and Figure 43 for apartments and detached housing respectively. There is very little change forecast for the apartment growth in this scenario, with a maximum shift of 200 apartments in any given small area. The reduction in detached housing growth occurs in outer locations on the fringe of Sydney. The suburbs that experience the greatest decline in detached housing growth are those located in low accessibility areas, with large dwelling growth projected.

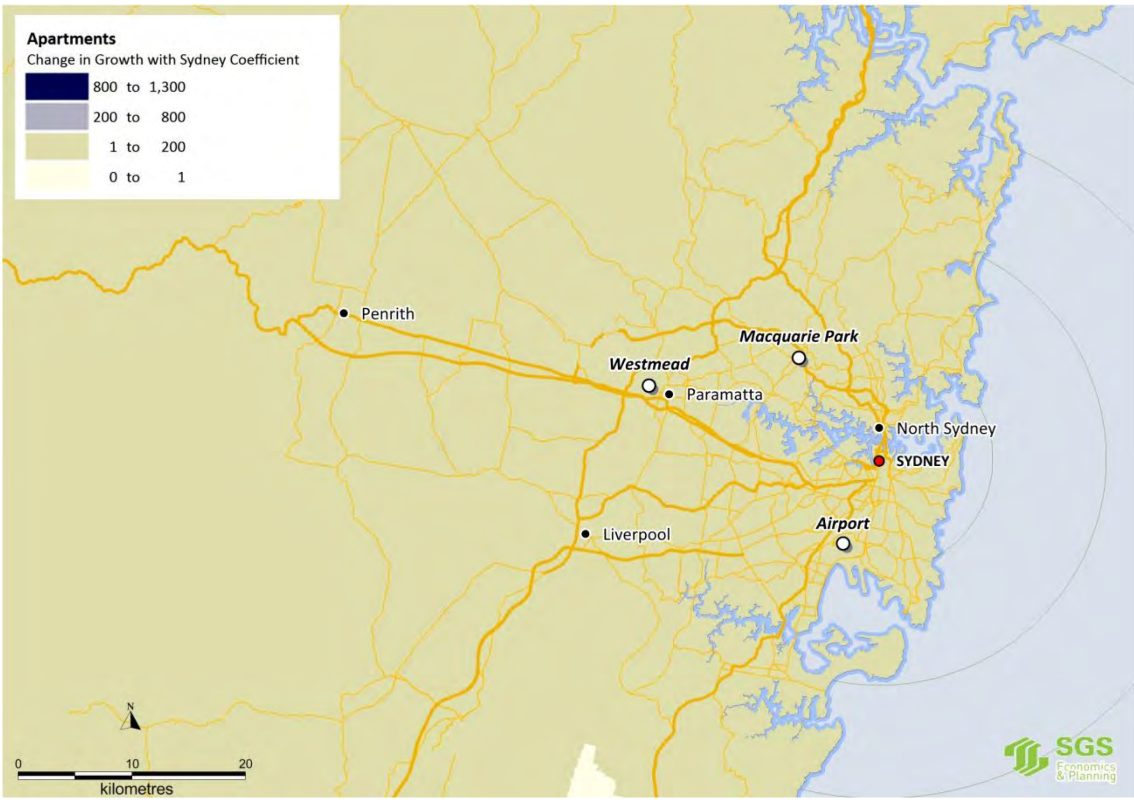
The unconstrained impacts under the Sydney scenario using the Melbourne EJD coefficient are shown in Figure 44 and Figure 45. In this scenario the impacts across the metropolitan area are comparatively much larger.

FIGURE 41. PERCENTAGE IMPACT ON EJD, SYDNEY



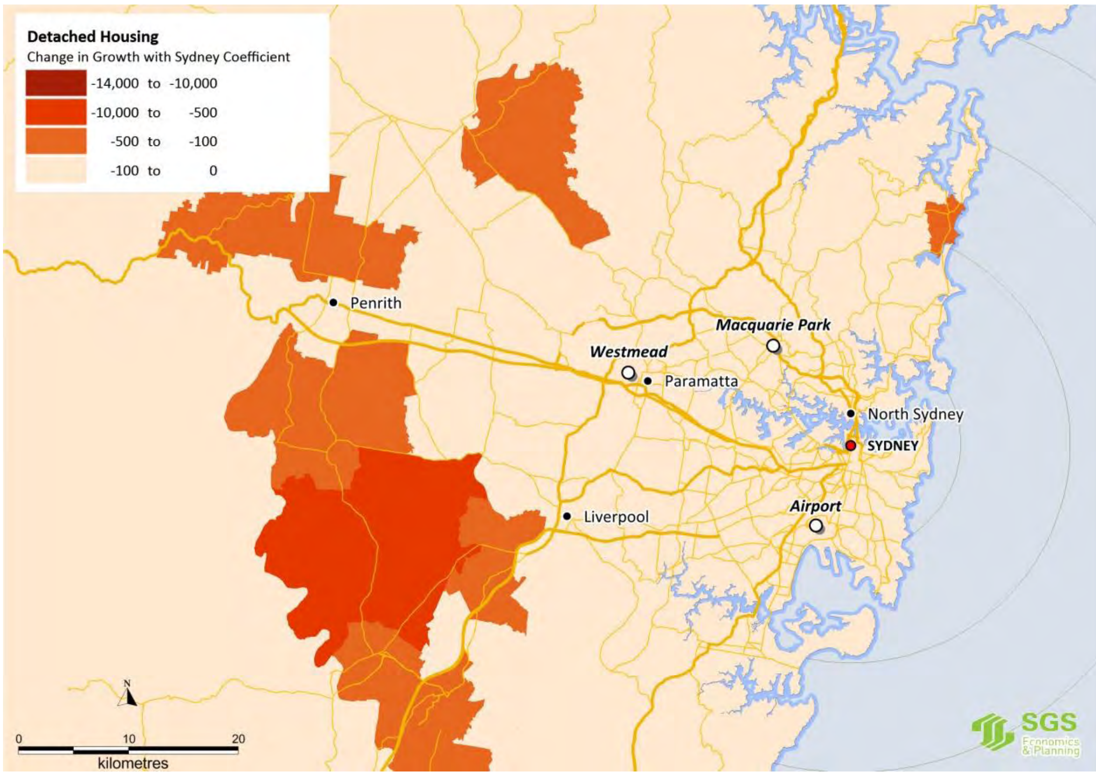
Source: SGS Economics & Planning

FIGURE 42. MAP OF IMPACT ON APARTMENT GROWTH, SYDNEY



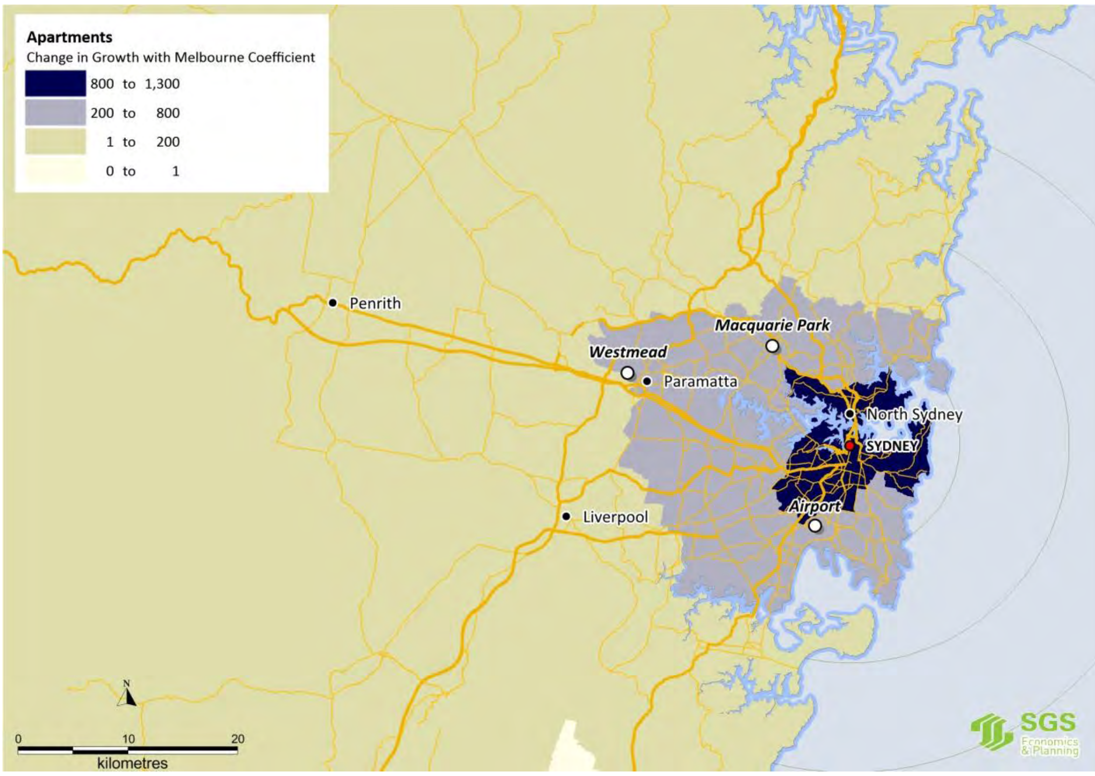
Source: SGS Economics & Planning

FIGURE 43. **MAP OF IMPACT ON DETACHED HOUSING GROWTH, SYDNEY**



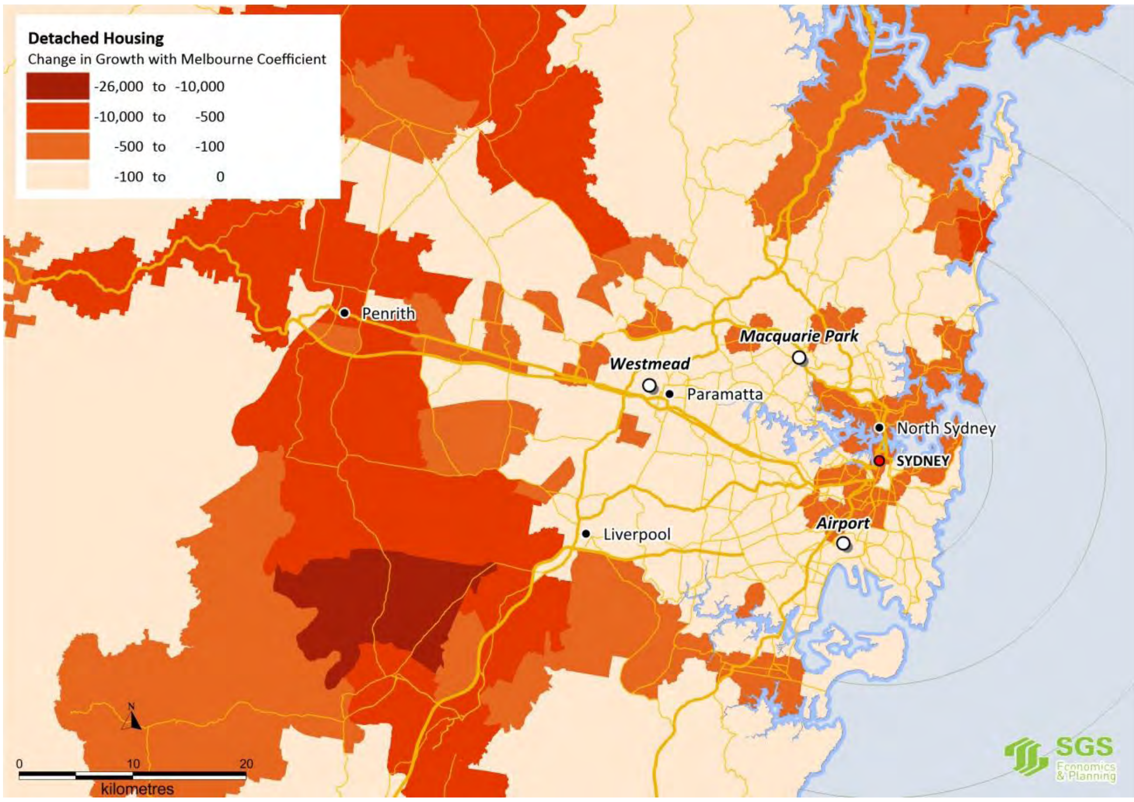
Source: SGS Economics & Planning

FIGURE 44. **MAP OF IMPACT ON APARTMENT GROWTH, SYDNEY WITH MELBOURNE EJD COEFFICIENT**



Source: SGS Economics & Planning

FIGURE 45. **MAP OF IMPACT ON DETACHED HOUSING GROWTH, SYDNEY WITH MELBOURNE EJD COEFFICIENT**



Source: SGS Economics & Planning

Housing impacts – land value

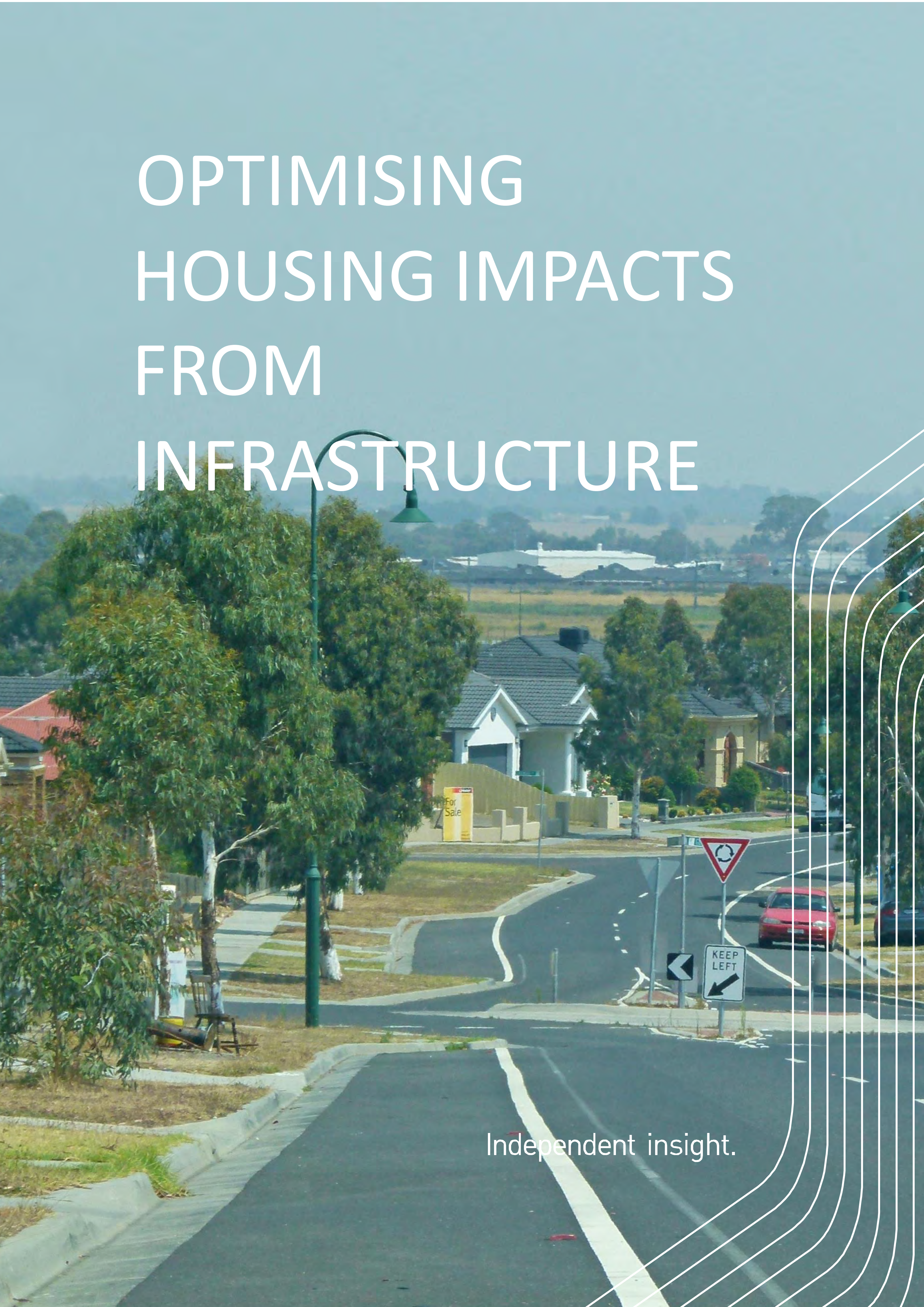
The impacts on land values in the three broad rings in Sydney are presented in Figure 46 for both the Sydney and Melbourne EJD coefficients. Across Sydney the total dollar impact from the construction of the additional apartments is estimated to be $3.9 billion (in 2013 dollars, using the Sydney coefficient). The majority of this comes from the inner and middle rings, which are estimated to produce $2.1 billion and $1.6 billion respectively. The land value impacts using the Melbourne EJD coefficient for the Sydney scenario are estimated to be $28 billion across the metropolitan region.

FIGURE 46 LAND VALUE IMPACTS, SYDNEY

Ring	Residual Land Value Impact (Millions)	
	Sydney EJD coefficient	Melbourne EJD Coefficient
Inner	$2,112	$12,922
Middle	$1,629	$12,762
Outer	$217	$2,353
Total	$3,958	$28,037

Source: SGS Economics & Planning

OPTIMISING HOUSING IMPACTS FROM INFRASTRUCTURE



Independent insight.

5 OPTIMISING HOUSING IMPACTS FROM INFRASTRUCTURE

5.1 Overview

The analysis set out in previous sections demonstrates that investment in infrastructure projects which significantly elevate the absolute effective job density, or connectivity, of an area can trigger significant housing intensification in such areas. The strength of this effect appears to vary between Sydney and Melbourne, though this variation may be more a reflection of data limitations in the Sydney analysis, rather than a real world difference in housing behaviours. Overall, the research suggests that a sizeable proportion of households are prepared to switch to more compact, higher density, housing if they are afforded the opportunity to move into an area with high access to opportunity be this in employment or in relation to other urban services.

Whilst major transport investment may generate the *potential* for housing intensification, the extent to which this potential is realised will depend on a range of factors. The appropriateness of the planning controls affecting the areas in question will be uppermost amongst these. Also of relevance is the fact that underlying housing development potential may not find expression because of 'market failures'. For example, fragmented land holdings may hamper the market from undertaking housing projects of sufficient scale. Similarly, key brownfield sites for housing construction may be constrained by unknown contamination risk or lack of co-ordinated asset management amongst institutional owners.

This section of the report discusses the kinds of 'interventions' necessary to overcome these barriers and enable infrastructure projects to generate their maximum impact on dwelling construction.

For the purposes of this discussion four spatial elements have been defined in respect of the impacts of major transport investments and the consequences for planning and related interventions. These are illustrated in schematic form in Figure 47, and are outlined as follows:

- **Zone of moderate EJD impact**
  As demonstrated in foregoing sections of this report, the EJD effects of major infrastructure projects can extend over considerable geographic distances. This is because major projects generally have the effect of linking up existing major arteries thereby expanding the accessibility footprint of the metropolis. Here, the 'zone of moderate EJD impact' is defined by the aggregation of those small areas (say SA2s) which collectively accommodate two thirds of EJD uplift generated by the project.

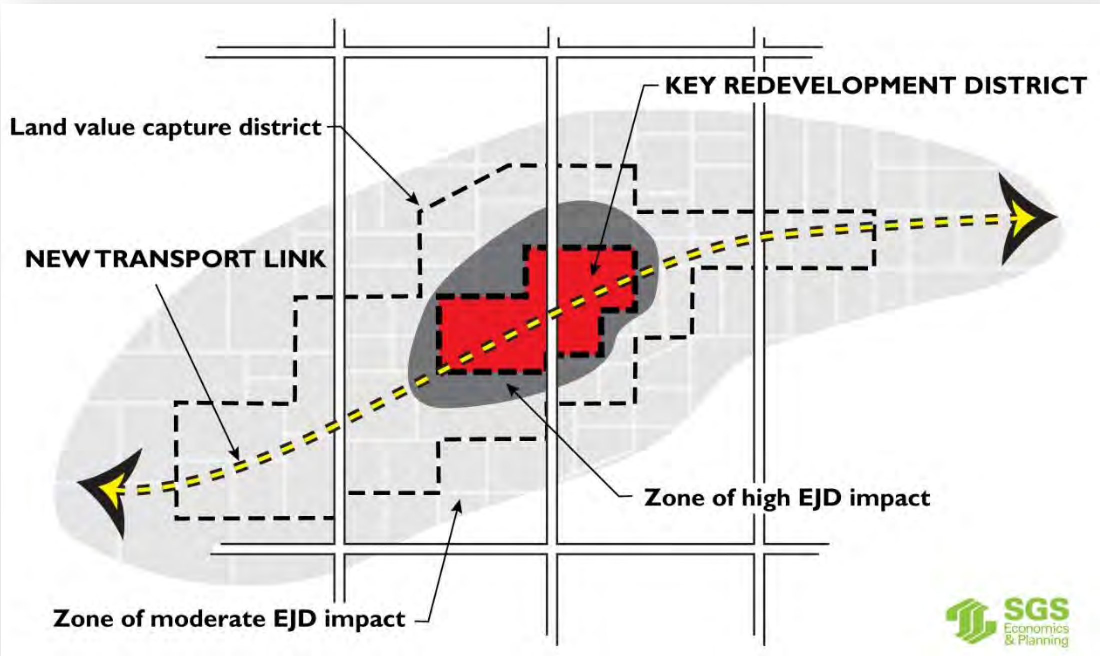
- **Zone of high EJD impact**
  The zone of high EJD impact is nested within the zone of moderate impact and might be defined by those areas collectively enjoying a 50% share of the total lift in effective job density.

- **Key redevelopment district**
  The key redevelopment districts are likely to be situated within the zone of high EJD impact, and would be expected to show a heightened potential for transport induced housing intensification. These areas might be candidates for focussed planning intervention by way of state mandated

development corporations. These might facilitate private sector development after the fashion of Dandenong in Melbourne or East Perth in WA.

- **Land value capture district**
  The land value capture district would involve a conservative 'in-board' delineation of the zone of moderate EJD impact. In broad terms, this can be seen as the 'benefitted area' of the transport project. This might be a candidate for special funds raising strategies linked to the uplift in land value enjoyed by constituent properties.

FIGURE 47. **SCHEMATIC OF EJD IMPACT AREAS**



Source SGS

The remainder of this Section of the report identifies relevant concepts, methodologies and case studies for practical interventions into these various sub areas directed at unlocking housing potential and/or funding sources for the transport projects in question.

5.2 Optimising housing supply in the zone of moderate EJD impact

In this zone, the key 'intervention' is in fact to make existing planning arrangements effective, so that they facilitate rather than militate against appropriate densification. These issues have been the subject of extensive research and policy deliberations over the past 15 years since the formation of the Development Assessment Forum (DAF) at the initiative of the Commonwealth. The discussion below draws extensively from research previously conducted by SGS for AHURI and the Residential Development Council of the PCA regarding the prospects for infill housing development in Australia's major cities[7].

[7] SGS Economics and Planning Pty Ltd (2012) Planning Governance and Infill Housing Supply in Australian Metropolitan Areas, commissioned by AHURI and RDC (unpublished consulting report)

Broad reforms

SGS's research resonates with the work of DAF and other writers[8] regarding the priority need to 'de-politicise' planning for infill housing to the extent that this is possible. This imperative applies at both the plan making and development assessment ends of the spectrum.

With respect to ***plan making*** there are many calls in the literature to have the minister 'above the fray', that is, to preside over the planning system with ultimate authority but without becoming routinely involved in individual development assessment decisions and disputes.

Also present, but less well articulated, in the literature is the proposition that the subsidiarity principle should govern the allocation of planning responsibilities to local government versus other, higher order, authorities (regional planning commissions or state governments). That is, local governments should have jurisdiction over matters with purely local consequences, while higher order spheres of governance should have plan making and development assessment authority over those parts of the metropolis which clearly have a sub-regional or metropolitan wide role or impact. The areas affected by city shaping projects such as those tested in this report could well fall into the bailiwick of these higher order jurisdictions.

Further on the question of ***development assessment***, there is now a broad consensus, in the literature at least, that greater use of 'code assessable' development and independent planning panels along the lines of the DAF model is warranted. Code assessable development refers to housing (and other) projects which can be approved via technical appraisal against a set of discrete and measurable performance requirements, obviating the need for recourse to political decision making by councillors and the like.

SGS's previous research has also stressed the need for more discipline in the application of ***development contributions*** in respect of infill housing and, indeed, all development projects. Such disciplines relate to conceptual separation of up-front user charges from other forms of development contributions (impact mitigation payments, betterment taxes and inclusionary provisions), careful consideration of alternative user pays mechanisms before resorting to up-front charges, confinement of up-front charges to basic infrastructure items and strict application of the nexus principle in apportioning costs.

Strategic planning for infill housing

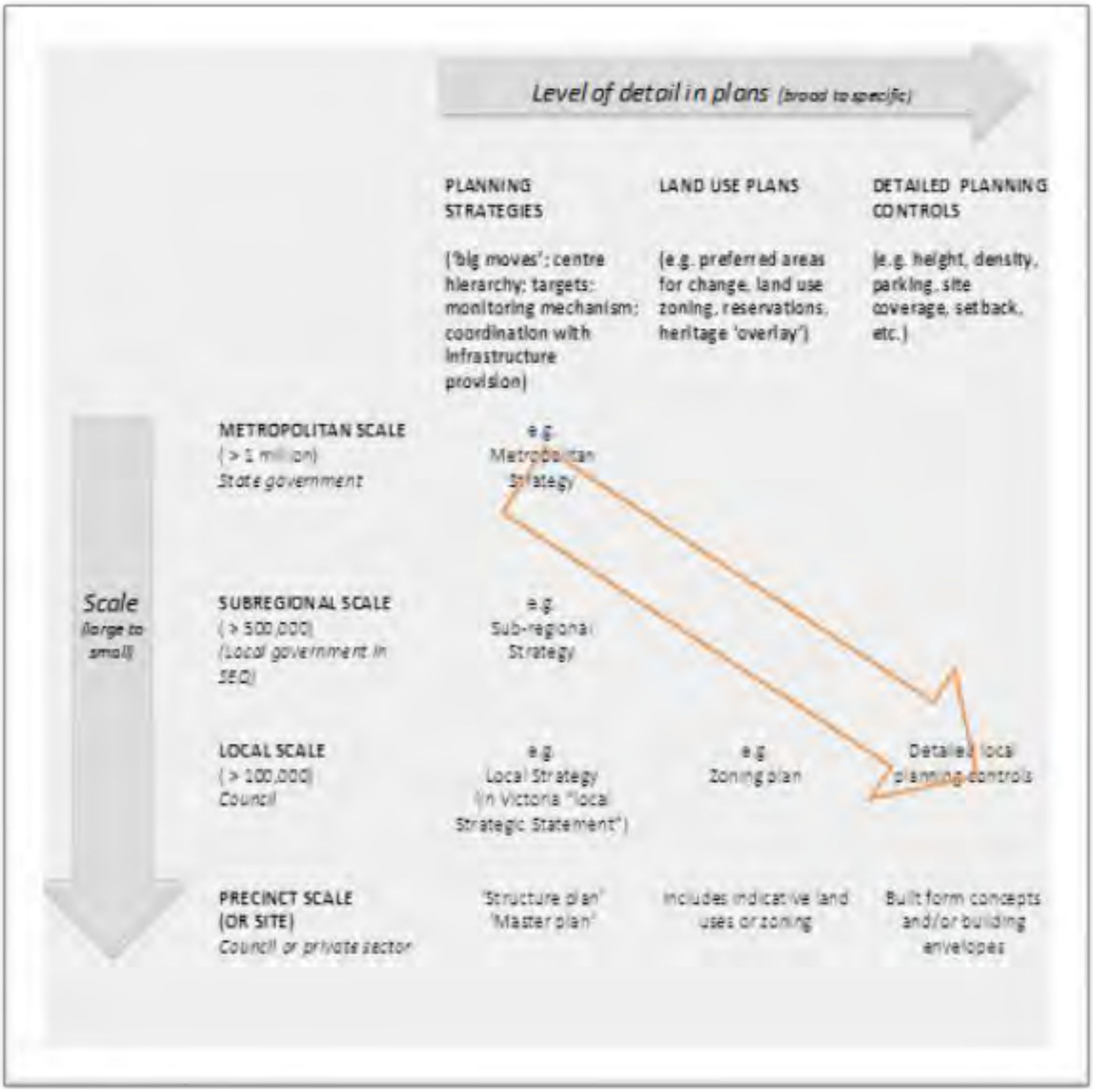
SGS's analysis of existing practices across most Australian metropolitan areas has identified something of a structural flaw in the approach to housing development such as that which might be anticipated in the abovementioned 'zones of moderate EJD impact'. There are strong competencies and established institutions to prepare plans on the metropolitan scale, and these establish the 'big moves' sought in metropolitan structure, including the hierarchy of centres and overall housing requirements in different parts of the city. Concurrently, there are well established mechanisms in place whereby local governments prepare detailed strategies and planning controls at the local level. The gap lies in translating 'big picture' planning strategies into detailed local schemes (Figure 48). Planning at the sub-regional level is generally underdeveloped or completely absent. One notable exception is Queensland, where the Brisbane City Council and the now enlarged municipalities elsewhere in the state can operate at the sub-regional scale.

It is also interesting to note that the NSW Government is proposing to tackle this problem head on in its comprehensive review of the State's planning legislation and administrative systems. The White Paper on *"A New Planning System for NSW"* proposes the formation of Sub-regional Planning Boards which will comprise delegates from constituent Councils and State Government appointees. These Boards will have the power to make binding provisions – to serve regional and metropolitan interests – in planning schemes which otherwise will be developed and managed by local Councils. On the face of it, such a

[8] See for example, Steven Rowley and Peter Phibbs (2012) Delivering diverse and affordable housing on infill development sites Australian Housing and Urban Research Institute, Western Australia Research Centre UNSW-UWS Research Centre, August

mechanism would be of great advantage were a State Government to propose City shaping transport projects which are known to have significant synergistic and 'knock on' effects across a regional geography. Appropriate planning scheme provisions to enable rapid adjustment in the housing stock as accessibility and connectivity rise could be rolled out more readily under these arrangements.

FIGURE 48. **CONNECTING METRO STRATEGY TO LOCAL PLANS**



Source: SGS

Without mechanisms of this type, the lack of a coherent translation path from metropolitan strategy to local planning tends to create an intractable political tussle between a state or territory government seeking more efficient and compact urban structures, and local communities intent on preserving what they see as their right to undisturbed enjoyment of current residential amenity.

These mechanisms can also mitigate another key problem in the planning regulation of housing – that controls over density and site coverage are 'out of sync' with market realities. In its review of infill housing controls across Australian cities SGS found that, in some jurisdictions at least, local planning strategies and/or zones may set out to encourage housing development, but in reality, the combination of the various controls in statutory schemes effectively rule out economically viable projects.

There is, therefore, a need to rethink institutional arrangements to give a voice to regional and sub-regional constituencies and to mediate the inevitable tensions between metropolitan and local priorities in a more enabling political environment.

5.3 Optimising housing supply in key redevelopment districts

Spontaneous market interest in redevelopment projects within 'high EJD impact' nodes can be anticipated. However, such latent interest can be constrained by various market failures.

One such market failure concerns the difficulty faced by private developers in assembling sites of suitable scale to support viable housing projects. The 'hold out' issue is well documented in economic theory, whereby the last two or three land holders in a fragmented development precinct seek to exploit their monopoly position. It can be expected that this issue is more pronounced in locations close to transport infrastructure which have been pre-designated for higher density development. According to theory, the market left to operate on its own devices cannot optimise the development potential of such key sites. Government can justifiably exercise its right of eminent domain to complete land assembly so that welfare maximising use of these sites can proceed.

The theory may be robust, but effective practice in this area is much debated. While most jurisdictions reserve the right of governments to compulsorily acquire land for public purposes (the provision of roads, water supply infrastructure, hospitals and the like), the use of these powers to assemble land so that third parties can engage in projects for private profit is rare and generally controversial. A more common approach is for mandated urban renewal authorities to assemble land for the purposes of government transacted development projects so that surpluses are seen to directly accrue to the community. Examples include Places Victoria's redevelopment initiative in Dandenong and the operations of several separate development authorities in Perth covering East Perth and Subiaco, amongst others.

In previous SGS research, many development authorities with compulsory purchase powers reported that these are used as a last resort; in general, such authorities have been able to achieve their site consolidation objectives via commercial agreement. This can include innovative arrangements whereby the property owners in question may be brought in as equity investors in any prospective development project.

In addition to land assembly and associated area masterplanning, there may also be a case for deploying government owned land development agencies to address another potential area of market failure – the cleanup of brownfield land where the extent and cost of contamination is unclear. Private sector developers can be expected to avoid unspecified clean up risk, and owners may be reticent to release otherwise highly valuable housing land for fear of exposure to clean up costs. Publicly owned agencies may be able to pool these risks on a portfolio basis to release the latent boost in housing supply made possible by city shaping transport investments.

5.4 Value capture in benefitted areas

The analysis in this report shows that extensive areas can directly benefit, in terms of property value uplift, from city shaping transport projects. The areas impacted by value increases extend well beyond the immediate corridors of these projects and the nodal hotspots along their routes.

In principle, some of this uplift is appropriately captured by the public sector for reinvestment in infrastructure and replanning surrounding areas so that they adjust efficiently to this stimulus. However, infrastructure focussed land value capture arrangements are uncommon in Australia, especially if the areas in question lie some distance away from the projects in question.

Value capture can be effected via a number of mechanisms including:

1. Property development / development corporations
2. Infrastructure recovery charges
3. Tax Increment Financing (TIF)
4. Sale of air rights
5. Special assessment districts (tax).

Broadly speaking the first 4 of these mechanisms tend to be restricted to high impact areas, where there is a direct nexus between the infrastructure investment and property advantage. Accordingly, they can be an important complementary measure to the planning and land assembly interventions described above.

Having said this, infrastructure recovery charges could play a role in capturing land value uplift in areas positively affected but more distant from city shaping transport projects. Interestingly, the aforementioned White Paper on a New Planning System for NSW foreshadows a two tier development contribution framework for the State. Local authorities will still be able to levy local contributions for basic local infrastructure on a projected share of usage basis. However, the proposed Sub-regional Planning Boards will also be able to include 'Regional Infrastructure Contributions' to help defray the costs of major State provided infrastructure. The nexus principle appears to be much weaker in respect of these regional level contributions; they are, in our view, more readily justified as a form of betterment capture, part of which can be linked to the value uplift generated by city shaping transport projects.

Special tax districts would appear to be the best aligned mechanism for value capture within the broader uplift catchment of major projects. Although rare in Australia, an interesting case study is provided by the Melbourne Underground Rail Loop Authority (MURLA) Levy.

MURLA was established in 1971 to build the city's underground rail loop. The Authority was established under its own Act of Parliament known as the Melbourne Underground Rail Loop Act. Project funding came from a surcharge on train tickets with the balance from

- 1/3 State Government contribution
- 1/3 Melbourne City Council
- 1/3 Melbourne and Metropolitan Board of Works (via the Metropolitan Improvement Levy)

The MURLA levy was used to fund the contribution to be made by Melbourne City Council and imposed through a special rate. Although initially envisaged as a CBD business only levy it was ultimately imposed on all ratepayers in the municipality.

It is sometimes argued that State land taxes and Commonwealth capital gains tax already do the work of land value capture and there is no need to introduce new levies to this end. However, land taxes and capital gains taxes are conceptually different from the levies contemplated here as the former are not entirely linked to 'unearned gains' derived by public sector planning and infrastructure activities.

5.5 Affordable housing provision

The research in this report confirms that investment in city shaping transport projects which, by definition, significantly boost connectivity (EJD) in the established urban footprint effectively expands the supply of land available for housing development. That is to say, the same geographic area can be made capable of accommodating more (market demanded) dwellings given sufficient investment in infrastructure to improve access to jobs and other opportunities. This effective expansion in the supply of land for housing should, other things equal, place downward pressure on housing prices. In broad terms, this will improve housing affordability.

Spatially, this affordability benefit from an expanded land supply is likely to be felt most in outer urban and less well connected parts of the metropolis, which will have to compete more strenuously on price to attract buyers and tenants. Areas enjoying a boost in connectivity and therefore higher housing activity can be expected to maintain a price premium (though this might escalate at a slower pace compared to a scenario where the city shaping transport project is not built).

For reasons of community sustainability and local economic functionality (e.g. access to key workers), the reservation of some housing for lower and middle income groups in the EJD uplift areas, particularly in zones of high EJD impact, is likely to be warranted. This can occur in one of two ways (or a combination thereof):

- Dedicating a proportion of the proceeds from any tax on broad area value uplift to the provision of social housing in these advantaged areas
- Applying area wide inclusionary zoning so that all development in the advantaged areas are required to incorporate a proportion of affordable housing or make cash in lieu contributions so that this obligation might be met elsewhere within the same broad district.

TECHNICAL APPENDIX

Independent insight.

TECHNICAL APPENDIX

Regression results – all development types

The following presents the regression equations for the each of the four development types in Melbourne.

FIGURE 49. **ALL DWELLING TYPES REGRESSION RESULTS**

Periods:	3			
Cross-sections:	216			
Dependent Variable:	Share of dwelling change			
Independent variables				
	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.001	0.000	-3.164	0.002
Relative EJD	0.004	0.001	4.816	0.000
Share of dwelling stock	0.576	0.037	15.597	0.000
Share of new urban land	0.042	0.008	5.378	0.000
Remnant broad hectare/ growth area indicator	0.007	0.001	4.722	0.000
Adjusted R-squared:	0.489			

In summary, these results indicate that the share of net change in total dwellings is based on:

- The **share of existing dwelling stock**. With a location having a greater share of existing dwellings likely to have a greater share of the net change.
- The **share of new urban land**. With a location having a greater share of new urban land likely to have a greater share of the net change.
- The **relative EJD**. With a location having a higher EJD likely to have a greater share of the net change.
- **Remnant broad hectare and growth area** are likely to have a higher share than other locations.

FIGURE 50. **DETACHED DWELLINGS REGRESSION RESULTS**

Periods:	3			
Cross-sections:	216			
Dependent Variable:	Share of detached dwelling change			
Independent variables				
	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.003	0.000	22.843	0.000
Relative EJD	-0.009	0.001	-16.424	0.000
Share of dwelling stock	0.382	0.025	15.203	0.000
Share of new urban land	0.091	0.005	17.302	0.000
Broad hectare/growth area indicator (dummy)	0.009	0.001	18.524	0.000
Coast indicator (dummy)	-0.001	0.000	-3.409	0.001
Adjusted R-squared:	0.477			

In summary, these results indicate that the share of net change in total dwellings is based on:

- The **share of existing dwelling stock**. With a location having a greater share of existing dwellings likely to have a greater share of the net change.
- The **share of new urban land**. With a location having a greater share of new urban land likely to have a greater share of the net change.
- The **relative EJD**. With a location having a higher EJD likely to have a lower share of the net change.
- **Remnant broad hectare and growth area** are likely to have a higher share than other locations.
- **Coastal areas** are likely to have a higher share than other locations.

Compared to total dwellings, detached housing showed a stronger correlation with new urban land supply. It also had a negative relationship with improved levels of accessibility, reflecting, perhaps, the release of new urban land on the urban fringe, in locations with relatively poor access to jobs and services.

FIGURE 51. **SEMI-DETACHED DWELLINGS REGRESSION RESULTS**

Periods:	3			
Cross-sections:	216			
Dependent Variable:	Share of semi-detached dwelling change			
Independent variables				
	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.001	0.000	-4.985	0.000
Relative EJD	0.003	0.001	2.405	0.016
Share of dwelling stock	0.823	0.064	12.941	0.000
Broad hectare/growth area indicator(dummy)	0.002	0.001	3.141	0.002
Coast indicator (dummy)	0.000	0.000	2.040	0.042
Adjusted R-squared:	0.128			

In summary, these results indicate that the share of net change in total dwellings is based on:

- The **share of existing dwelling stock**. With a location having a greater share of existing dwellings likely to have a greater share of the net change.
- The **relative EJD**. With a location having a higher EJD likely to have a greater share of the net change.
- **Remnant broad hectare and growth areas** are likely to have a higher share than other locations.
- **Coastal areas** are likely to have a higher share than other locations.

Overall there was a relatively weak relationship between the share of semi-detached housing change in a location and any of the explanatory variables. This is illustrated by a very low adjusted R squared of 0.12 and the small coefficients attached to many of the variables. It appears that this form of housing – comprising dual occupancies and other small scale infill - is distributed opportunistically.

FIGURE 52. **APARTMENT DWELLINGS REGRESSION RESULTS**

Periods:	3			
Cross-sections:	216			
Dependent Variable:	Share of apartment dwelling change			
Independent variables				
	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.009	0.001	-6.847	0.000
Relative EJD	0.044	0.005	9.137	0.000
Share of new urban land	0.034	0.004	8.512	0.000
Coast indicator (dummy)	0.006	0.001	10.645	0.000
University indicator (dummy)	0.006	0.001	5.325	0.000
Labour market region (dummy)				
- North/West	0.004	0.001	3.855	0.000
- East/South-East	0.003	0.000	6.134	0.000
Adjusted R-squared:	0.313			

In summary, these results indicate that the share of net change in total dwellings is based on:

- The **share of new urban land**. With a location having a greater share of new urban land likely to have a greater share of the net change.
- The **relative EJD**. With a location having a higher EJD likely to have a greater share of the net change.
- **Coastal areas** are likely to have a higher share than other locations.
- Locations **near Universities** are likely to have a higher share than other locations.
- Compared to the **East/South East the North/West** is likely to have a slightly higher share of the net change[9].

Compared to total dwellings, apartments showed a stronger correlation with EJD along with some other key amenity variables (such as Coast and Universities). Also the existing housing stock or amount of existing urban land was not found to be significant.

[9] Reflecting perhaps a more accommodating Council posture towards infill development in the North/West versus the East/South regions of Melbourne.

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