MAKING THE MOST OF OUR OPPORTUNITIES

FIRST REPORT TO THE MUNICIPAL ASSOCIATION OF VICTORIA

A report for the
MUNICIPAL ASSOCIATION OF VICTORIA

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23 January 2019

PJB1228-MAV – Final revised 050219/MAV/2018

The authors thank Jason Thompson for the provision of some indicator data.

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Executive summary

This report looks at productivity and social impacts of Melbourne's rapid population growth. It projects the current productivity and infrastructure trends within Melbourne, exploring specific locational impacts. In so doing, it looks at inner, middle and outer areas and LGAs experiencing rapid population growth, as well as some LGAs that might need to cope with faster population growth as the *Plan Melbourne 2017-50* future of a more compact city evolves. The report also examines the traffic congestion, selected social and health impacts and touches on some environmental measures, associated with this rapid population growth.

Victorian population increased by 1.12 million over the decade to 2016, some 86.3 per cent of this growth occurring in Melbourne. Population numbers grew at an annual average rate of 2.3 per cent, largely driven by overseas migration, which accounted for about half the total Victorian increase. The result has led to Greater Melbourne adding a quarter to its total population over the decade. If this pattern was to continue, then 8 million is certainly in prospect for Melbourne by 2050. If current trends continue, this is predicted to increase the population share in the outer suburbs, thus increasing urban sprawl, an issue that is in conflict with the policy of a more compact city outlined in both *Plan Melbourne* and *Plan Melbourne 2017-2050.* This outcome also places the cost or burden of growth disproportionately on residents of outer suburban areas, many of whom are already struggling with disadvantage associated with lagging infrastructure and services and fewer work opportunities.

While there have been higher per capita growth rates in GDP than would have eventuated with lower levels of migration, our analysis suggests that productivity benefits from this rapid population growth have been largely illusory and need to be offset against significant environmental and social costs. Productivity growth can only be ensured if adequate resources are provided to the increased population, a condition that has not occurred since 1992, particularly for the outer metropolitan LGAs. Our analysis concludes that there was an underinvestment of $cvm126 billion, (at 2015-16), to cater for the 'excess in working age population' of about half a million by 2017. This underinvestment was in:

- transport infrastructure capital stock;
- commercial capital stock;
- community capital stock (e.g. hospitals and schools);
- industrial development;
- skills development; and
- knowledge creation investment.

By 2031, if the same trends prevail as over the last two to three decades, the additional shortage of investment expenditure will be an extra $cvm141 billion, representing an additional increase in the 'excess working age population' of around 350,000.

The report argues that this shortfall is partly reflected in, economic, social and environmental costs. Increased congestion levels on roads and public transport is one such cost, which reflects the extent of underinvestment in transport since 1980. It is estimated that an additional gross $163 billion transport infrastructure spending will be needed to 2031 to overcome the effects of this shortfall.

Thus, the total levels of additional investment expenditure required to remove excess working population numbers and mitigate increased congestion costs to 2031 sum to around $376 billion, well beyond current funding magnitudes. In considering how to shape the necessary infrastructure, Melbourne needs a complementary long-term land and transport strategy, rather than just a list of major projects.

Continued high population growth will make it very difficult for the road transport sector to make a proportionate contribution to the national 2030 GHG emissions reduction target of 26-28 per cent below 2005 levels. A range of complementary measures will be needed, such as following the *Plan Melbourne 2017-2050* intent to achieve a compact city, including delivery of 20 minute neighbourhoods, dramatically slowing urban growth on the fringe, increasing public transport share to over 20 per cent; and significant improvement in active travel opportunities. Such initiatives have multiple co-benefits in terms of health and wellbeing.

The six LGAs identified as having high population growth rates but low Gross Regional Product per Capita of working age population are Cardinia, Casey, Hume, Melton, Whittlesea and Wyndham, all found in the outer suburbs of Melbourne. In general, the further the distance from central Melbourne, the longer distances needed to travel to work, the greater the absence of public transport to make this trip, the further you live away from available public transport options, the lower the urban density and job density and the lower the productivity levels. A similar pattern can be found in social indicators that tend to deteriorate with distance from central Melbourne, where there this report reveals increasing concerns around health, affordable housing, poor levels of child development on entering schools, fewer people with higher qualifications, the high levels of youth unemployment, proportionately lower levels of social capital and higher levels of obesity.

The rate of population growth in many of these already disadvantaged and under-resourced LGAs would only seem to be compounding the personal socio-economic costs of residents and to society, issues not currently given sufficient consideration. In particular, the signs that early child development is at risk for some children, with the resultant outcome of early school leaving and high levels of youth unemployment on Melbourne's fringe, offers at least a partial explanation for resultant social problems of crime and poor mental health. It would seem that the current trends will be passing many of these social costs onto future generations.

Thus, this report argues that Melbourne's population growth, and the migration rate on which much of it depends, needs to be compatible with the level of resources the nation is willing to provide to support such growth. If investment expenditure is to be increased to meet demand, this will mean tax rates, together with user charges, would need to increase significantly. Part of the solution may be a major increase in regional population growth; however, major infrastructure spending will still be needed. As a postscript, this report does not take account of many other impacts of high population growth, such as on the natural environment. This would include issues such as the rapid biodiversity loss Australia is undergoing and resultant loss of ecosystem services, the loss of food growing land through urban sprawl, growing freshwater scarcity, and the growing risk of bushfire with the urban penetration into forested and grassland areas.

A second stage of this research is proposed, to identify the contribution that regional Victoria might make to support Victorian population growth and the factors that might best support the realisation of such regional growth opportunities.

1. Context

Melbourne is widely acknowledged as one of the worlds' most liveable cities, or *the* most liveable city according to The Economist Intelligence Unit (2017) each year from 2011. Partly reflecting this liveability, the city, and state more broadly, are experiencing high population growth rates at present. For example, the Federal Government's new National Cities Performance Framework (NCPF), which includes data for 21 Australian cities, indicates that Melbourne's population grew at 2.67 per cent over the year to June 2016 and at 2.31 per cent p.a., on average, over the 2006-16 decade. Growth rates of some individual municipalities in Melbourne are well above these rates, particularly in the outer urban growth fringe (e.g. Wyndham and Casey). Other international cities that are famed for their liveability are typically showing growth rates well below these levels. For example, over the five years to 2016, Vancouver grew at 1.3 per cent and Metropolitan Geneva at 1.2 per cent p.a. However, both cities are also growing from a smaller base, Vancouver at 2.46 million in 2016 and Geneva at 0.92 in 2016.

To gain a quick overview of Melbourne's growth, LGAs were aggregated into inner, middle and outer groupings, as follows:

- Inner = Glen Eira, Maribyrnong, Melbourne, Port Phillip, Stonnington, Yarra;
- Middle = Banyule, Bayside, Boroondara, Brimbank, Darebin, Hobsons Bay, Kingston, Manningham, Monash. Moonee Valley, Moreland, Whitehorse; and
- Outer = Cardinia, Casey, Frankston, Greater Dandenong, Hume, Knox, Maroondah, Melton, Mornington Peninsula, Nillumbik, Whittlesea, Wyndham, Yarra Ranges.

Map 1 shows these areas.

Map 1: Melbourne regions as defined for this report

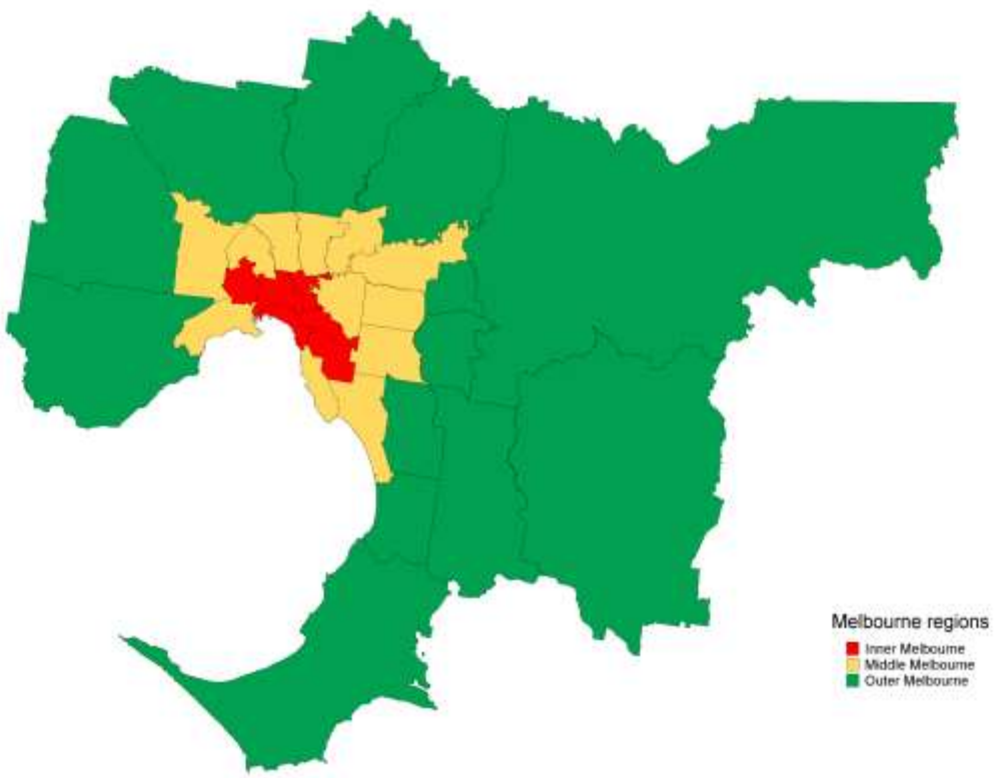


Table 1.1 shows the distribution of population, jobs and population growth across these groupings. Inner Melbourne had less than 15 per cent of Greater Melbourne's total resident population in 2016 but accounted for one fifth of population growth over the 2011-16 period, evident in the rapid expansion of apartment living. However, a much higher proportion of jobs, one in three, are located in this part of Melbourne and the ratio of jobs per 1000 resident population (1229) in inner Melbourne is well over twice the average for the city as a whole (528). The high job density of the inner area is a strong argument supporting population growth in this part of the city but the gap between jobs and residents means a huge tidal flow of workers, with associated congestion challenges.

Middle Melbourne is more balanced in terms of population and jobs, having 38.7 per cent of resident population and 30.9 per cent of jobs, but could still do with deeper job penetration, as illustrated by a jobs/1000 resident population ratio that is about 100 below the ratio for the city as a while. One of the purposes of the National Employment and Innovation Clusters in Plan Melbourne 2017-2050 (Victorian Government 2017) is to help increase relative job penetration in middle Melbourne and improve the accessibility of high-tech/knowledge-intensive jobs to outer urban residents.

Outer Melbourne, which housed 46.6 per cent of Greater Melbourne's total resident population in 2016, accounted for an even higher share of population growth between 2011 and 2016, at 57.5 per cent. This indicates that the outer suburbs are becoming increasingly important in relative terms for housing the city's growing population. However, only one in three jobs are located in outer Melbourne and the jobs per 1000 resident ratio is only 389, indicating large numbers of people are required to regularly travel considerable distances for work. This is unfortunately mirrored by a strong correlation, at LGA level, between the proportion of commuters having a commute of 2 hours or longer and an LGA's distance from central Melbourne (r=.576; p=.001). The intention in both Plan Melbourne and Plan Melbourne 2017-2050 was to see Melbourne becoming relatively more compact. Notwithstanding high population growth in inner Melbourne, under the high population growth rate that the city is experiencing, a more compact settlement pattern is clearly not happening.

Table 1.1 Population, population growth and jobs in Melbourne

Area	Census population in 2016	Share of 2016 population (%)	Population growth 2011-16	Share of population growth 2011-16 (%)	Share of jobs (%)	Jobs/1,000 resident population
Inner	650524	14.7	95652	20.2	34.8	1229
Middle	1707568	38.7	106169	22.4	30.9	424
Outer	2057349	46.6	272822	57.5	34.3	389
Total	**4415441**	**100.0**	**474643**	**100.0**	**100.0**	**528**

Source: Based on ABS n.d.

1.1 The impact of this population growth

There is a strongly expressed argument, often propounded by business groups and more recently by the Australian Council of Trade Unions, the Australian Council of Social Services, the Australian Industry Group and others, that the current level of migration to Australia (190,000) should be maintained on a permanent basis and proportionally increased, as population grows (Benson 2018). This migration is said to add 1 per cent to GDP each year for 30 years and is argued to be 'essential to Australian society and our economy...' as well as 'social development' and the 'wider community' (Benson 2018' p.1, The Compact, p.5).

This report explores the question of what the impact of continued high population growth, largely driven by international migration, might be on Melbourne residents. It explores how such on-going growth may affect productivity, social wellbeing and the environment. Are the above claims about the benefits of continued high population growth correct? Does population growth have some associated costs and how significant might these be relative to benefits of growth? This report explores these difficult questions and sets out the basis or evidence on which its conclusions are drawn, to enable those conclusions to be discussed by others. A range of potential impacts are considered. We hope that this will encourage wider debate about the benefits and costs of alternative population growth profiles and settlement patterns for Melbourne, to help ensure that it remains one of the world's most liveable cities.

The analysis and discussion in the paper is largely based on data at LGA level, in order to be of relevance for individual local governments and also to make use of the wide range of available data at this spatial level. However, we acknowledge that, in some situations, using LGA level data may hide localised problems or opportunities that disappear in aggregation (sometimes characterised as the 'head in the oven, feet in the fridge problem'. On average, the temperature is just right!).

1.2 Areas of strain associated with high population growth

Providing infrastructure and services to cater for continuing rapid population growth puts stresses on government budgets and on resource supply systems. Some supply chains are not well placed to respond quickly. One result is that people moving into new growth suburbs can expect delays in availability of services such as public transport, arterial roads and secondary and higher education, together with long work trips and congested travel conditions, particularly in peak periods. These challenges arise partly due to the total *scale* of new infrastructure and services required to meet the needs of the greatly expanding population. However, a literature review undertaken by SGS (2016) found that infrastructure service provision to greenfield sites *costs* approximately 2 to 4 times more than infill, due to the need for new 'headworks' and community services. They found an inverse association between density and infrastructure costs. Cost thus compounds challenges arising from scale of development.

In SGS's (2016) examination of literature on the comparative costs of infrastructure to accommodate population growth across a range of locations, they found 16 papers dated from 1995. They note that at least five of the studies acknowledged that broader social and environmental costs were not considered in their respective costings. Two included inactivity-related health costs and greenhouse gas emissions in their infrastructure costs, as well as distance to the CBD, transit accessibility and activity intensity (population and jobs per hectare) (Trubka et al. 2009 and 2010). Biddle et al. (2006) argue that the economic, social and environmental benefits of brownfield development far outweigh higher costs arising from to the need for decontamination. Kinhill et al. (1995) point out that it is necessary to investigate the perceived personal benefits and costs, while an earlier SGS (2012) report argued that triple bottom line benefits of infill were superior, due to improved social interaction and access to existing services, a reduced reliance on private transport and longer term land savings. The literature did not offer a comparison with regional areas, although SGS concluded that cost efficiencies could be derived where development in regional areas can be consolidated.

As noted, this report looks at Melbourne's population growth and explores what it might mean, in coming years, in terms of some key economic, social and environmental outcomes. A particular focus is the productivity, governmental infrastructure and service funding implications of continued rapid population growth in Melbourne in terms of its prospective impact on the public sector borrowing requirement. Our expectation, a priori, is that this will constitute a significant barrier to continued high productivity growth, implying growing deficits in terms of infrastructure and services availability, particularly in fast growing suburbs. If this is correct, one implication is that alternative growth futures should be considered. For example, slower population growth and/or accelerated growth of regional Victorian population are options, which will be examined in some detail in a future report.

Section 2 sets out some detailed data on population growth, identifying sources and rates of growth. It points out that Victoria's main regional cities are also experiencing strong population growth rates at present. Section 3 sets out a number of economic, social and environmental performance indicators for cities, drawing on the National Cities Performance Framework (NCPF) but adding a small number of important performance indicators for which we have relevant evidence. A sub-set of these indicators is then used in Section 4 to establish base performance levels for Melbourne. That section includes some discussion about key drivers of particular indicators. Section 5 summarises the recent Infrastructure Australia (2018) and Infrastructure Victoria (2016) discussions of Melbourne's future infrastructure needs. Section 6 sets out our analysis of how productivity performance has been impacted by population growth and discusses the productivity implications of a continued high population growth rate. Section 7 discusses how a number of other indicators might change in coming years, under a continuing high population growth trajectory, dimensioning the broad scale of task that might be required if performance levels are to be sustained or improved across all indicators. Section 8 sets out the report's conclusions.

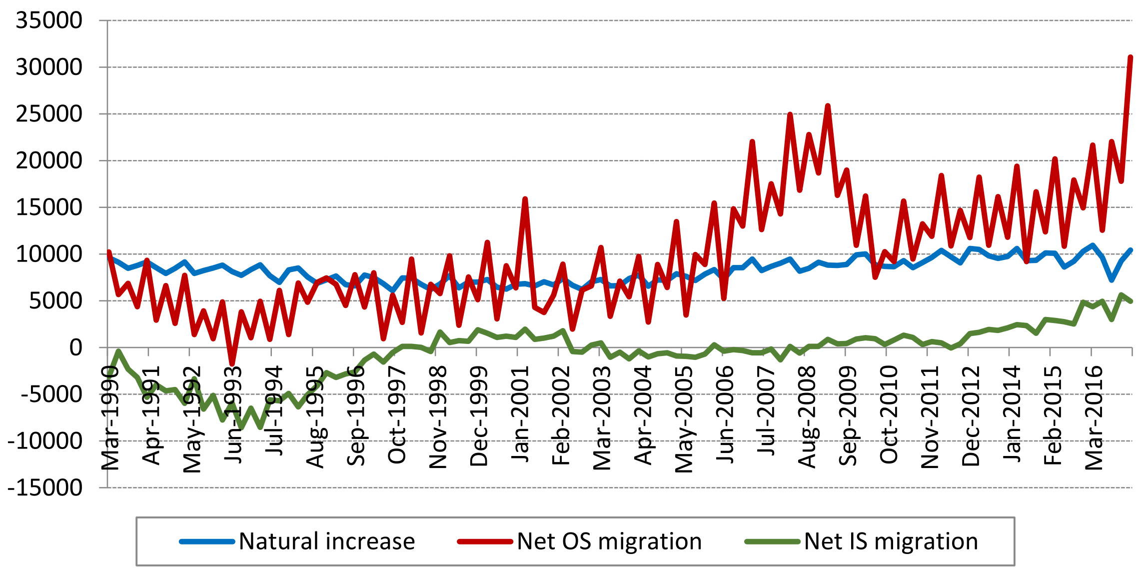
2. Victorian and Melbourne population growth

2.1 Victoria

In the 10 years to 2016, Victoria's population increased by 1.12m, around 60 per cent of which was attributable to net overseas migration. Figure 2.1 shows quarterly Victorian population growth, in absolute numbers, between the March Quarters 1990-2016, with the separate growth contributions of natural increase, net overseas migration and net interstate migration identified.

During the 1990s, Figure 2.1 shows that *net interstate migration* was largely a negative influence on Victorian population growth, *natural increase* typically added about 7,000 to 8,000 a quarter and *net overseas migration* added around 5,000 a quarter. In more recent years, however, net interstate migration has turned around, recently adding about 5,000 a quarter to the state's population, natural increase has grown to around 10,000 quarterly gain in the last decade and net overseas migration has provided about 15,000-20,000 quarterly gain over the same period, jumping to an increase of over 30,000 in the last quarter shown. All three sources have added to growth in numbers in recent years, with net overseas migration being the strongest source but the turnaround in net interstate migration is also notable. As some number plates suggest, for increasing numbers of people, Victoria is the place to be!

Figure 2.1: Components of Victorian population growth since 1990 (quarterly data)



Source: ABS 2017, Table 2.

2.2 Melbourne

Of Victoria's population increase of 1.12 million over the decade to 2016, Melbourne accounted for 86.3 per cent, population numbers growing at an annual average rate of 2.3 per cent. Greater Melbourne added a quarter to its total population over the decade. Regional Victoria added 153,400, or +11.8 per cent over the decade. Greater Sydney added 773,600 (+18.2 per cent), which was smaller in both absolute numbers and in terms of growth rate than Melbourne's increase. Brisbane and Perth each grew by about 450,000, less than half Melbourne's growth in absolute numbers but showing similar growth rates to Melbourne (23.7 per cent and 28.2 per cent respectively over the decade).

Some outer Melbourne growth areas grew particularly quickly over the decade. The following four fringe SA2s were in Australia's top 10 for absolute population increase:

- Tarneit +28,800 (+372 per cent);
- Cranbourne East + 22,600 (+534.2 per cent);
- Truganina + 21,850 (+698.5 per cent); and
- Doreen +19,200 (+701.5 per cent).

Melbourne SA2 also added 26,200, to be in Australia's top 10 SA2s by growth in absolute numbers. Some other SA2s had huge growth rates but with lower (but still large) absolute numbers involved. For example:

- Point Cook population grew from 300 to 15,300 (or +5000 per cent); and
- Craigieburn West went from 228 to 14900 (+6435 per cent).

If this pattern was to continue, then 8 million is certainly in prospect for Melbourne by 2050, close to London's current population, and 10 million for Victoria, as projected by DELWP (2016).

3. Performance indicators

3.1 The National Cities Performance Framework indicators

This section of the report identifies a number of performance indicators that might be relevant in making policy decisions about future population growth rate and population distribution, for Melbourne and regional Victoria. In developing the listing, we have drawn on the new National Cities Performance Framework (NCPF), indicators set out in *How great cities happen* (Stanley, Stanley and Hansen 2017) and with indicators that can be derived from NIEIR's data base, and other sources, all framed within a triple bottom line approach (economic, social and environmental).

The NCPF lists various indicators that help shed light on city performance, separating *contextual indicators* and *performance indicators*. These are defined as follows:

- contextual indicators highlight the circumstances and characteristics of a city on dimensions not amenable to, or appropriate for, local policy intervention… (Commonwealth of Australia 2017, p. 28); and
- performance indicators reflect the performance of cities in achieving wider economic, social and environmental objectives… (Commonwealth of Australia 2017, p. 29).

Box 3.1 sets out the listed contextual indicators and Box 3.2 shows the performance indicators that are included in the *National Cities Performance Framework Report* (Commonwealth of Australia 2017). Data availability was a key functional criterion for indicator selection in the initial set of National City Performance Indicators.

Box 3.1: Initial National City Performance Framework: Contextual indicators

Population size and growth	Index of Relative Socio-economic Disadvantage
Indigenous population share	Languages other than English
Population density	Age dependency ratio
Dwelling type	Housing prices
Household size	Sector share of employment
Housing tenure	Disability rate (New)
Life expectancy	Household income
Share in bottom income quintile	LinkedIn connectivity

Source: Commonwealth of Australia 2017, Box 6.

Including population size and growth among contextual indicators is somewhat perplexing, given the definition of contextual indicators. We would certainly contest the idea that population size and growth are *not amenable to, or appropriate for, local policy intervention*. To think otherwise is to abrogate responsibility for population outcomes, which can certainly be affected at local level. However, population size and growth can be seen as inputs that impact on the economic, social and environmental outcome performance indicators set out in Box 3.2.

Box 3.2: Initial National City Performance Framework:
Performance indicators

Jobs and Skills
- Employment growth
- Unemployment rate
- Participation rate
- Educational attainment

Infrastructure and Investment
- Jobs accessible in 30 minutes
- Work trips by public and active Transport
- Peak travel delay

Liveability and Sustainability
- Adult obesity rate
- Perceived safety (New)
- Access to green space
- Green space area
- Support in times of crisis
- Suicide rate
- Air quality
- Volunteering (New)
- Greenhouse gas emissions per capita
- Office building energy efficiency
- Access to public transport

Innovation and Digital Opportunities
- Knowledge services industries
- Broadband connections
- New business entrants and exits
- Patents and trademarks

Governance, Planning and Regulation
- Governance fragmentation

Housing
- Public and community housing
- Homelessness rate
- Rent stress
- Mortgage stress
- Housing construction costs
- Dwelling price to income ratio
- Population change per building approval

Source: Commonwealth of Australia 2017, Box 7.

As indicated, we compared the NCPF listings to the performance criteria set out in Stanley, Stanley and Hansen (2017) and to indicators that can be assembled from NIEIR's database. These comparisons suggest some inclusions to the NCPF listing if key economic, social and environmental outcomes of population growth and distribution are to be assessed from a policy perspective. The capacity to project future indicator levels under alternative population growth outlooks, however, suggests reducing the number of indicators covered by the NCPF listing.

Significantly, *economic output and labour productivity* are not currently included in the NCPF performance indicators, on the grounds that reliable city-level data is not available. Agglomeration economies are a major policy rationale for larger cities. This population *scale* benefit, and the existence, or otherwise, of comparable effects in smaller regional areas, should be a very important consideration in shaping future population settlement strategy/policy. NIEIR has prepared regional output and labour productivity estimates over many years. They form an important element of this report.

The NCPF indicator listing excludes *costs of congestion*, which are a major economic waste and concern for citizens. For example, BITRE estimated congestion costs (measured as avoidable economic deadweight losses) at $16.5 billion in total for Australian capital cities in 2015, with Melbourne at $4.62b (BITRE 2015). These costs are only estimated for capital cities, and then only on an irregular basis, this being the reason why congestion costs are not included in the NCPF indicators. They are, however, a huge impost on Victorians and should form a vital part of thinking about population policy for Melbourne and regional Victoria, for which purpose irregular Melbourne-level data is sufficient. Congestion costs are, therefore, included in the performance indicators used in the present report.

We see the NCPF performance indicator focus on *Jobs accessible in 30 minutes*, measured by car only in terms of application, as misguided in terms of policy for more sustainable cities. A major contribution of *Plan Melbourne* (DPCD 2014) and *Plan Melbourne 2017-2050* (Victorian Government 2014, 2017) was the introduction of the idea of the *20 minute city* or *neighbourhood*, where access to most of the services needed for a good life are available within a 20 minute trip from a person's place of residence by public or active transport. We include access by car and PT to improve the scope of this indicator.

The NCPF indicator set is short on performance indicators that relate to urban social capital and health, both of which should form important inputs to decision-making about city/regional size and growth rate. Our own research shows strong connections between mobility, social capital, social inclusion and wellbeing (e.g. Stanley et al. 2011, 2012). We draw on this research and relevant indicators to suggest how population growth might impact elements of social wellbeing. Indicators for cardiovascular health, obesity and mental health and early childhood development, at LGA level, are also used in this report.

3.2 Selected KPIs

Against this background, we use the indicators listed in Table 3.1 to shed light on the economic, social and environmental effects of continued high population growth in Melbourne. Ideally, this same set of indicators will then be used to assess alternative distributions of future population, such as a faster rate of growth in regional Victoria.

Table 3.1 Selected city performance indicators

Indicator no.	Indicator	Spatial unit
1	**Productivity ($GRP/hour worked)**	LGA
2	**Congestion costs /vkm**	Melb.
(3)	**Educational achievement**	
3.1	- Children starting school with one or more developmental delays	LGA
3.2	- Year 9 literacy rate (%)	LGA
3.3	- Year 9 numeracy rate (%)	LGA
3.4	- Bachelor's degree or higher (%)	LGA
4	**Youth unemployment (%)**	
(5)	**Accessibility**	LGA
5.1	- Jobs accessed in 30 minutes by car	LGA
5.2	- Jobs accessed in 30 minutes by PT	LGA
6	**Inequality**	
(7)	**Housing affordability**	LGA
7.1	- Dwelling price/HHI ratio	LGA
7.2	- Rental and mortgage affordability index	LGA
8	**GHG emissions (tonnes per capita)**	
(9)	**Greening and open space**	LGA
9.1	- Access to green canopy (% cover)	LGA
9.2	- Access to natural areas (ha/1000pop)	LGA
9.3	- Access to open space (ha/1000 pop)	
(10)	**Social capital**	LGA
10.1	- Trust others in general (%)	LGA
10.2	- Trust in people in neighbourhood (%)	LGA
10.3	- Network extent and use	LGA
(11)	**Health**	
11.1	- Obesity (% reporting)	LGA
11.2	- Cardio health (% reporting)	LGA
11.3	- Mental health	LGA

4. Examining current levels of key performance indicators

4.1 Context

This section of the report looks in detail at the key performance indicators identified in Table 3.1, to assess current or *base level performance* in Melbourne. It includes some discussion of some key factors impacting particular KPIs, which will be influential in terms of how those KPIs might develop in coming years, under a future of continued rapid population growth, the subject matter of Section 6.

4.2 Productivity (Table 3.1 indicator 1)

A key purpose of this report is to gain insight into how urban structure and transport infrastructure investments affect urban productivity. NIEIR undertook analysis of this topic for the Ministerial Advisory Committee on Plan Melbourne, showing that productivity levels (measured as GRP per hour worked) generally decline as distance from the CBD increases and that the gap in productivity levels between inner and outer urban areas has been increasing over the last two decades. Similar findings emerged from NIEIR research on Sydney. We summarise that work here because it provides a starting point for some of the analysis in Section 6 of this report.

Stanley & Co and NIEIR then explored this question further in research for Infrastructure Victoria (Stanley and Brain 2016), focussed on the National Employment and Innovation Clusters (NEICs) in Plan Melbourne, and then in subsequent work for the Australian Bus Industry Confederation (Stanley, Brain and Cunningham 2017). This involved analysis at SA2 level, with the productivity of each SA2 being estimated based on its labour catchment, as defined by road and public transport travel times and respective trip numbers (weighted) for 2011, as shown in Figure 4.1. These catchments were defined from morning peak journeys, which are mainly work and educational trips. The core data base consisted of:

(i) peak car and public transport trips and associated travel times for 2011 between SA2 regions. Morning (AM) peak travel data was used because it was seen as the best single indicator of labour catchments; and

(ii) gross product generated within each SA2 boundary by 86 2-digit ANZSIC industries, along with estimates for total hours worked within each SA2. These estimates were prepared by NIEIR. The estimates are available quarterly; however, the only data used were for the Census benchmark years of 2001, 2011 and estimates for 2015.

Travel times were used in this analysis to derive "decay" coefficients, for defining the catchment for a given area. Catchment GRP (gross regional product), for a given SA2, is defined as:

$$GRP_i^c = \sum_{j=1}^{279} d_{ij} \cdot GRP_j \qquad (1)$$

Where:

GRP^c_i = The catchment GRP for SA2 *i* in $\$_{2014}$ million.

d_{ij} = Decay coefficient for SA2 *j* for *i* catchment, based on travel time.

GRP_j = Gross regional product of SA2 *j* in $\$_{2014}$ million.

The d_{ij} coefficient values range between 0 and 1 and are weighted values, where the weights for any SA2 are based on car and public transport travel volumes between that SA2 and its various catchment SA2s. For car travel, the d_{ij} values for each SA2 were estimated from AM peak trip-travel time data. After 90 per cent of the trips into an SA2 had been accounted from all other SA2s, the d_{ij} was assigned a value of 0.

For public transport, access/egress and waiting time accounts for a significant proportion of trip time, additional to in-vehicle time, and many trips are 'forced', in the sense that the traveller has little choice. Based on analysis of AM peak public transport catchments, a functional catchment in terms of public transport in-vehicle travel times was defined by:

If $tt_{ij} < 45$ *minutes*, $d_{ij} = 1$
If $tt_{ij} > 85$ *minutes*, $d_{ij} = 0$.
Otherwise, $d_{ij} = 1 - (tt_{ij} - 45)/40$

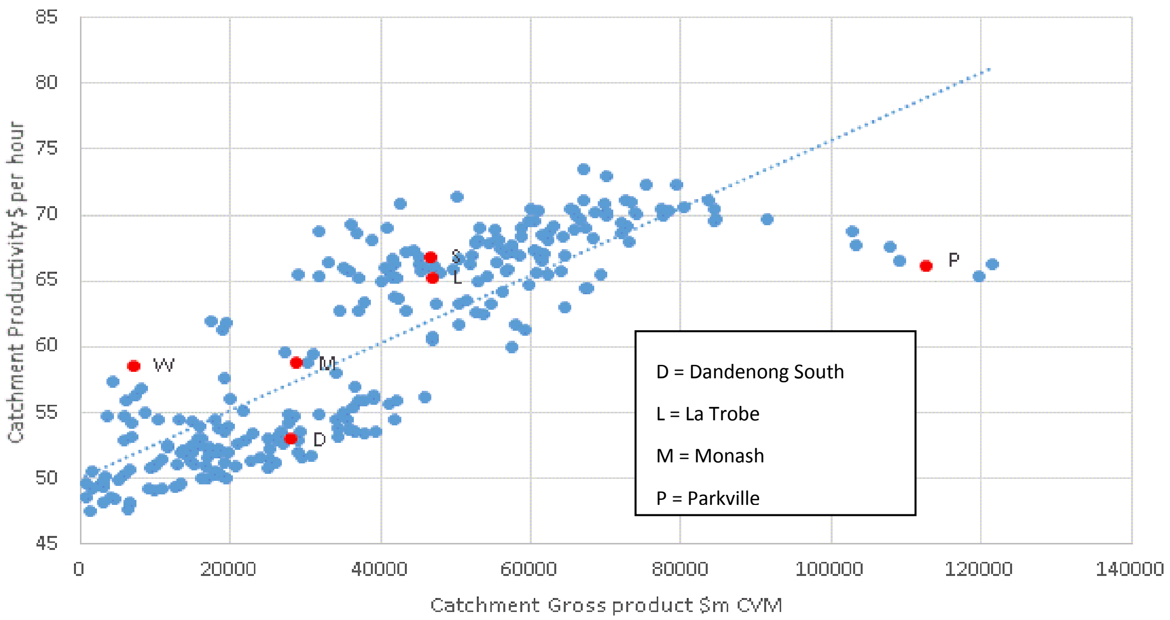
Where:

tt_{ij} = Total travel times between SA2 i and j in minutes by public transport.

The apparent flattening of the data points in Figure 4.1, at a productivity level of about $65-75 per hour, reflects the preponderance of SA2s in close proximity to Melbourne's central core. In a sense they define the broad central activity cluster.

SA2 productivity, measured at catchment level in 2011 (Figure 4.1, which also shows where the NEICs sit in the overall pattern), increases with catchment scale, i.e. bigger economic catchments tend to be more productive, for reasons such as agglomeration economies. In light of this scale relationship, it seems reasonable to assume that continued population growth in Melbourne will lead, ceteris paribus, to additional productivity gains, through larger labour catchments and the economies these generate.

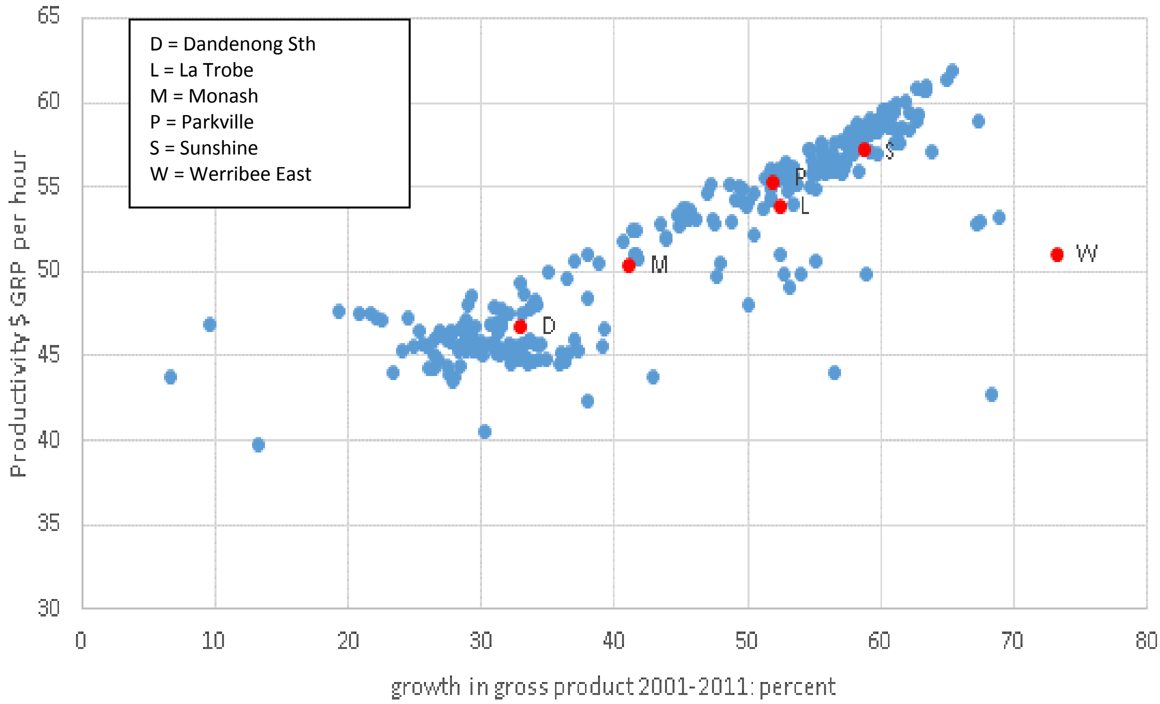
Figure 4.1: Catchment productivity versus GRP in 2011



Source: Stanley, Brain and Cunningham (2017), Figure 2.

Figure 4.2 shows that the SA2s with higher productivity levels in 2001 tended to have faster rates of productivity growth over the ensuing decade. By implication, if the objective was simply to maximise total urban productivity growth, it would be best to invest in those areas that already have relatively higher productivity levels. However, this approach would have adverse impacts on the equitable distribution of urban opportunities.

Figure 4.2: Catchment productivity growth 2001-11, versus catchment productivity in 2001



Source: Stanley, Brain and Cunningham (2017), Figure 3.

To help understanding of the way transport improvements might contribute to productivity growth across Melbourne, the relationship between the productivity of a given SA2 catchment and the scale of its labour catchment, as defined in equations (1) and (2), was explored. Catchment scale in this analysis was based on weighted car and PT catchments and the public transport catchment was also included as a stand-alone variable, to test whether this might have any separate influence on catchment productivity. The model was estimated in log form so that the respective coefficients are directly interpretable as elasticities. Table 4.1 sets out summary SA2 data and Table 4.2 shows the modelling results. The adjusted R^2 for the equation was 0.90 and all independent variables are highly significant.

Table 4.1 Descriptive data for Melbourne 2011 SA2 productivity analysis

Variable	Units	Mean	Standard deviation	N
Productivity ($Prod_i$)	$GRP/hr	60.2	7.7	273
Catchment size all modes (weighted; $GRPT_i$)	$GRPm	39390	29758	273
Catchment size PT ($GRPPT_i$)	$GRPm	54391	32100	273

Source: Stanley, Brain and Cunningham (1017), Table 2.

Table 4.2 shows key elasticity values (the unstandardised B coefficients) of 0.086 and 0.035 for SA2 catchment productivity with respect to (1) weighted car and PT travel time and (2) PT travel time respectively. In other words, reducing weighted car and PT travel times to an SA2 by 10 per cent would generally be expected to increase its catchment productivity by 0.86 per cent. Reducing PT travel times in the catchment by 10 per cent would have a separate effect of increasing GRP by 0.35 per cent.[1]

Table 4.2 SA2 productivity model, based on travel catchment analysis

Model	Unstandardised coefficients		Standardised coefficients		
	B	Std. Error	Beta	T	Sig.
Constant	2.845	0.28		100.417	0.000
Log $GRPT_i$ = log $GRP weighted by AM peak car and public transport catchment trips for SA2 i	0.086	0.004	0.618	20.292	0.000
Log $GRPPT_i$ = log $GRP for AM peak public transport catchment for SA2 i	0.035	0.003	0.304	9.973	0.000
Log OD = log of outlier dummy variable for 2011.[2]	0.115	0.005	0.490	25.068	0.000
a. Dependent variable: Log of productivity (*Log* $Prod_i$)					

Source: Stanley, Brain and Cunningham (2017), Table3.

A key question is, why should the public transport catchment be found to be significant over and above its value in the total GRP catchment variable? One explanation is that it is not simply peak travel times (particularly to work) that are important as productivity drivers, but also intra-day travel times within the catchment. The greater the public transport infrastructure available in the peak travel, the greater will be the public transport infrastructure available to undertake non-peak business travel and to meet other social needs, including education.

Recalling the connection between catchment productivity level and subsequent catchment productivity growth, as shown in Figure 4.2, a further equation was developed to estimate the impact of the increase in productivity from Table 4.2 on future GRP catchment growth. This equation was evaluated from the data between 2001 and 2011, with productivity growth between 2001 and 2011 expressed as $GRPTG_i = GRPT_{2011,i} / GRPT_{2001,i}$. Table 4.3 sets out the result (adjusted R^2 = 0.84). All variables are again in log format, so the coefficient values can again be read as elasticities. The estimated equation indicates that productivity growth will be higher in an SA2 that starts with higher productivity levels and that has a higher PT share of AM peak trips. Our interpretation of the PTS_i elasticity from Table 4.3 is that the more diverse the public transport infrastructure is in a given SA2, the more likely businesses within that SA2 catchment will use any increase in productivity to invest the gains to drive future increases in productivity and/or expand their businesses.

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1 Because of the importance of this model for testing the link between transport and productivity outcomes, it was also estimated using pooled data for 2001, 2011 and 2015 to test for stability. The key coefficient estimates were stable, with the two key elasticity values reducing only marginally, from 0.086 to 0.079 for weighted car and PT travel time and from 0.035 to 0.029 for the PT effect. These values are almost identical to the estimates for the same coefficients found from Sydney SA2 data in other work undertaken by NIEIR.

2 This outlier dummy variable was applied after estimating the equation without dummies and identifying residuals. Where residuals exceeded +/-10 per cent, a dummy of +/-1 was applied, to reflect exogenous influences in the productivity equation, and the model was re-estimated. The re-estimation made little difference to coefficient values.

Table 4.3	SA2 productivity growth and public transport					
	Unstandardised coefficients		Standardised coefficients			
Model	B	Std. Error	Beta	T	Sig.
Constant	-0.168	0.037		-4.475	0.000
Log $PROD_{2001,i}$ = log of productivity in 2001	0.093	0.009	0.320	10.369	0.000
Log PTS_i = log of AM peak PT trip share to SA2	0.016	0.001	0.483	15.641	0.000
Log OD = log of outlier dummy variable	0.033	0.001	0.596	24.779	0.000
a. Dependent variable: Log of productivity (*Log* $GRPTG_i$)					

Source: Stanley, Brain and Cunningham (2017), Table4.

This analysis indicates that productivity levels in part of a city can be enhanced by infrastructure investment that increases the scale of its labour catchment. Potential add-on productivity benefits from increasing an area's public transport catchment size have also been identified, which argues for careful targeting of PT investment towards locations where growth in economic activity is highly desired (e.g., the NEICs). Targeting such areas will also improve social wellbeing and health, thus also indirectly leading to additional productivity gains. Such investment targeting is not currently apparent in Melbourne in terms of the NEICs. The analysis also suggests an inherent tendency for those areas that start with high productivity levels to grow that productivity faster than places that start at lower productivity levels, which poses challenges for outer urban growth areas. These typically have relatively low productivity levels, with the gap increasing between their productivity levels and those of inner urban locations. Section 6 extends this analysis with LGA level data.

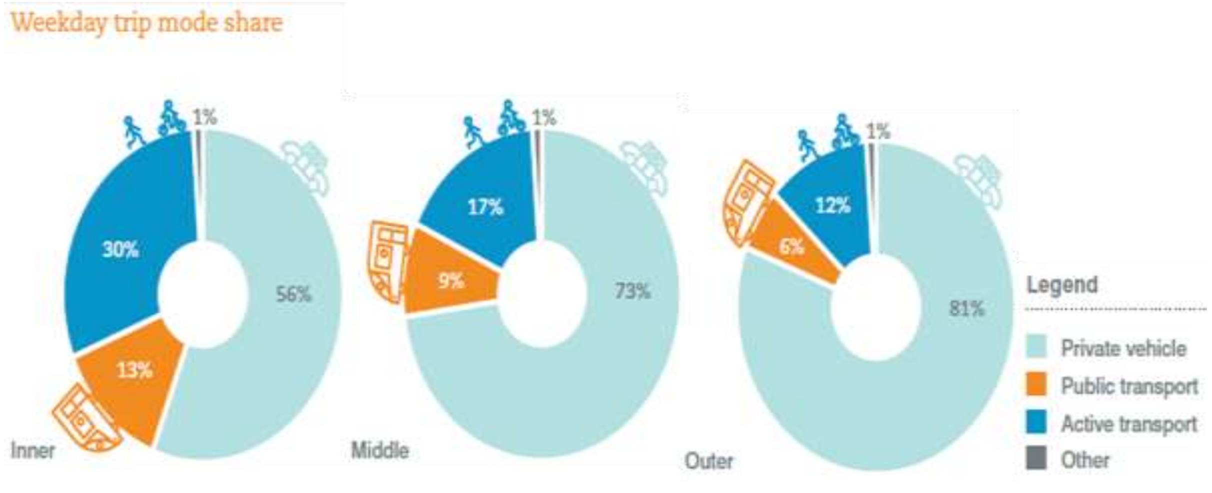
4.3 Road traffic congestion costs and key influencers (Table 3.1 indicator 2)

The recent benchmarking report prepared for the Property Council of Australia (Property Council of Australia and The Business of Cities 2018a) highlights the scale of Melbourne's traffic congestion problems, ranking Melbourne at 131st out of 189 cities measured globally on this indicator. BITRE (2015) suggests that traffic congestion costs totalled $4.62 billion in Melbourne in 2015, associated with an estimated 40.38 bvkms of road traffic. These figures imply *average congestion costs* of 11.4c/vkm in Melbourne in that year. The BITRE database that sets out these figures implies that *marginal congestion costs* over the 2012-2015 period averaged around 27 cents per vkm, implying that each *additional* vkm of road traffic adds about 27 cents to total congestion costs. Marginal congestion costs being more than double average costs reflects the steep slope of the road marginal congestion cost curve.

Congestion costs are affected by the growth in motor vehicle use and the travel mode share. Melbourne VISTA survey data for 2013 suggests that 12.3 million trips were made on a typical weekday, with cars (drivers and passengers) accounting for 82 per cent and public transport 9 per cent. These PT trips represented 13 per cent of weekday person kilometres travelled (i.e. average trip length is longer by PT) (TfV n.d.), a better indication of mode share than is provided by the share of trips by PT, since kilometres more accurately represent transport effort – unfortunately this measure is often not provided in discussion of mode shares. Figure 4.3 indicates that the public transport share of trips declines as distance from the centre increases, indicating the regressive nature of Melbourne's current public transport service provision.

The journey to work is the trip purpose for which most detailed, and most recent, comprehensive information on mode choice is available, although this trip only accounts for about one quarter of total personal trips. Chris Loader's very useful Charting Transport blog has analysed this data, showing that Melbourne's PT share of journey to work trips increased from 14.16 per cent in 2006 to 18.15 per cent in 2016[3], or a gain of about four percentage points over 10 years. The current rate of infrastructure spend on PT should see an acceleration in this rate of increase in PT mode share as new projects are opened.

Figure 4.3: Public transport weekday trip mode share



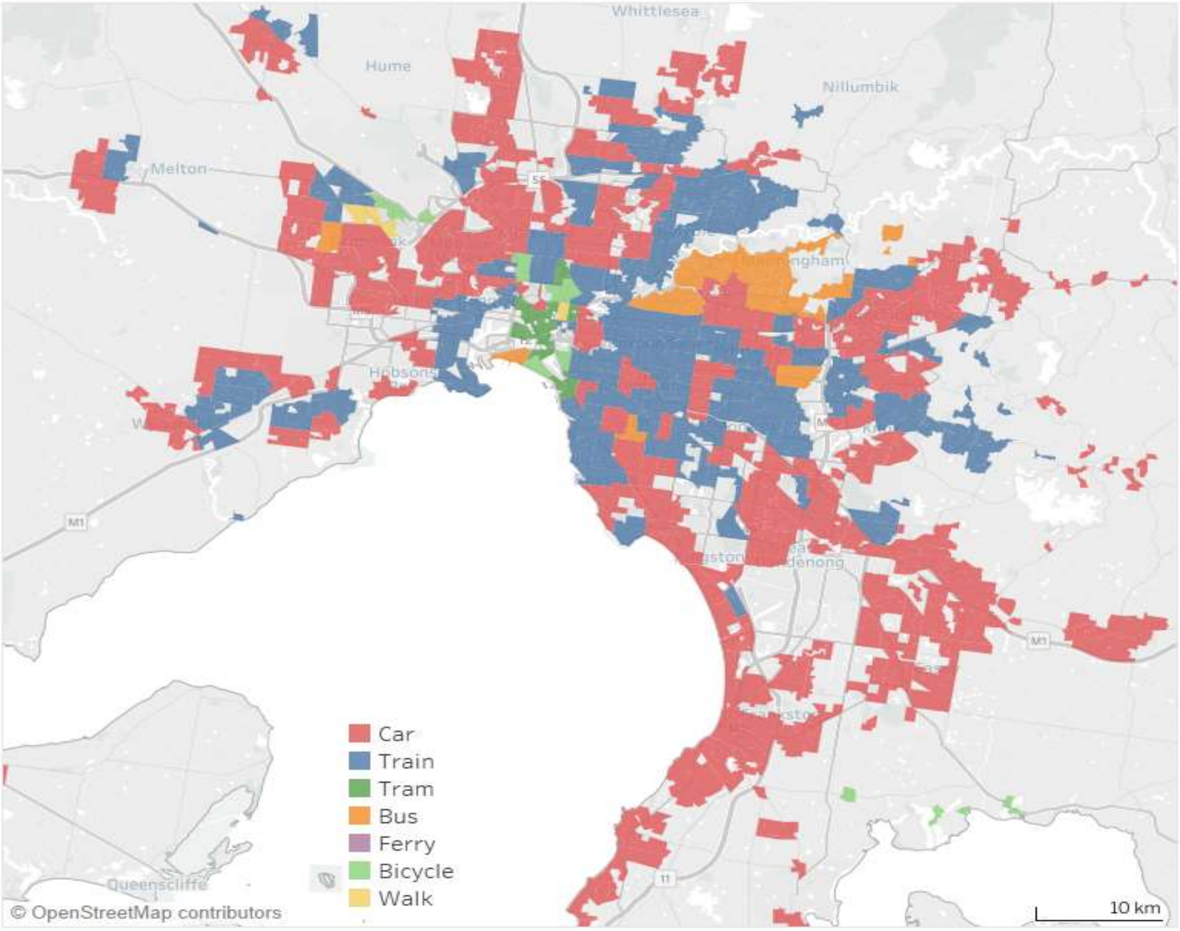
Source: https://transport.vic.gov.au/content/docs/VISTA-2013-Travel-in-metropolitan-Melbourne.PDFz. Page 4.

Loader has also analysed which modes showed the greatest growth in use for the journey to work, between the 2011 and 2016. Figure 4.4 shows that, as expected, car use showed greatest growth in the outer suburbs, where public transport alternatives are poorest, train performed well in the middle suburbs, particularly in the eastern sectors, with bus use growing strongly in the Doncaster corridor and tram in inner Melbourne.

Land use transport policy measures can impact growth in Melbourne's road traffic levels and mode shares. As a consequence, such measures may be able to ameliorate growth in congestion costs and other associated external costs of road use (e.g. air pollution, greenhouse gas emissions). Stanley, Ellison, Loader and Hensher (2017) include some relevant analysis in this regard. The following discussion draws heavily on that work, which focused on analysing morning peak trips, where the congestion effect is most marked. While the analysis was about mitigating greenhouse gas emissions from road transport, it necessarily involves consideration of factors that affect growth in VKT and in PT use during the AM peak, because of the contribution these make to GHG emissions. This analysis is also relevant to discussion of congestion.

3 https://chartingtransport.com/2017/12/05/how-is-the-journey-to-work-changing-in-melbourne-2006-2016/.

Figure 4.4: Mode with the largest growth in journeys to work by home locations – 2011-2016



Source: https://chartingtransport.com/category/mode-share/.

Table 4.4 shows 2011 data for a number of socio-economic, land use and travel variables for the AM peak, at SA2 (local area) level. The table shows that the mean number of car trips substantially outnumbers the mean number of PT trips, at SA2 level, by a factor of almost 7 (reflecting mode shares for trips). The variables set out in the table are thought to be potentially significant influences on car and/or public transport trip rates. *Population aged 5-17* is included because of the large swing from walking, cycling and PT to car for the (peak) journey to school in Australian capital cities over the past few decades.[4]

[4] To reduce problems of multi-collinearity, this variable was expressed instead as *Proportion of population aged 5-17*.

Table 4.4	Descriptive Statistical Area Level 2 data for Melbourne 2011 AM peak travel analysis			
Variable	**Units**	**Mean**	**Standard deviation**	**N**
Car trips	Number	6921	3415	275
Public transport trips	Number	1013	801	275
Population	Number	14941	7083	275
Proportion of population aged 5-17	Proportion	.154	.065	275
Population density	Pop/hectare	20.03	15.60	275
Job density	Jobs/hectare	15.33	64.68	275
Average weekly household income	$/household	1612	365	275
Average car travel time (weighted by trips)	Minutes	14.00	2.65	275
Average PT travel time (inc. walk/wait) (weighted by trips)	Minutes	73.96	17.73	275
Motor vehicles per capita	Number	0.585	0.103	272*

Note: * 3 zones are industrial, having no residential population.
Source: Stanley, Ellison, Loader and Hensher (2017), Table 2.

Separate linear multiple regression models were developed by Stanley, Ellison, Loader and Hensher (2017) for 2011 car and PT trip rates at SA2 level. The Adjusted R^2 value for the car trips model was 0.941 and was 0.843 for PT trips, so the various independent variables in each model explain a substantial part of the variation in the respective dependent variables.

Looking only at the significant independent variables, Table 4.5 suggests that AM peak car trips at SA2 level increase with population, the proportion of the population aged 5-17 (reflecting the increasing dependence on car for the trip to education in Melbourne) and also with household income but reduce slightly as population density increases and as car travel times increase. All these significant variables have the expected signs. The motor vehicles per capita variable has an unexpected sign but is not significant. The implied elasticity of car use with respect to population is 1, suggesting that doubling population will double car use (other things being equal). The car use model thus reinforces the obvious point that a bigger Melbourne population implies greater car use, which will, in turn, increase congestion costs (and GHG emissions), unless sufficient counter-acting measures are taken.

Table 4.6 sets out the equivalent model for public transport trips. In terms of the significant variables, PT trip numbers at SA2 level increase with population, population density, job density, household income (better services tend to be found in higher income areas, particularly closer to inner Melbourne) and with increasing car travel times but reduce with longer PT travel times. The proportion of the population aged 5-17 and motor vehicle ownership were not significant. The implied population elasticity is 0.85 for PT use, lower than the comparable car elasticity value (1.0), suggesting a tendency for the PT mode share to decline, relative to the car share, as population grows.

Calculations of the implied elasticity of AM peak car trips at SA2 level with respect to population density, at mean values of all variables, suggests a value of -0.13 (i.e. doubling SA2 population density will reduce AM peak car trips by about 13 per cent). Conversely, doubling both population and job densities increases projected PT trips by about 30 per cent (implying an elasticity of PT use with respect to combined population and job density of 0.30. The population density contribution is 0.23 and job density 0.07. Stanley, Ellison et al. (2017) suggest that these values are broadly consistent with findings in the well regarded Ewing and Cervero (2010) meta-analysis. The elasticity values reported herein are used in Section 6.4 to suggest how car/PT use might change as Melbourne grows, with associated congestion implications.

Table 4.5	Model for car trips generated at SA1 level in Melbourne in 2011[a]				
	Unstandardised coefficients		Standardised coefficients		
Model	B	Std. Error	Beta	t	Sig.
(Constant)	11328.027	619.581		2.143	0.033
Population	0.462	0.008	0.958	61.124	0.000
Proportion of population 5-17	3543.841	926.361	0.068	3.826	0.000
Population density	-43.731	5.532	-0.200	-7.905	0.000
Job density	-1.141	0.904	-0.022	-1.263	0.176
Ave HHI	0.359	0.185	0.038	1.942	0.010
Av PT travel time	-3.589	5.055	-0.019	-0.710	0.478
Av car travel time	-86.140	21.620	-0.067	-3.984	0.000
Motor vehicles per capita	-119.940	809.317	-0.004	-0.148	0.882

Note: a. Dependent Variable: Car trips.
Source: Stanley, Ellison, Loader and Hensher (2017), Table 3.

Table 4.6	Model for public transport trips generated at SA2 level in Melbourne in 2011[a]				
	Unstandardised coefficients		Standardised coefficients		
Model	B	Std. Error	Beta	t	Sig.
(Constant)	661.490	251.214		2.633	0.009
Population	0.057	0.003	0.499	19.646	0.000
Proportion of population 5-17	-.238.659	355.228	-0.020	-0.672	0.502
Population density	11.200	2.117	0.218	5.291	0.000
Job density	4.459	0.345	0.362	12.943	0.000
Ave HHI	0.089	0.084	0.036	1.064	0.288
Av PT travel time	-14.391	2.077	-0.320	-6.927	0.000
Av Car travel time	18.107	8.297	0.060	2.182	0.030
Motor vehicles per capita	-182.635	319.248	-0.023	-0.572	0.568

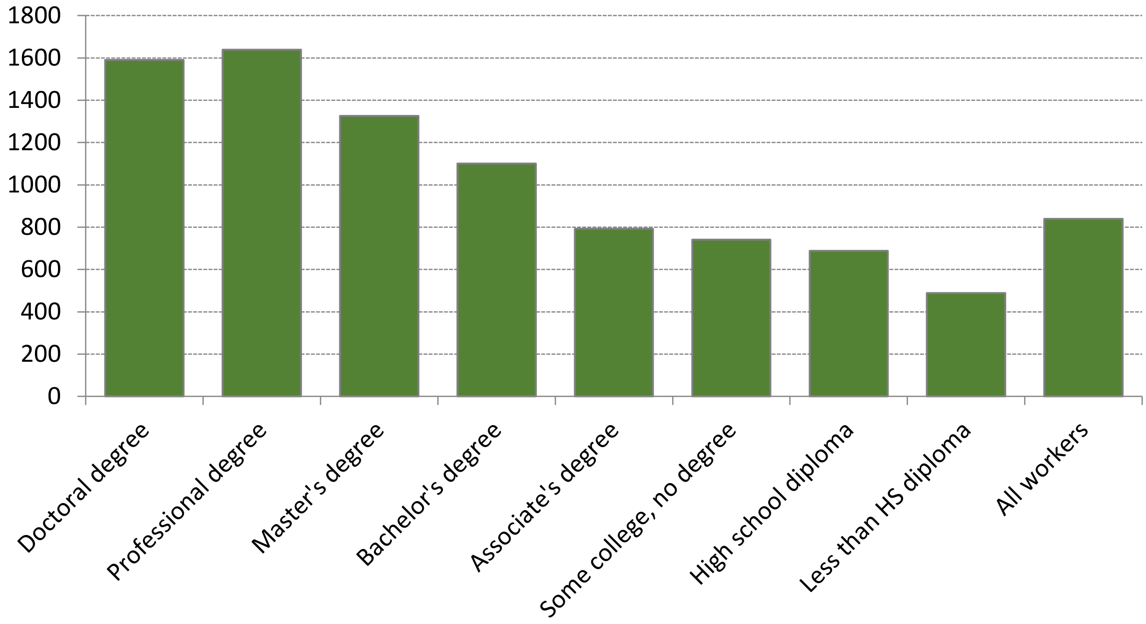
Note: a. Dependent Variable: PT trips.
Source: Stanley, Ellison, Loader and Hensher (2017), Table 4.

4.4 Education

There is a high personal and societal value in achieving a good education. An OECD report found that the private long-term economic value of having a tertiary degree instead of finishing education at upper secondary level is roughly twice as large as the advantage that a person with an upper secondary education has over someone with a lower level of education (OECD 2012). The benefits are indicated by the increase in gross earnings.

More recent US data from the Bureau of Labour Statistics shows the value of education in terms of median weekly earnings for those aged 25 and over in full-time salaried employment. Figure 4.5 shows that those with a bachelor's degree earned about 60 per cent more than those with a high school diploma, while those with a high school diploma earned around 40 per cent more than those with a lesser level of education. Higher degree holders earned 30+ per cent more than those with bachelor's degree.

Figure 4.5: Median weekly earnings ($US2014)



Source: Current Population Survey, U.S. Bureau of Labour Statistics, U.S. Department of Labour.

The passage towards achieving a higher degree starts right at the beginning of the education process, attendance at pre-school, as well as the circumstances of the child's family environment. About 6 in 10 of all children starting school get through early and middle childhood with the kinds of academic and social skills needed for later success (Lamb et al. 2015). About 10 per cent of the population remain behind across all stages of education. Thus poor early development is a matter of serious concern to both the individual and the wellbeing of society more generally. Delayed early development leads to either poorer outcomes in terms of health and/or employment for adults, or more difficult and costly later interventions to change this trajectory. The *sooner* a child receives access to healthcare, intellectual and social stimulation and guidance from loving and attentive adults, the more likely that child will grow up to be happy, healthy and productive (The Smith Family 2010, p.6).

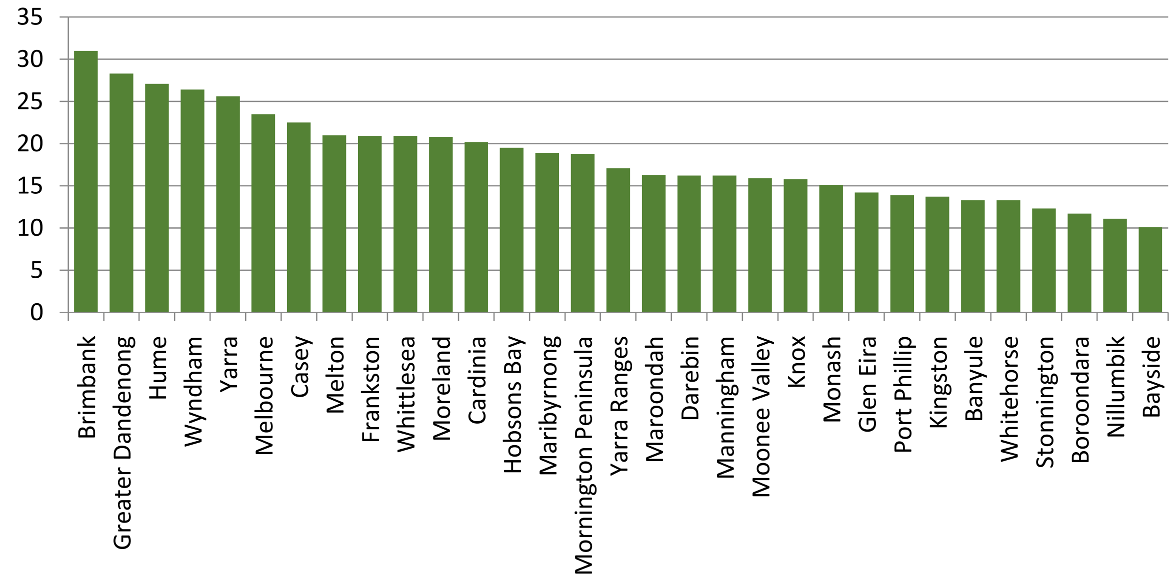
Those children with a poor start to their education in terms of intellectual and socio-emotional progress tend to be the children who drop-out from education early (Heckman 2008). A quarter of Australian school students are not finishing Year 12 (Lamb et al. 2015). Those who are the lowest achievers in maths aged 15, have only half the likelihood of other students of completing year 12.

Low educational achievement is also linked with social exclusion (Buddelmeyer et al. 2012). Early school leavers and those with a Certificate II, have lower levels of inclusion than those with other levels of education attainment, the relationship being highly elastic.

4.4.1 Children starting school with one or more developmental delays (Table 3.1 indicator 3.1)

The Australian Early Development Census (Australian Government 2016) has examined the percentage of children on school entry who have reached the developmental milestones of: physical health and wellbeing; social competence; emotional maturity; language and cognitive skills; and communication skills and general knowledge. The Australian average sits at 22.0 per cent of children having one or more developmental delays on reaching school age, the comparable Victorian rate being 19.9 per cent in 2015. Figure 4.6 shows the proportion of children with one or more developmental vulnerabilities in each metropolitan Melbourne LGA. Three industrial areas have the highest proportions, all exceeding 25 per cent: Greater Dandenong has the highest percentage, followed by Brimbank and Hume. A number of rapidly growing outer growth areas are close behind: Wyndham, Casey, Melton, Whittlesea and Cardinia, all exceeding the state average, suggesting lags in service provision under growth pressures. Yarra also exceeds 25 per cent, with Melbourne close, at 23.5 per cent. Old inner/middle eastern/southern LGAs typically are at the low end of the scale, with Bayside, Nillumbik and Boroondara having the lowest proportions vulnerable on one or more domains.

Figure 4.6: Child development vulnerability on one or more domains (%)



Source: Australian Government n.d.

There is a significant correlation between the rate of an LGA's population growth and the percentage of children living in that LGA who are vulnerable on one or more developmental domains (r=.521; p=003). In other words, a faster rate of population growth is associated with a higher proportion of children vulnerable on one or more developmental domains. This may be because of lags in the provision of pre-school services but also because of poor mobility options to enable access to pre-school in fast growing outer suburbs, where (for example) bus service provision typically lags well behind residential growth. Continued high population growth in some LGAs suggests this as an issue that needs careful attention, given the high personal lifetime costs and societal costs of poor early years.

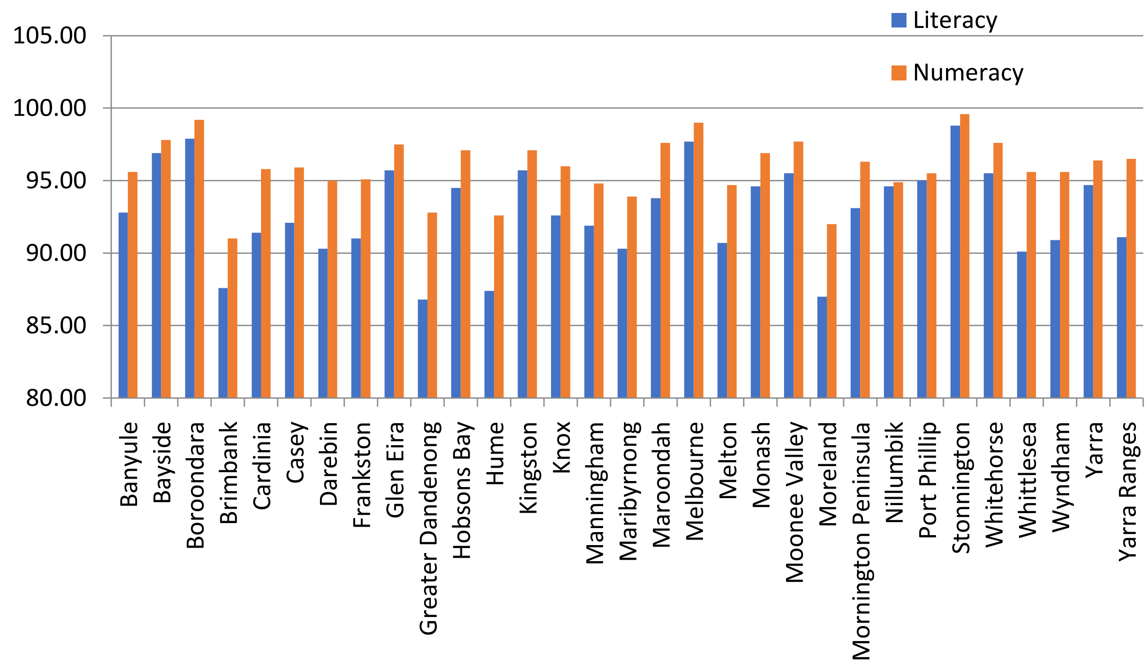
Child developmental vulnerability at LGA level is significantly negatively correlated with an LGA's SEIFA IRSD index (r=-.851; p=.000), the level of trust of neighbours (r=-.706; p=.000), trust of others (r=-.578; p=.001), number of people spoken to yesterday (r=-.530; p=.002). Social capital development is thus a key requirement for child development.

4.4.2 Year 9 literacy and numeracy rate (Table 3.1 indicators 3.2 and 3.3)

There is a very high correlation at LGA level between the percentage of Year 9 students achieving minimum national literacy standards and those achieving minimum national numeracy standards (r=.915; p=.000). Both are also highly correlated with an LGA's socio-economic status, as measured by the SEIFA Index of Relative Socio-Economic Disadvantage (p=.000 on both), with the prevalence of bachelor's degrees, or higher, among the population (p=.000 on literacy standards and p=.003 on numeracy), with trust in general (p=.000 for each) and trust of neighbours (p=.000 on literacy and p=.015 on numeracy) and with social networks (p=.01 for each) and numbers of people spoken to yesterday (Social capital networks) (p=.025 on numeracy and p=.002 on literacy). Also, Year 9 literacy standards at LGA level, but not numeracy standards, have a significant negative correlation with distance from Melbourne (r=-.369; p=.041).

At LGA level, the highest percentages of Year 9 children achieving minimum national literacy and numeracy rates are found in Stonnington, Boroondara, Melbourne and Bayside (Figure 4.7). The lowest percentages are typically found in the older industrial suburbs of Greater Dandenong, Hume and Brimbank, with Moreland also being at the low end.

Figure 4.7: Year 9 students attaining minimum national literacy and numeracy standards, by LGA within Greater Melbourne (%)



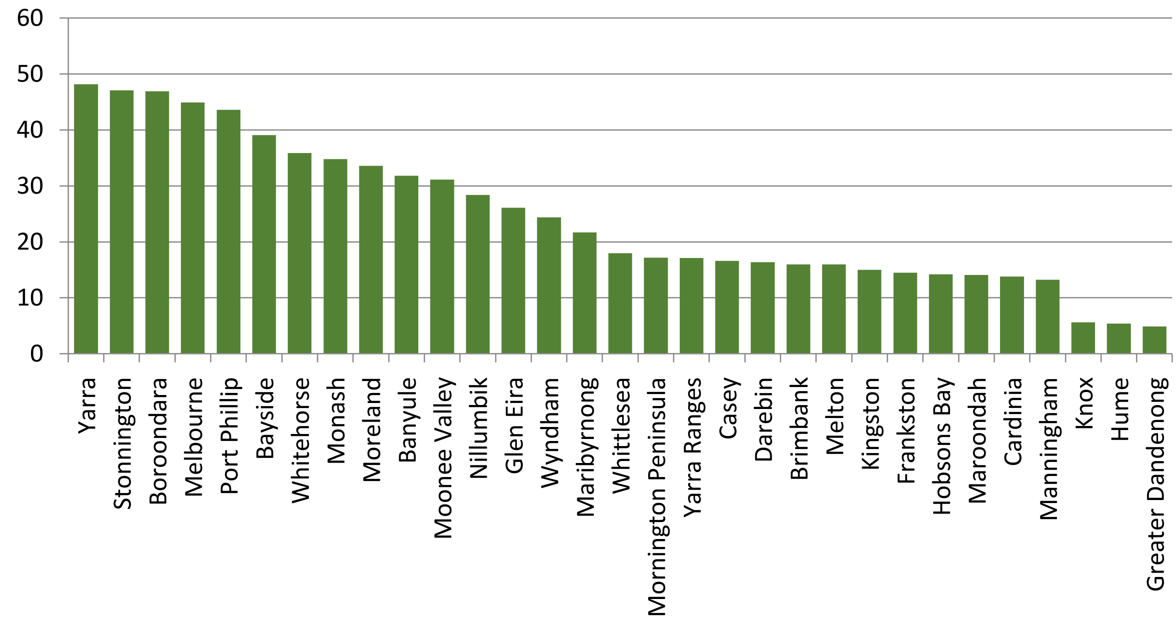
Source: https://www2.health.vic.gov.au/about/reporting-planning-data/gis-and-planning-products/geographical-profiles.

Importantly, and as shown by comparison between Figures 4.5 and 4.6, a strong negative correlation exists between achievement on literacy and numeracy standards and the proportion of children who are vulnerable on one or more developmental domains (r=-.676; p=.000 on literacy; r=-.602; p=.000 on numeracy). Child developmental vulnerability, in turn, is also highly correlated with an LGA's SEIFA IRSD rating (r=-.851; p=.000). In other words, Year 9 students do better on literacy and numeracy standards if they have a good start to their educational lifetimes, and this is more likely if they live in areas with a higher SEIFA IRSD rating. The rate of population growth over the 2011-16 period is not highly correlated with either Year 9 literacy or numeracy achievement (but child vulnerability is).

4.4.3 Bachelor's degree or higher (Table 3.1 indicator 3.4)

One in four Melburnians aged 15 years or over in 2016, held a bachelor's degree or higher. This indicator is highly and positively correlated with an LGA's incidence of people who hold high-tech jobs (r=. 674; p=.000) and with LGA productivity[5] (r=. 360, p=. 047). Incidence of bachelor's degrees, or higher, is thus a useful economic indicator at LGA level. Figure 4.8 shows that the highest incidence of bachelor's degrees, or higher, in Greater Melbourne is found in the inner and nearby LGAs of Yarra, Stonnington, Boroondara, Melbourne, Port Phillip and Bayside. The lowest proportions are found in Greater Dandenong, Hume and Knox. Outer urban growth LGAs tend to fall in the middle to lower part of the range: most, with the exception of Wyndham, are at least 6 percentage points below the average share for all LGAs (of 24.4 per cent in 2016), although incidence of bachelor's degrees, or higher, is not significantly correlated with the rate of population growth.

Figure 4.8: Ranking of LGAs by proportion of people aged 15 years or over who hold bachelor's degrees, or higher



Source: ABS Quickstats 2016.

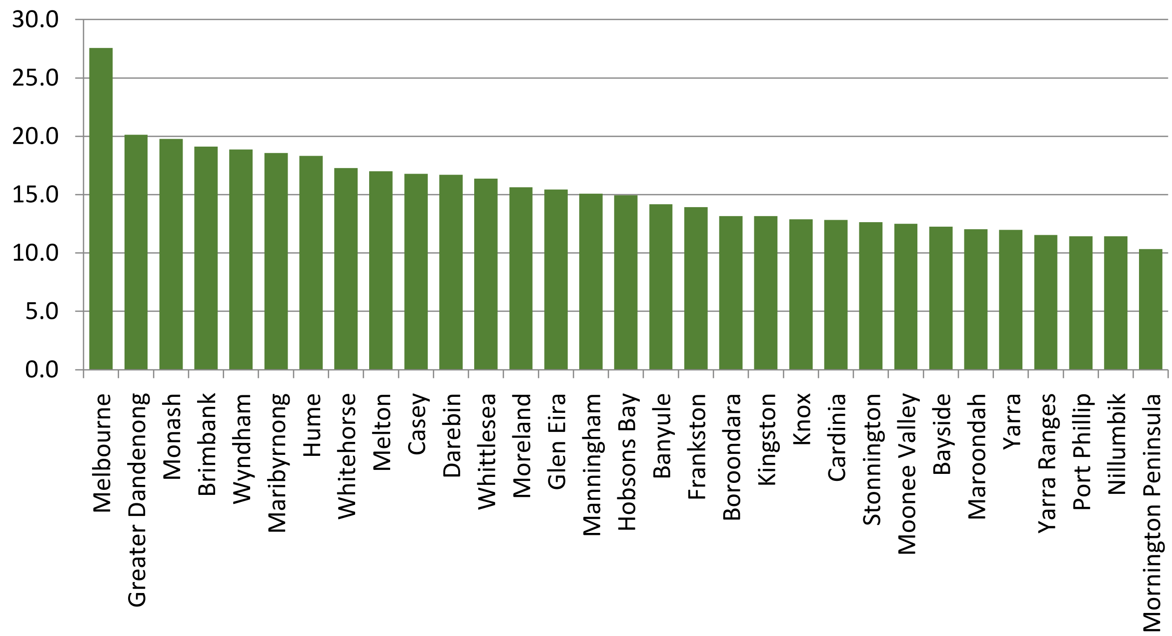
5 Where productivity here is defined as Gross Regional Product per hour worked, with GRP measured at market prices as the sum of the gross values added of all resident producers at market prices, plus taxes less subsidies on imports.

4.5 Youth unemployment (Table 3.1 indicator 4)

Figure 4.9 shows youth (15-19) unemployment rates by LGA. The City of Melbourne has the highest rate, at over 25 per cent (possibly due to the high student population), with 15 LGAs then having rates between around 15-20 per cent and a further 15 being between 10-14.5 per cent. The second group (15-20 per cent) are largely outer urban LGAs and/or older industrial areas (e.g., it includes Greater Dandenong, Brimbank, Wyndham, Maribyrnong, Hume, Melton and Casey). Inner suburbs, apart from Melbourne, tend to be at the lower end of the range (e.g., Port Phillip, Yarra, Stonnington and Bayside), although Glen Eira is mid-range.

Youth unemployment does not include the levels of under-employment, nor disengagement from education and searching for work. In February 2017, the under-employment rate for youth aged 15 to 24 years of age sat at about 18 per cent (Vandenbroek 2017).

Figure 4.9: Youth (15-19 year old) unemployment rates by LGA



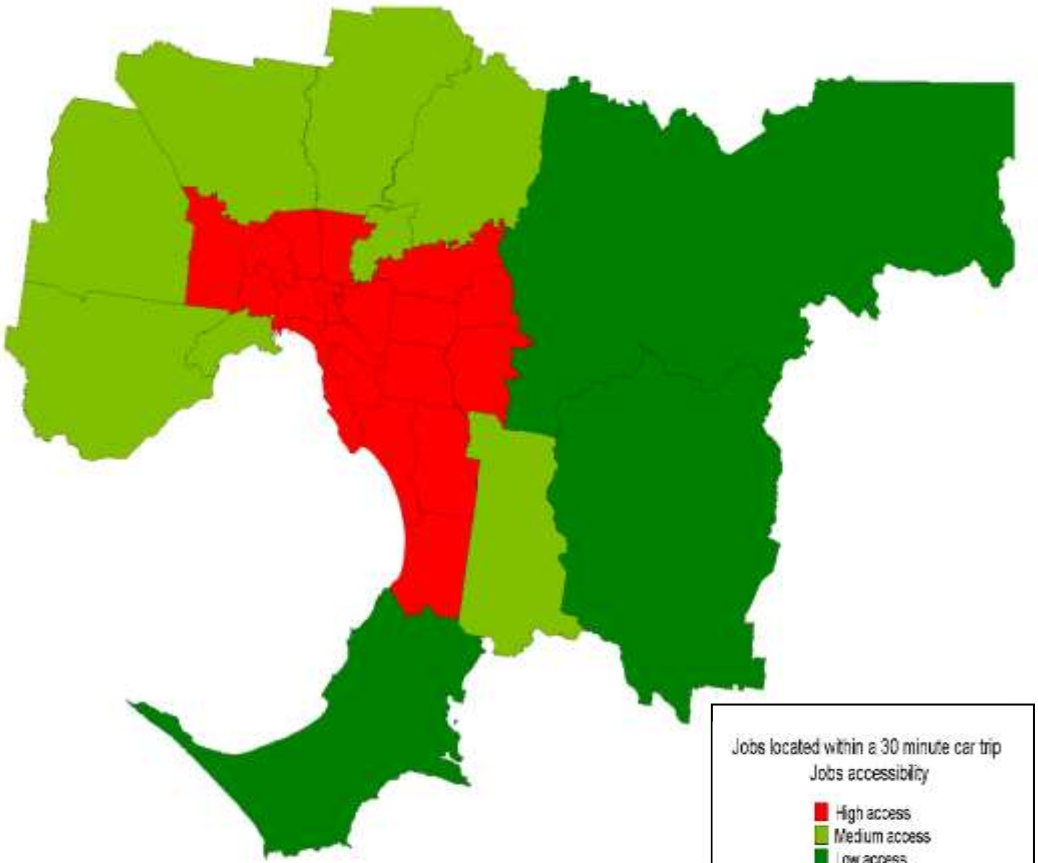
4.6 Job accessibility by car and public transport (Table 3.1 indicators 5.1 and 5.2)

Employment accessibility across Melbourne is an important indicator of relative economic opportunity by location. This is usually shown in terms of numbers of jobs accessible in particular travel time bands, typically 45 or 60 minutes, by car and public transport respectively. We have chosen 30 minutes instead, recognising that a city that talks about being a series of 20 minute neighbourhoods should not be thinking about 45-60 minute one-way work trips. Figures 4.10 (a) and (b) are the resulting figures for car and public transport respectively, as estimated for 2017. In these Figures, 'low access' is defined as under 70,000 jobs accessible in 30 minutes, 'medium access' is 70,000-250,000 jobs accessible in this time and 'high access' is greater than 250,000 jobs.

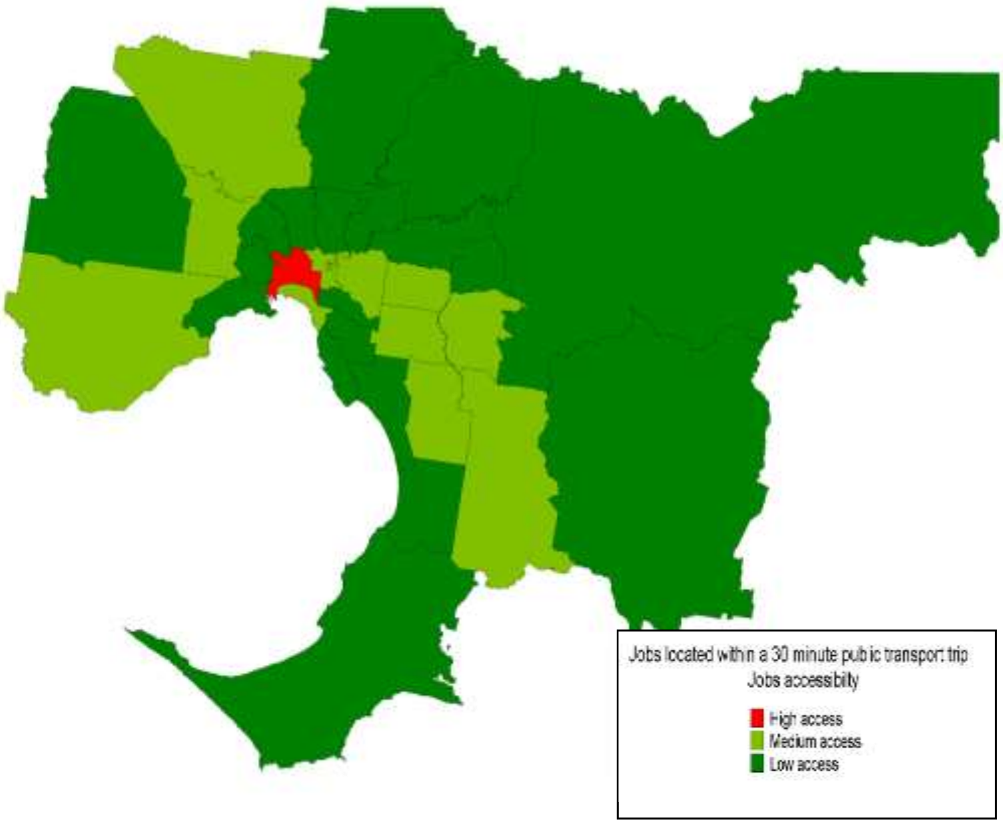
It will be no surprise that this shows much better accessibility for locations that are more central, with public transport accessibility well below that by car for outer and middle urban residents, particularly across the northern and bayside suburbs. Car access to jobs is much better through the middle suburbs than it is by PT, although the south-eastern suburbs are showing the benefit of rail corridor upgrades. The outer east has relatively poor access to jobs by both car and PT, reflecting a shortage of local jobs as much as anything else.

To add to this analysis, we draw on our analysis in Section 4.3 above and use some work we undertook for Infrastructure Victoria in 2016 to show the challenges confronting public transport users in terms of peak trip times. Table 4.4 above showed that, at SA2 level, the average AM peak car trip duration, which will be mainly for work or education purposes, was 14 minutes, whereas the average PT AM peak trip duration was 74 minutes, including access, egress time, walk and wait time. The following discussion takes this comparison to a finer level of detail for accessing Melbourne's National Employment and Innovation Clusters, which formed a key innovation in the land use development strategy for Plan Melbourne (DTPLI 2014) and Plan Melbourne 2017-2050 (DELWP 2017).

Figures 4.10(a) and (b): Jobs accessible within 30 minutes by car and public transport



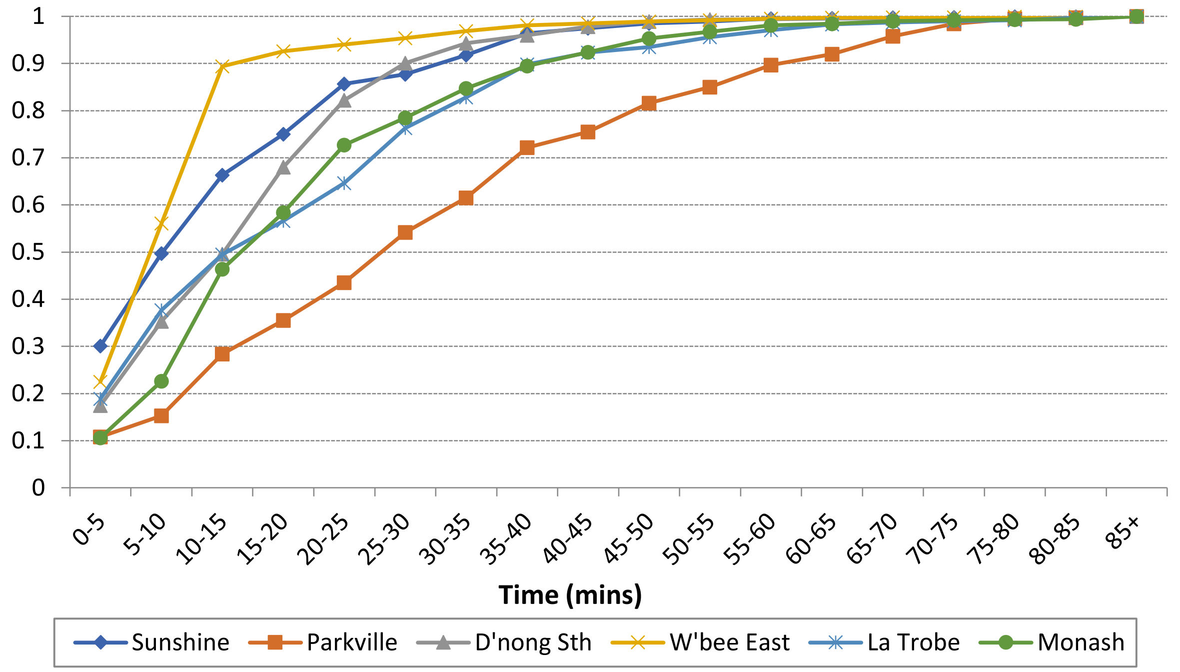
Source: NIEIR.



Source: NIEIR.

Figure 4.11 shows, for 2011, the cumulative proportion of jobs in each of the (then) 6 NEICs plotted against AM peak access time by car. 50 per cent or more of all jobs in each NEIC were accessed (2011) in 25-30 minutes or less by car in the AM peak, with all except Parkville having 50 per cent in the 10-15 minutes trip time duration or less. 90 per cent of all AM peak car trips to all NEICs except Parkville are around 35 minutes or better. Curves that are lower and more to the right have relatively longer travel times. The newest urban centre, East Werribee, the smallest and only outer urban NEIC, has the shortest AM peak car travel times, reflecting a more localised catchment for work and school trips. The more established middle urban clusters to the north (La Trobe) and east (Monash) have larger catchments and longer travel times. Parkville has the longest duration AM peak car trips (lowest travel time curve in Figure 4.11), indicating the most extensive catchment. The South Dandenong and Sunshine catchments are more localised than those for La Trobe and Monash but less so than for Werribee East.

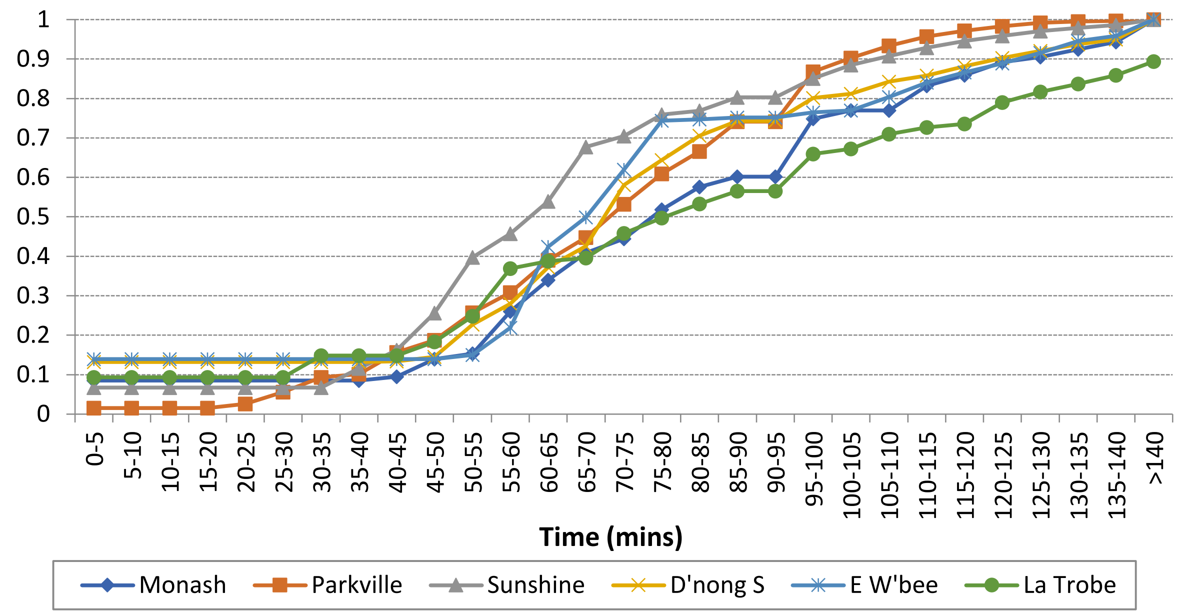
Figure 4.11: Cumulative travel time curves for NEIC AM peak work trips by car in 2011 (proportion of trips)



Source: Stanley and Brain (2016), Figure 7.3.

Figure 4.12 shows comparable information for public transport trips, with cumulative travel times including access, egress and wait/transfer time components (called access/egress hereafter). The access/egress components explain the substantial flat sections in each NEIC's cumulative PT trip time duration distribution curve, to the left of the figure, typically at around 30-40 minutes. This is recognised positively in some discussions as the healthy incidental daily exercise that accompanies public transport use, in contrast to driving. Parkville has the shortest and lowest flat section, indicative of the higher PT frequencies to the central/inner city and dense inner urban PT networks. Trip times are typically much longer by public transport than by car, partly because of the access/egress components. The figure shows that the 90th percentile for AM peak trips is greater than 100 minutes in all cases by PT, including access/egress stages, while the 50th percentile is in the 60-80 minutes range. The comparable car times were much shorter.

Figure 4.12: Cumulative travel time curves for NEIC AM peak work trips by PT in 2011 (proportion of trips)



Source: Stanley and Brain (2016), Figure 7.4.

4.7 Inequality (Table 3.1 indicator 6)

See Section 6.2.2 for a discussion on Inequality

4.8 Housing affordability

4.8.1 Dwelling price to household income ratio (Table 3.1 indicator 7.1)

Housing costs represent a large share of the household budget and, for many, is the most significant single expense. In Australia an average of almost 32 per cent of household income is spent on home loan repayments whilst, for renters, the average spent on housing rent is around 25 per cent of income. What is emerging in cities such as London, New York, Vancouver, Sydney and Melbourne is a widening gap between household income and the cost of housing to buy or rent.

The Fourteenth Annual *Demographia* International Housing Affordability Survey (Cox and Pavletich 2018) rates 293 metropolitan housing markets in nine countries, these being Australia, Canada, China (but only for Hong Kong), Ireland, Japan, New Zealand, Singapore, United Kingdom and the US. The survey measures middle income housing affordability in terms of the 'median multiple' in 2017, which expresses median house prices in terms of multiples of median household incomes. *Demographia* focuses on house prices (not units) and does not take account of different lot sizes across different cities. The least affordable housing is classified as 'severely unaffordable', defined by *Demographia* as a house-price-to-income ratio of 5:1. Some 28 'severely unaffordable' housing markets were identified among major metropolitan markets (cities with more than 1 million people). These included all five Australian cities in the survey. Sydney was ranked second in the top ten least affordable major metropolitan markets with a house-price-to-income ratio of 12.9 (a substantial increase on the already high 9.8 ratio in the 2014 report), with Melbourne ranked fifth worst at 9.9

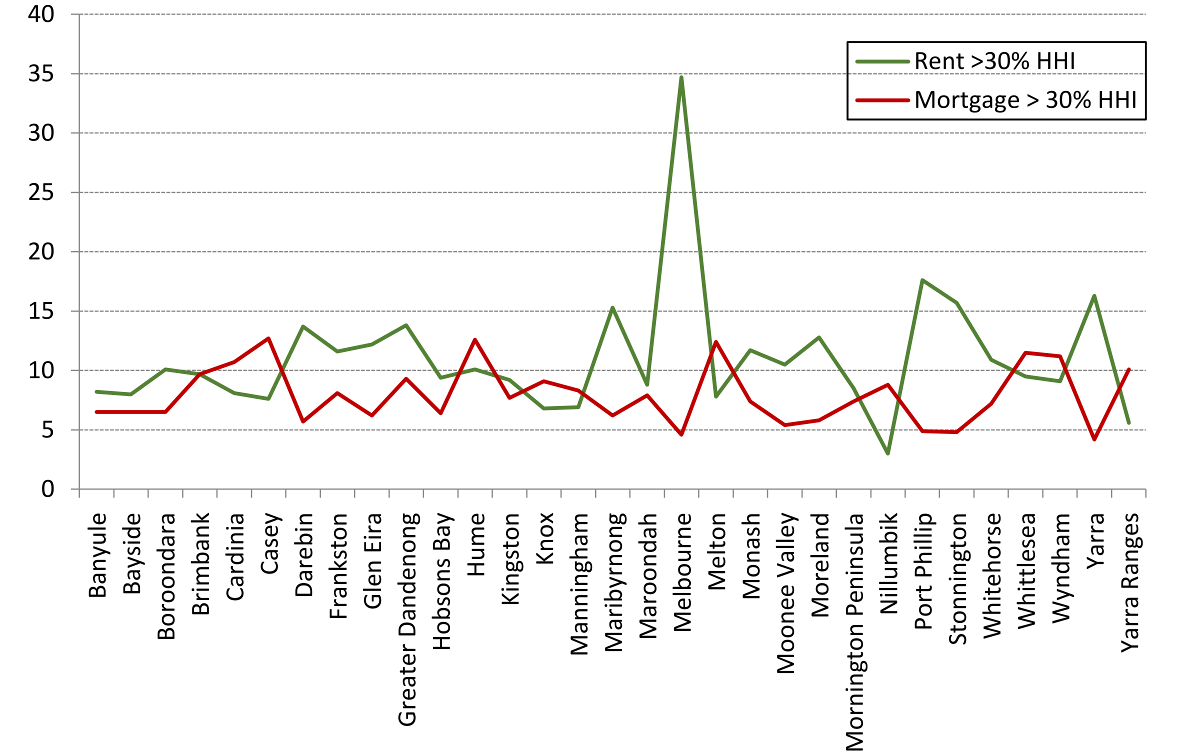
(8.7 in the 2014 report). In 1985 the average house price in Melbourne was around 2.5 times the average household disposable income.

4.8.2 Rental and mortgage affordability (Table 3.1 indicator 7.2)

Within Melbourne at LGA level, Figure 4.13 shows the proportion of renters and mortgage payers who allocate 30 per cent or more of their weekly household income to paying rent or mortgage repayments respectively, which is one measure of rental and mortgage stress. The very high Melbourne rental figure probably reflects the large student population. High proportions of renters paying 30 per cent or more of household income on rent tend to be in inner suburbs, such as Port Phillip, Yarra, Stonnington, Maribyrnong and Glen Eira, the correlation between LGA distance from Melbourne and the proportion of LGA households who pay more than 30 per cent of household income on rent being negative and significant at better than 1 per cent level (r=-.539; p=.002). Inner urban densification may thus create risks of increased rental stress. However, some outer area lower household income LGAs, such as Hume and Greater Dandenong, also have relatively high proportions of renting households paying 30 per cent or more of household income on rent.

Conversely to the general pattern on rental exposure, the highest proportions of households paying 30 per cent or more of weekly household income on mortgage repayments tend to be found in outer suburbs, with Cardinia, Casey, Hume, Melton, Whittlesea, Wyndham and Yarra Ranges being the only LGAs where the figure exceeds 10 per cent of the relevant households. The correlation between LGA distance from Melbourne and the proportion of households paying 30 per cent or more of weekly household income on mortgage payments is positive and significant at better than 1 per cent level (r=.761; p=.000). This suggests that higher interest rates would be felt in those outer suburbs, in particular, and that increasing population numbers in outer suburbs will be putting more people at potential risk of mortgage stress.

Figure 4.13: Percentage of households with rent payments or mortgage payments greater than, or equal to, 30 per cent of household income



Source: ABS Census Quickstats 2016.

4.9 Greenhouse gas emissions (Table 3.1 indicator 8)

Australians are one of the world's highest per capita emitters of greenhouse gases (Stanley, Ellison, Loader and Hensher 2017). Australian transport sector GHG emissions in 2015 were 94.8Mt CO_2-e and have grown by 55 per cent since 1990, with the sector's share of Australian emissions increasing from 15 per cent in 2002 to over 17 per cent in 2015 (DEE 2017)[6]. These data suggest that the transport sector is acting as a drag on national emissions reductions performance. Road transport represents 84 per cent of transport sector GHG emissions, and needs to play a lead role in sector emissions reduction. Road transport GHG emissions were 72.6Mt in 2005, increasing to 80.8 Mt in 2015 (DEE 2017). Melbourne's share of the total Australian road transport GHG emissions is estimated to have been around 10.6 Mt in 2005 and 11.3Mt in 2015, with cars accounting for over 60 per cent of these emissions.

The discussion in Section 4.3, on road congestion and management of growth in vehicle kilometres of motor vehicle travel, is also highly relevant to urban GHG emission performance, as is the regulatory setting that establishes the vehicle emissions intensity requirements (CO_2grams/vkm) of the vehicle fleet. Australia lags behind Europe in this regard. Section 7.7 discusses these matters in some detail.

The government does not provide data on non-transport GHG emissions.

6 Note that the above numbers do not include electric rail emissions, indirect emissions, or emissions from international shipping and aviation.

4.10 Greening and open space

The term 'green cover' is used here to refer to the greening of space within or very close to urban areas. The form of green cover can include trees along streets, parks and gardens, sports/recreation grounds, areas of indigenous/natural vegetation, waterways and highway verges. Knowledge of their value to humans and for the protection of biodiversity is steadily growing. The features of green cover serve different functions, although their value often overlaps their form.

Plan Melbourne identified benefits of making Melbourne a greener city, listing cooling to reduce heat and UV impacts, reduced air pollution and energy costs, enhanced liveability, improved physical and mental wellbeing, protected biodiversity and enhanced visitor appeal (DTPLI 2014, p. 126). Plan Melbourne 2017-2050 subsequently included Action 91 whole-of-government approach to cooling and greening Melbourne, aiming to create urban forests throughout the metropolitan area (DELWP 2017).

Infrastructure Victoria (2016, p. 165) expands this list of benefits to include:

- creating space for physical activity to address obesity and diabetes rates and reduced fitness, particularly in young children
- creating inclusive community spaces to address social exclusion, noting the ageing population and the increasing importance of positive mental health
- opportunities for walking and cycling for transport
- providing shade to mitigate the 'heat island effect' to address the challenges of climate change, heat-related death and increasing urban densities
- protecting and enhancing natural environments and supporting biodiversity by providing the critical connections within and between ecosystems
- reducing emissions and addressing air quality, including acting as a carbon sink
- providing a more efficient and effective means of managing stormwater to protect against flooding
- delivering energy savings through natural temperature regulation.

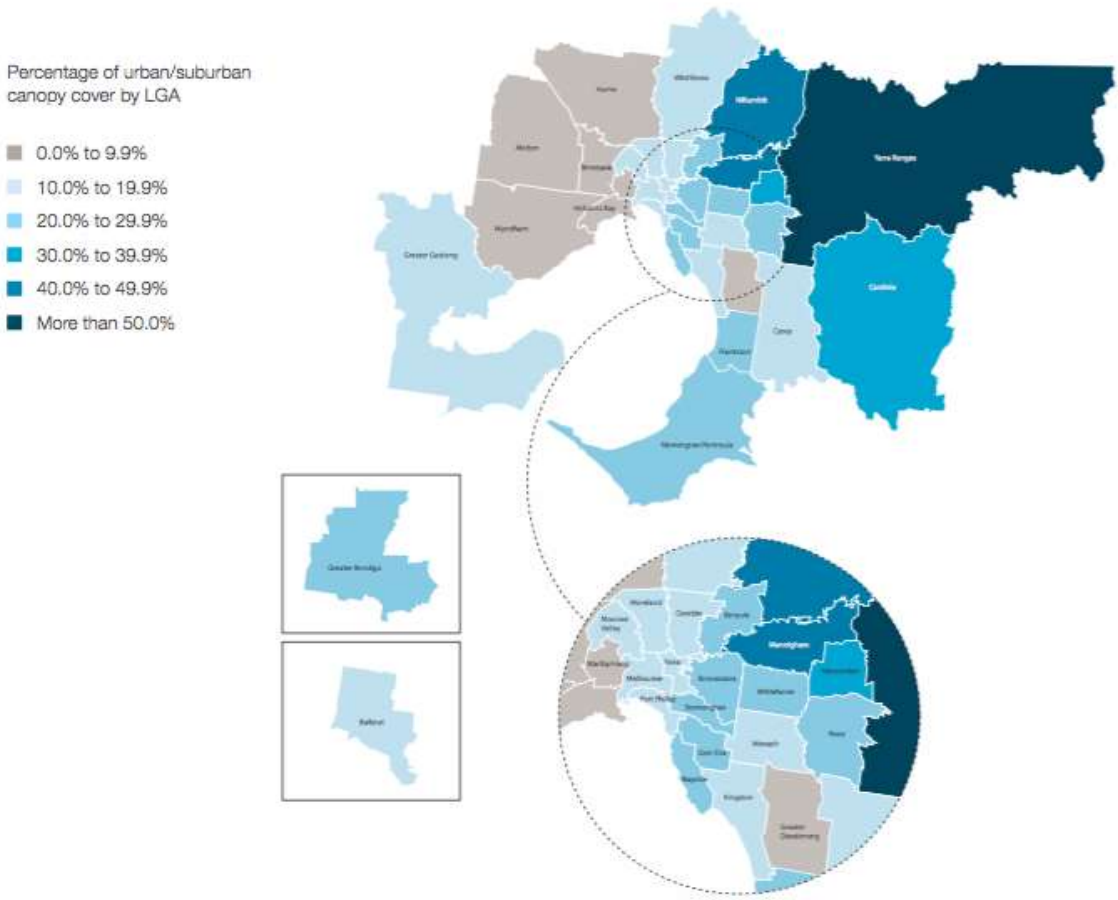
To these benefits can be added opportunities for creative play for children. Recent research has demonstrated that child development and wellbeing can be hampered if the child is not given the chance to interact with the natural environment (Laird and McFarland 2017). Opportunities to meet and undertake hobbies and group activities build health, wellbeing and social capital. Environmental amenity improves where areas have green cover.

How green cover is described and measured is variable, such that it is not always possible to distinguish the different forms of green cover and the quality of the cover. For example, 'natural areas' may be polluted or invaded by weeds and a 'sports or recreation area' may be an unimproved paddock.

4.10.1 Access to green canopy (Table 3.1 indicator 9.1)

A green canopy is important for humans for shade, visual and psychological amenity and as habitat for some species, but a more complex plant system with lower and middle storey is also needed for healthy ecological systems (Fisher 2015). Figure 4.14 shows the relative extent of green cover across Melbourne. The north-east (Nillumbik and Manningham) and outer east (particularly Yarra Ranges) are relatively well provided, whereas the west and north-west have very low proportions of green cover, partly reflecting the historical presence of grassland. Greater Dandenong in the south-east also has a low proportion of green cover. Rapid population growth in the north and west is adding to the proportion of Melbourne's population living in areas of relatively low green cover, increasing the urgency of increasing green cover in these locations. Equally, however, urban infill risks reducing green cover in existing areas, a reminder that greening strategies are needed across the entire city. The west stands out as very urgent, given the conjunction of its very high population growth rate and low starting level of green cover.

Figure 4.14: Per cent of canopy cover by LGA



Source: B Jacobs, N Mikhailovich and C Delaney, *Benchmarking Australia's urban tree canopy: An i-tree assessment (NY13028)*, 2014, the Institute for Sustainable Futures, University of Technology Sydney, accessed in Infrastructure Victoria (2016) Victoria's 30-year infrastructure strategy, Victorian Government, December, p.165. http://www.infrastructurevictoria.com.au/sites/default/files/images/30-year%20strategy%20-%20Accessible%20version.DOCX. Accessed 20 April 2018).

4.10.2 Access to natural areas (Table 3.1 indicator 9.2)

Interaction with the natural environment is said to improve health and wellbeing and increase productivity, also offering a sense of place and belonging to local residents, a place for inspiration and spiritual comfort, as well as tourism opportunities (European Union 2011, Gill 2011, Marselle et al. 2013, Stanley et al. 2017). The many values of such access can be seen as fundamental for child development: allowing unstructured play, supporting independence, cognitive development and emotional resilience; as well as for social interaction needs for all ages, and stress reduction.

Research has shown that interaction with natural areas can lead to beneficial psychological, physiological and endocrinological effects in humans, the latter referring to good microorganisms which regulate the body's immune functioning (Rook 2013). Indirectly, value is achieved for humans through the regulation of essential ecological processes and life support systems, through bio-geochemical cycles and other biospheric processes. This includes air quality, carbon sequestration and storage, waste water treatment, pollination, the maintenance of biogeochemical cycles in the environment, soil formation, erosion control, nutrient cycling and a moderator of extreme events. The value of natural capital and ecosystem services to humans is globally worth US$33 trillion, higher than the global Gross Domestic Product (GDP), measured at US$30 trillion (Constanza et al. 2007). Thus opportunities to preserve and facilitate such services within an urban area should be taken-up.

The UK has developed indicators for extent of natural cover and access to these areas (Mayor of London 2002).

- No person should live more than 300 metres from at least one area of accessible woodland of no less than 2ha in size.
- There should also be at least one area of accessible woodland of no less than 20ha within 2km of people's homes.
- At least 1ha of Local Nature Reserve per 1,000 people should be provided.

The Woodland Trust (2015) has a slightly modified version covering all of the UK, where the first target is increased to 500m and size is reduced from 2ha to 0.75ha in urban areas, and the distance for the second measure is increased from 2 to 4km or an 8km round trip. Woodland is defined as 'land under stands of trees with, or with the potential to achieve tree crown cover of more than 20 per cent' (The Woodland Trust 2015, p.3). In 2015, only 15 per cent of Greater London's population was able to meet this first indicator, while 73.4 per cent met the second one.

In terms of the availability of public 'natural' areas in metropolitan Melbourne, data from the Victorian Planning Authority's data portal has been used, encompassing 'conservation reserves' plus 'natural and semi-natural areas'. Total availability across all 31 LGAs is 230,000 ha. Figure 4.15 shows the data for 30 LGAs, totalling about 80,000ha, It excludes Yarra Ranges Shire, which has 154,400 ha of such open space (including areas beyond the metropolitan boundary), which would dwarf all other columns in the chart. Outer urban municipalities (Cardinia, Wyndham, Whittlesea and Mornington), together with Nillumbik, stand out as having the largest areas under these land uses. Casey and Melton, also outer urban growth areas, are next in scale but have much smaller areas classified as conservation, natural and semi-natural areas, than the other outer municipalities listed. At the other end of the scale, not surprisingly, are a number of inner urban LGAs, with Glen Eira (zero ha), Stonnington (27ha), Yarra (109ha) and Maribyrnong (150ha) having the smallest land areas under these uses.

A better appreciation of availability of natural areas (and other open space) for human purposes takes population numbers into account, particularly resident population but also, in the case of major employment centres, would ideally include workforce numbers, or in the case of holiday destinations, visitor numbers, if a more comprehensive assessment was to be performed than is feasible in the current report. Figure 4.16 shows availability of conservation areas plus natural and semi-natural areas, in terms of hectares per 1000 residents, with Yarra Ranges again not shown, to avoid distorting the chart.[7] Yarra Ranges has almost 1000 ha of land under these uses per 1000 residents, or 1m^2 per capita, which is about five times the level of availability of the second highest ranked LGA, Cardinia at 205ha/1000 residents. Excluding Yarra Ranges, the average per 1000 residents across the remaining LGAs is 17.5ha. Highest availabilities are in Cardinia, Nillumbik

7 The tables in this and the next section show open space distribution for areas both within and outside of the UGB. It includes some planned open space, including around 11,000 hectares of proposed conservation land in the form of the Western Grasslands Reserve (OS_STATUS is "planned").

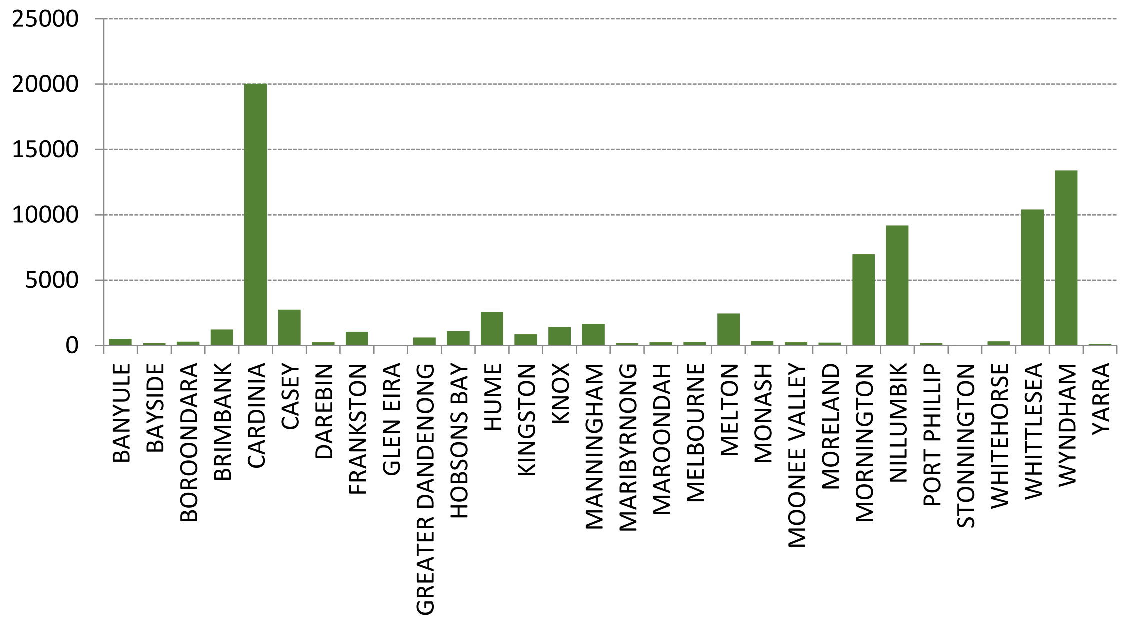
(143ha/1000 residents), Wyndham (59ha/1000), Whittlesea (50ha/1000) and Mornington Peninsula (41ha/1000), mainly outer urban municipalities. Lowest availabilities of conservation, natural and semi-natural area per 1000 residents are in Glen Eira (0), Stonnington (0.2ha/1000 residents), Yarra (1.2ha/1000) and Port Phillip (1.3ha/1000), all being well below the average figure of 17.5ha/1000 residents (excluding Yarra Ranges Shire).

If minimum LGA availability targets or standards, along UK lines, of

- no-one living more than 500 metres from at least one area of accessible woodland of no less than 0.75ha in size (as per the UK Woodland trust standard) plus
- at least 1ha of Local Nature Reserve per 1,000 people being be provided

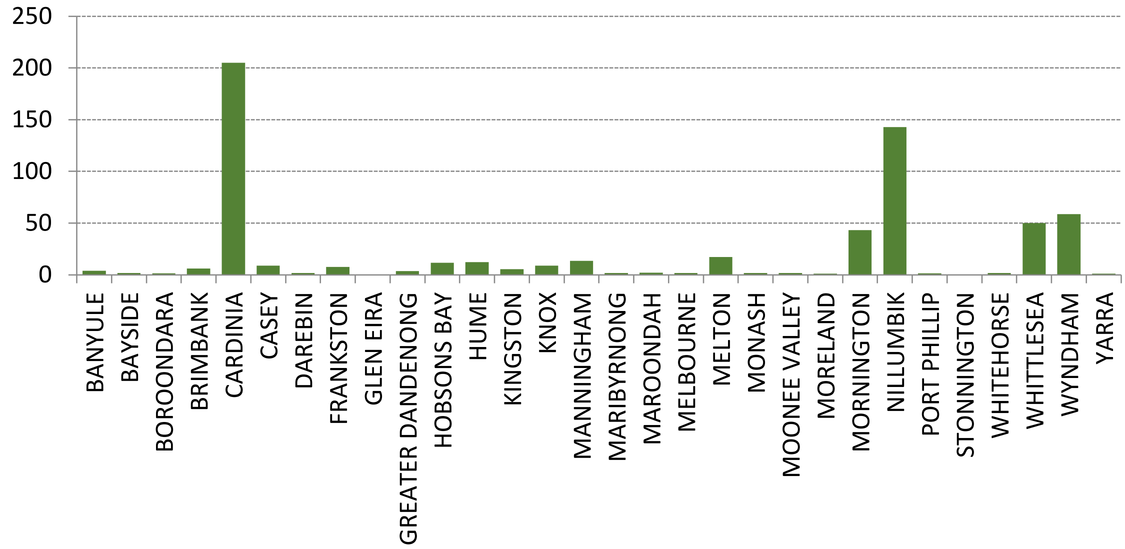
then 2/31 LGAs would not have met this standard in 2016, accounting for a total resident population of 260,000. If the second target has been raised to 2ha/1000, then 14/31 LGAs would have fallen short, with total population involved of 1.9 million. This emphasises the importance of thought about community need to access to public conservation, natural and semi-natural areas.

Figure 4.15: Hectares of public conservation area, natural and semi-natural area by LGA (excluding Yarra Ranges)



Source: Data provided by Victorian Planning Authority.

Figure 4.16: Hectares of public conservation area, natural and semi-natural area per 1000 residents by LGA (excluding Yarra Ranges)



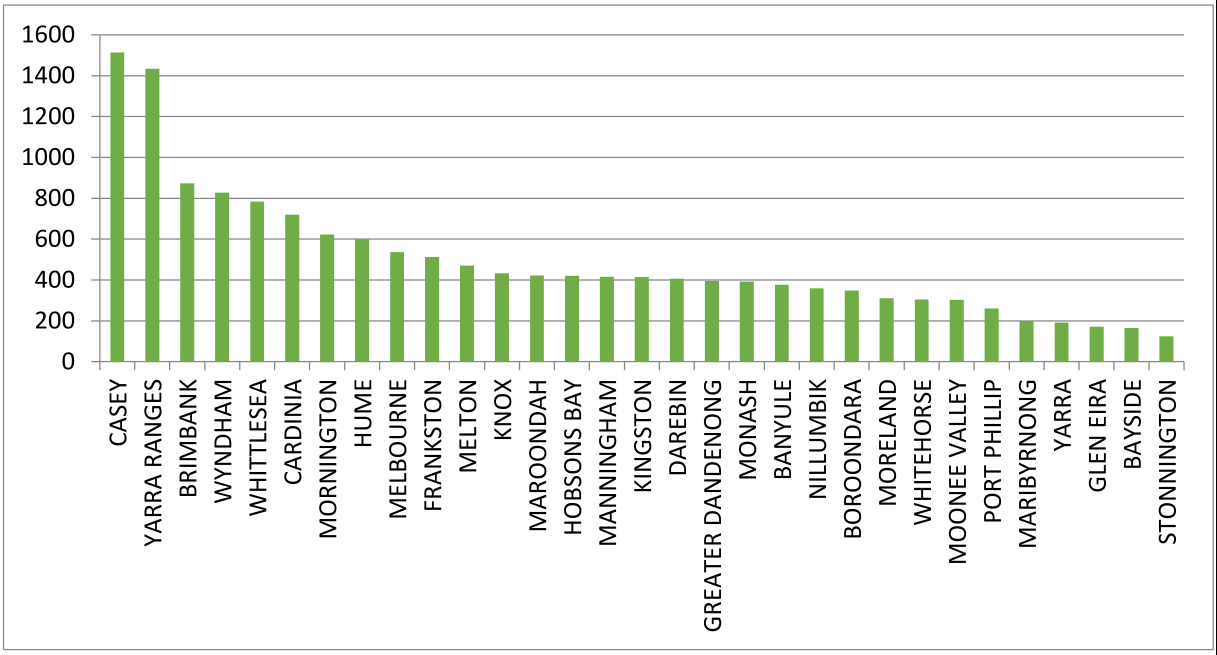
Source: Authors' calculations based on land use data provided by VPA.

These data can only be indicative of relative availability, since they do not allow for the possibility of people being able to access open space in other (e.g., neighbouring) LGAs. However, Figure 4.18, later in this chapter, deals with this to some extent, by showing the proportion of residents within a 400 metre walking distance of public open space.

4.10.3 Access to other open space (Table 3.1 indicator 9.3)

Data at LGA level on hectares of other forms of public space, which is mainly parks and gardens plus sports fields and recreational open space, is set out in Figure 4.17 and called 'other open space'. Total availability across the 31 LGAs (this time including Yarra Ranges) is 15,300 ha, much smaller than the total 'conservation, natural and semi-natural' land area. The figure shows that the largest areas of other open space are again generally found in the outer suburbs, particularly Casey and Yarra Ranges, which both exceed 1400ha, but also Whittlesea and Wyndham, each having around 800ha. Brimbank is again well provided, with over 800ha. The inner suburbs of Stonnington (125ha), Bayside (1765ha), Glen Eira (171ha) and Yarra (191ha), have the smallest areas under these other open space land uses.

Figure 4.17: Hectares of other public open space, including parks and gardens, sports fields and organised recreation space, by LGA



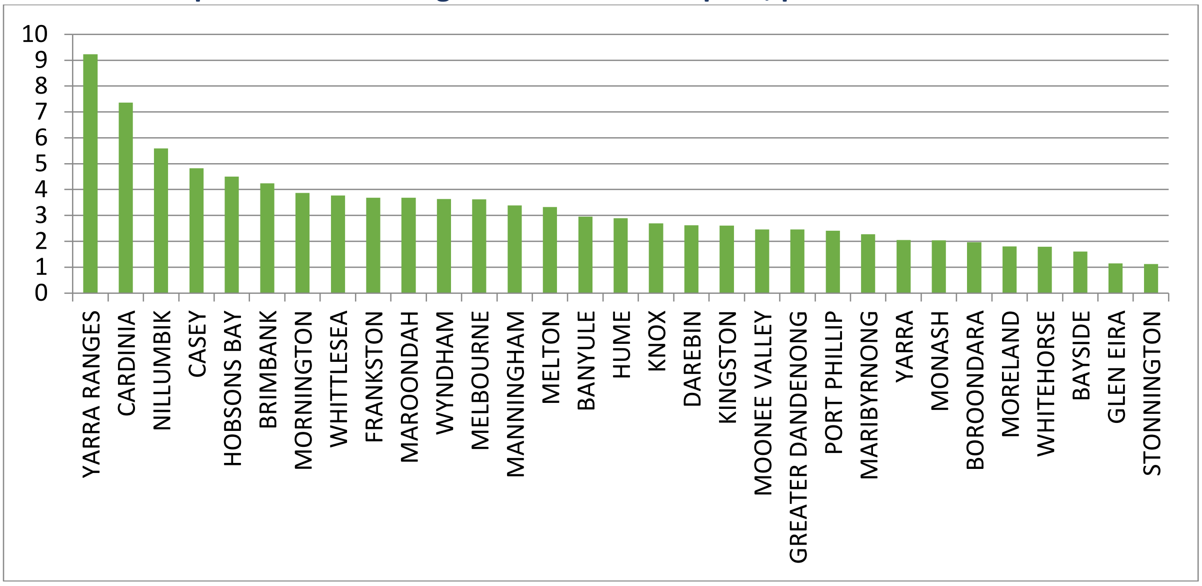
Source: Data provided by VPA.

Open space availability has traditionally been considered in terms of standards, commonly described in terms of availability per 1000 population, or availability as a percentage of area or of catchment. Veal (2013) shows the lack of a scientific basis for such standards but recognises their persistent application. Open space planning standards per 1000 population have been common in Australia and we use that measure herein. Veal (2013) notes the long-standing British (National Playing Fields Association, now Fields in Trust) standard of 2.43ha/1000 population and US (National Recreation Association, now National Recreation and Parks Association) figure of 4ha/1000 population, with the Australian 'standard' being 2.83ha/1000 population. Demand/need based standards are now commonly argued to be a preferred approach to standards but the preceding standards can usually be argued to be loosely derived on interpretations of need, albeit that these may sometimes have been set in another time.

Figure 4.18 shows that Yarra Ranges has the highest level of availability of other open space per 1000 residents, at 9.2ha/1000, almost three times the average availability level of 3.3ha/1000 across Greater Melbourne. Cardinia (7.4ha/1000), Nillumbik (5.6ha/1000), Casey (4.8ha/1000), Brimbank (4.2ha/1000) and Mornington (3.9ha/1000) are all solidly above the average availability level and all are above the UK and Australian standard figures, most also being above the US standard.

Urban infill in LGAs towards the lower end of the range, however, needs to recognise the importance of adding to open space availability. Open space is in relatively short supply per 1000 residents in Stonnington and Glen Eira (both around 1.1ha/1000), Bayside (1.6ha/1000), Moreland and Whitehorse, both at 1.8ha/1000 residents and Boroondara (2.0ha/1000). Some 15 inner/middle urban LGAs, out of a total of 31 in Greater Melbourne, are below the indicated 2.83ha/1000 standard or benchmark, these LGAs having a total population of 2.1 million in 2016, before considering any future population increase.

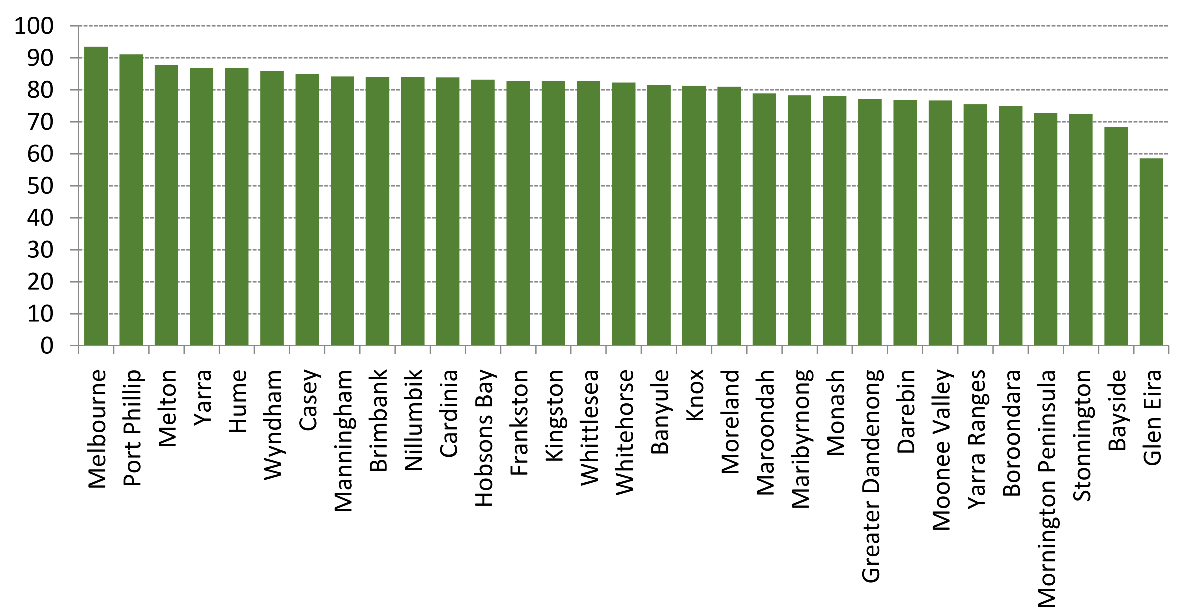
Figure 4.18: Hectares of other public open space, including parks and gardens, sports fields and organised recreation space, per 1000 residents



Source: Authors' calculations based on land use data provided by VPA.

Figure 4.19 shows the proportion of each LGA's population living within a 400 metre walk of public open space. Numbers around 80 per cent are usual, suggesting that over one million people currently lack this level of accessibility. Melbourne City and Port Phillip both exceed 90 per cent of residents within 400 metres walking distance of public open space, whereas Glen Eira is under 60 per cent. Private public space would, of course, offset this shortfall to some extent, for those who have such space. Bayside, Stonnington and Mornington Peninsula are also towards the low end of the scale. Outer urban growth municipalities tend to be in the low to mid 80 per cent range.

Figure 4.19: Population within 400m walkable distance of public open space (POS) per municipality



Source: VPA (2017), Table 11.

4.11 Social capital

Social capital has been selected as an important performance indicator group because of the growing recognition of its importance for the good functioning of people and society. An early theorist, Bourdieu (1985), defined social capital as where individuals can use membership in groups and networks to secure benefits relating to social connections and economic and cultural resources. Another important theorist, Putnam (1995), postulates that declining social capital is associated with negative economic and political consequences.

Research by the authors of this report has shown a strong statistical association between trip making (accessing activities outside the home) and improving a person's social capital and sense of community, and a reduction in the risk of social exclusion, which leads to improved self-assessed wellbeing (Stanley et al. 2012). More recently, a meta-analysis of 148 studies revealed that those people with stronger social relationships live longer, the findings being consistent across age, gender, initial health status, cause of death and follow-up period (Holt-Lunstad et al. 2010). The authors concluded that the influence of social relationships on risk for mortality is comparable with other well-established risk factors for mortality. Social capital influences not only physical health, as psychological resources conferred by social connectedness can also act as a 'social cure' for psychological ill-health, as shown in a cross-lagged panel analysis of a large longitudinal national probability sample ($N \approx 21,227$), the New Zealand Attitudes and Values Survey (Saeri 2018).

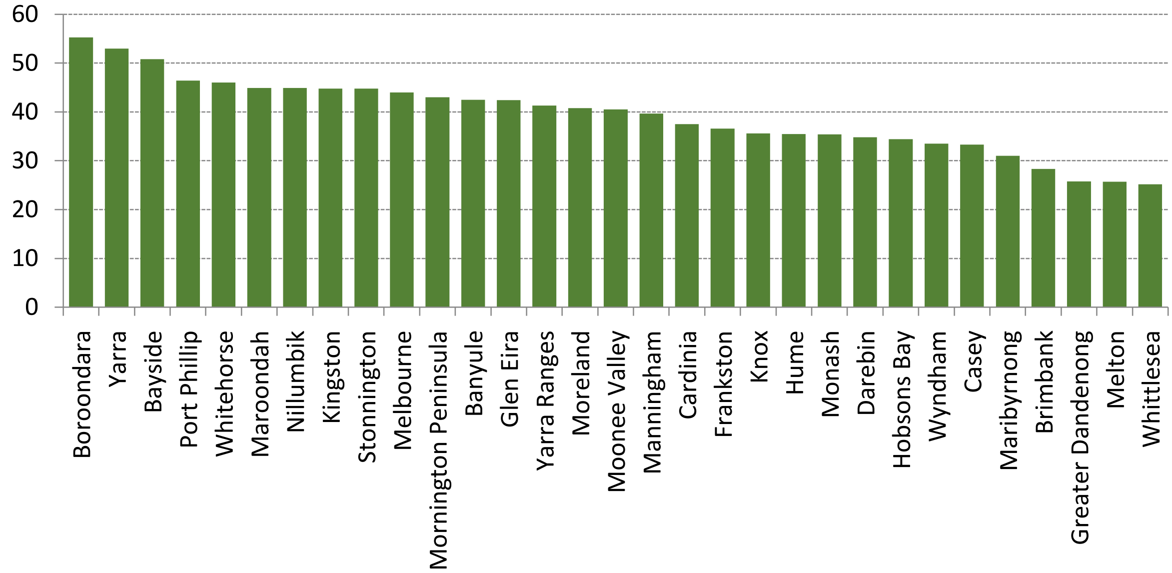
Thus, good interpersonal relationships are important for individual and family wellbeing, and community strength, as well as having links with employment opportunities and increasing the capacity of individuals, thus increasing productivity. The absence of social capital has been shown to increase the risk of poor mental and physical health and shorten a person's life span. All these factors suggest that social capital is a very important resource and should be promoted through government policy.

While the definition of social capital varies between theorists and researchers, the ideas of social interaction, mutual assistance and trust come strongly through most versions. Measures of these aspects also vary, but for this report, we have used two measures of trust and a measure of the extent and use of networks.

4.11.1 Trust other people in general (Table 3.1 indicator 10.1)

Data at LGA level on the proportion of people who agree that 'most people can be trusted' in set out in Figure 4.20, showing that the LGAs with the highest proportion of people who agree with this statement are resident in the inner/middle (north-eastern to south-eastern) urban LGAs of Boroondara, Yarra, Bayside, Port Phillip, Whitehorse, Maroondah and Nillumbik. Growth suburbs tend to occupy the lower rankings on this scale, with Whittlesea, Melton, Casey and Wyndham all being among the lowest 7 lowest ranking LGAs. Greater Dandenong, Brimbank and Maribyrnong are also at the low end of the scale.

Figure 4.20: Proportion of LGA residents who think that most people in general can be trusted



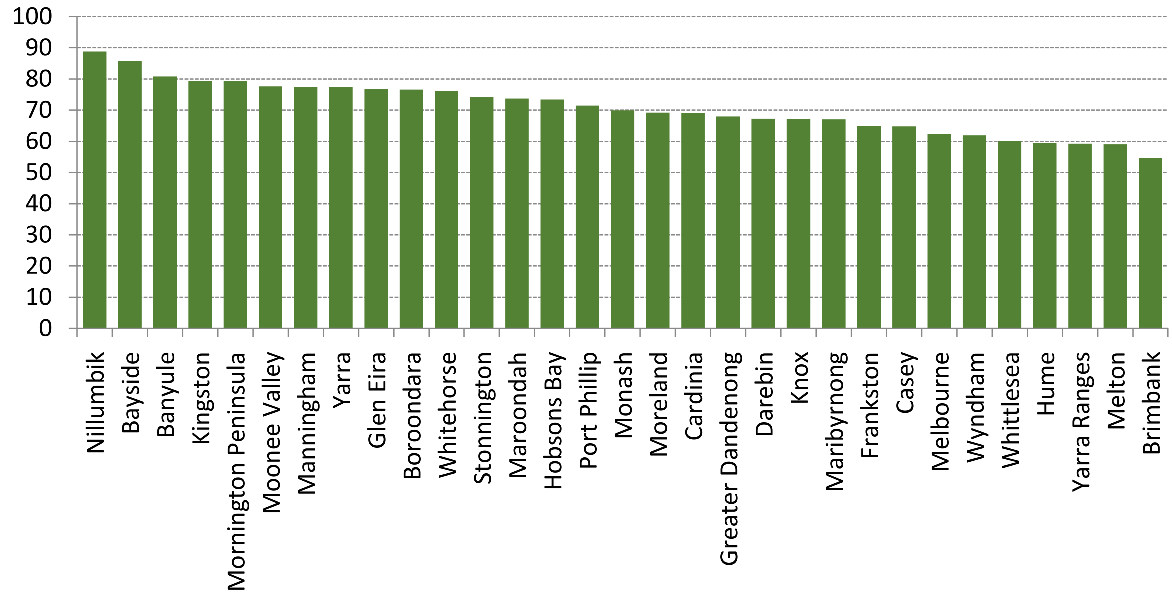
Source: Data courtesy of Low Carbon Living CRC Co-Benefits Calculator Project.

A significant correlation was found between trust of others in general at LGA level and the following variables: LGA productivity, measured as GRP per hour worked (where GRP is at market prices and equals the sum of the gross values added of all resident producers at market prices, plus taxes less subsidies on imports) (r=.544; p=.001); the proportion of those aged 15 or more who hold a bachelor's degree, or higher (r=.633; p=.000); the proportion of LGA jobs that are high tech (r=.360; p=.023); and, with an LGA's SEIFA IRSD index (r=.633; p=.000). Correlation analysis also suggests a significant negative association between trusting others at LGA level and LGA population size (r=-.379; p=.035). No significant correlation was found between an LGA's population growth rate between 2011 and 2016 and trust of others in general.

4.11.2 Trust people in the local neighbourhood (Table 3.1 indicator 10.2)

Figure 4.21 shows the proportion of people by LGA who think that most people in their neighbourhood can be trusted. The highest ranked LGAs tend to be located in middle urban Melbourne in the north to south east, with inner eastern LGAs next. Outer urban LGAs tend to be towards the low end of the rankings, with Melton, Yarra Ranges, Hume, Whittlesea, Wyndham and Casey occupying 6 of the bottom 8 places.

Figure 4.21: Proportion by LGA who agree that most people in their neighbourhood can be trusted



Source: https://www2.health.vic.gov.au/about/reporting-planning-data/gis-and-planning-products/geographical-profiles.

Trust in neighbours, at LGA level, was found to be significantly negatively correlated with an LGA's population size (r=.-.532; p=.002). Those who were more likely to trust their neighbours were also more likely to trust others (r=.689; p=.000). Given the focus of this report on population growth, a faster rate of LGA population growth was also shown to be significantly *negatively correlated* with the proportion of people in the LGA who think that most people in their neighbourhood can be trusted (r=-.501; p=.004). Faster population growth is thus likely to reduce this element of neighbourhood social capital. Multiple regression analysis suggested that LGA population, LGA population growth rate and an LGA's SEIFA IRSD index provide a good model for predicting the proportion of people who trust neighbours (together explaining 58 per cent of the variability in trust neighbours at LGA level). The model suggests that the extent to which people say that they trust people in their neighbourhood decreases with the population size of their LGA and with the rate of population growth but increases as the level of socio-economic advantage increases, all three variables being significant at a 5 per cent level or better (Table 4.7).

Table 4.7 Trust people in the neighbourhood, population growth and socioeconomic disadvantage

Coefficients[a]					
	Unstandardised coefficients		Standardised coefficients		
Model	B	Std. Error	Beta	t	Sig.
(Constant)	-5.835	24.785		-0.235	0.816
Population at 2016 census	-5.111E-5	0.000	-0.293	-2.290	0.030
Population change 2011-16 (%)	-0.245	0.103	-0.297	-2.379	0.025
SEIFA IRSD index	0.085	0.023	0.479	3.712	0.001

Note: a. Dependent Variable: Trust people in neighbourhood (%).
Source: Authors.

4.11.3 Networks (Table 3.1 indicator 10.3)

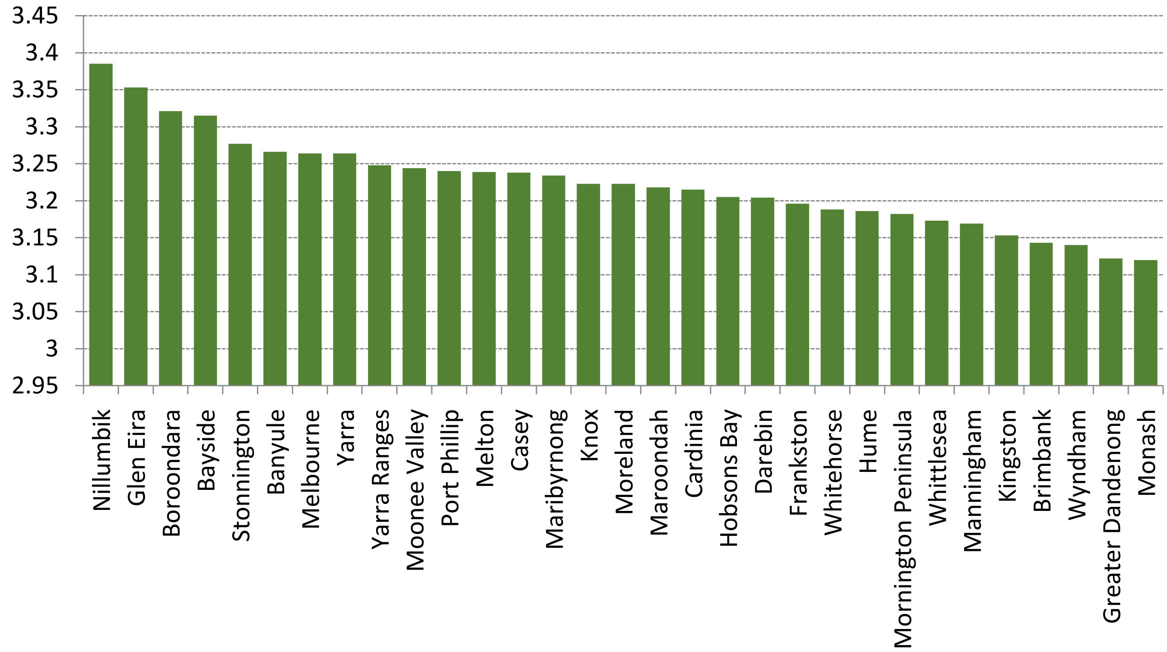
Social interaction or connectedness is critical for good physical and mental health (Cruwys et al., 2014), and those with weak social connections die earlier than those with strong social connectedness (Holt-Lunstad et al., 2010). The direction of this association has been clarified in a major New Zealand study, where a causal relationship was found where a lack of social contacts led to poor mental health (Saeri et al. 2018)

Data from the Low Carbon Living CRC Co-Benefits Calculator Project was used to rate LGAs according to the social networks of residents. Respondents answered the following question:

- How many people did you talk to yesterday?

Answers were coded as 1 to 4, where 1 = 'none at all', 2 = 'less than 5', 3 = '5 to 9'; 4 = '10 or more'. Figure 4.22 shows the ranking of LGAs according to this indicator.

Figure 4.22: Ranking of LGAs according to number of people spoken to yesterday



Source: Data courtesy of Low Carbon Living CRC Co-Benefits Calculator Project.

The highest ranked LGAs are Nillumbik, Glen Eira, Boroondara, Bayside, Stonnington and Banyule, all middle or inner urban LGAs. Lowest ranked LGAs are Monash, Greater Dandenong, Wyndham, Brimbank, Kingston, Manningham, Whittlesea and Mornington Peninsula, several of which are outer urban. Casey, Melton and Cardinia are mid-ranked.

Rankings on this indicator are significantly positively correlated with: LGA productivity (r=. 562; p=.001), feel safe walking alone down your street after dark (r=.649; p=.000), trust others (r=. 567; p=.001), trust people in the neighbourhood (r=.484; p=.006), SEIFA (IRSD) index (r=. 626; p=.000) and median house price (r=. 488; p=.005). There is a significant negative correlation with child development vulnerability (r=-.530; p=.000), population size at the 2016 census time (r=-.426; p=.017) and the proportion who live within 400 metres of public open space (r=-.311; p=.089). There is also a strong positive correlation between number of people spoken to yesterday and the proportion of residents aged over 15 who hold a bachelor degree or higher (r=.489; p=.005) and, at the 10 per cent significance level, with population density (r=.316; p=.083). The number of people spoken to yesterday by LGA residents was also negatively correlated with the LGA rate of population growth between 2011 and 2016 but this correlation was not significant.

This assessment suggests that LGAs with larger social networks and greater capacity to get help from various others when needed will tend to have higher productivity levels, higher levels of trust, higher house prices, less socio-economic disadvantage, lower levels of child developmental vulnerability and more university educated residents. A higher rate of population growth seems to be negatively associated with trust and with the likelihood of being able to get help from various others but not with the number of people with whom residents speak.

4.12 Health

Good levels of physical and mental health facilitate good personal functioning and reduce the cost burden of remedial services to society as a whole. Many of the key drivers of health reside in living and working conditions. These social determinants of health result in health inequality based on locations. Poor land use decisions and urban planning have been linked to the development of non-communicable diseases (Giles-Corti et al. 2016). The problems that arise as a result of poor planning include traffic exposure due to travel distances, thus exposure to air pollution, traffic noise, social isolation due to urban street design, safety from crime, physical inactivity, prolonged sitting and unhealthy diets due to availability and accessibility of healthy food. A key action to improve health is said to be improving urban design to achieve a more compact city that shifts from a car-based mobility to more active mobility and greater use of public transport (Stevenson et al. 2016).

This recommended action is also an important part of the story to reduce poor mental health, experienced in any one year by 20 per cent of Australians (Black Dog Institute, undated). The most common mental illnesses are depression, anxiety, and substance use disorder, illnesses that may occur together. Other less common forms of mental illness include substance abuse disorder (5 per cent in any one year), psychotic illness (3 per cent in their life-time) and eating disorder (2 per cent in their lifetime). About 54 per cent of people with mental illness do not access any treatment.

The annual cost of mental illness in Australia has been estimated at $20 billion, which includes the cost of lost productivity and labour force participation. In 2003, mental disorders were identified as the leading cause of healthy years of life lost due to disability (Mindframe, undated).

Health is included in the indicators to explore how population growth in Melbourne may be influencing health outcomes. Three health measures are used to illustrate this: obesity, cardiovascular problems and mental health.

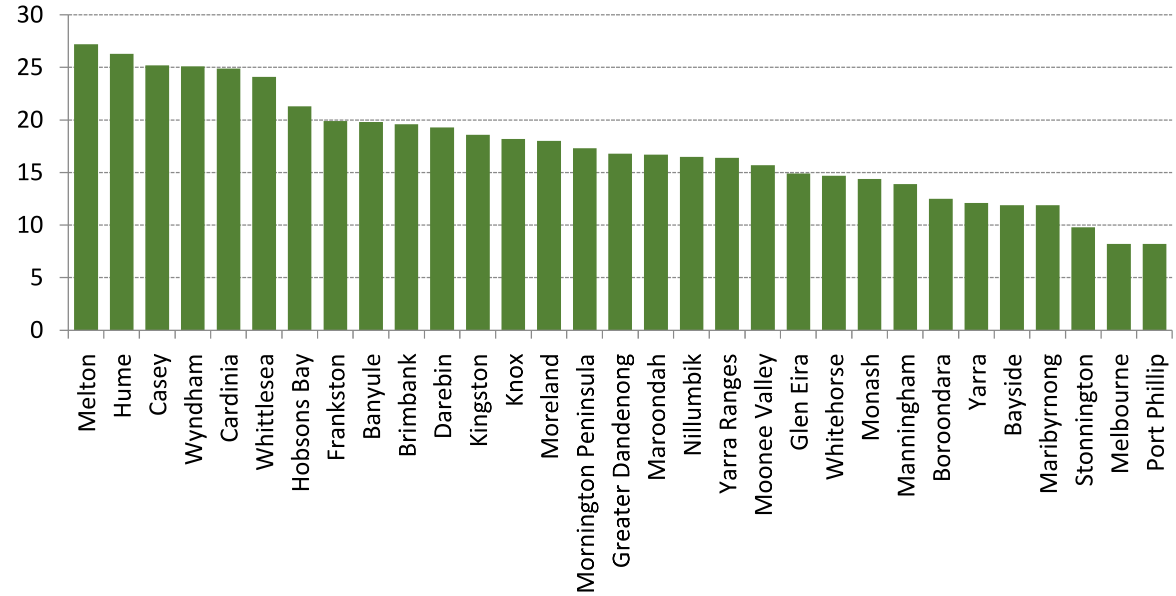
4.12.1 Obesity – Per cent reporting (Table 3.1 indicator 11.1)

Weight is commonly measured using the Body Mass Index (BMI), derived from a person's weight in kilograms divided by the square of their height in meters. A BMI between 18.5 and 25 is considered normal. A BMI between 25.0 and <30 is viewed as overweight and a BMI of 30.0 or higher is considered to be in the obese range.

In 2014-15, 63.3 per cent of Victorians were overweight or obese (ABS 2014-15). Those living in regional and remote areas and those highly disadvantaged were more likely to be overweight and obese, as were those with an English speaking background and those employed.

Across Melbourne, the highest percentages of the population reporting obesity tend to be found in the outer suburbs, with Melton, Hume, Casey, Wyndham and Cardinia filling the top 5 positions (Figure 4.23). High reliance on cars for mobility seems likely to be a contributor to this result. While correlation should not be confused with causation, the high correlation between obesity reporting and car use for the journey to work (r=.728; p=.000), commutes longer than 2 hours (r=.623; p=.000) and travel time to Melbourne (r=.668; p=.000) are suggestive that car dependence in the outer suburbs may be a contributory factor in the obesity reporting outcomes. Inner urban LGAs occupy the lower end of the obesity reporting scale, with Port Phillip, Melbourne, Stonnington, Maribyrnong and Bayside having the 5 lowest rates. Availability of open space, both natural and recreational, is not significantly correlated with obesity, since the LGAs with the higher rates of obesity reporting tend to be outer areas where open space availability is greatest. In other words, this open space availability is not enough to counter other influences that lead to more obesity reporting in such locations, such as travel habits. The role of diet is also likely to be very important but is beyond the scope of the present report.

Figure 4.23: People reporting obesity, by LGA (%)



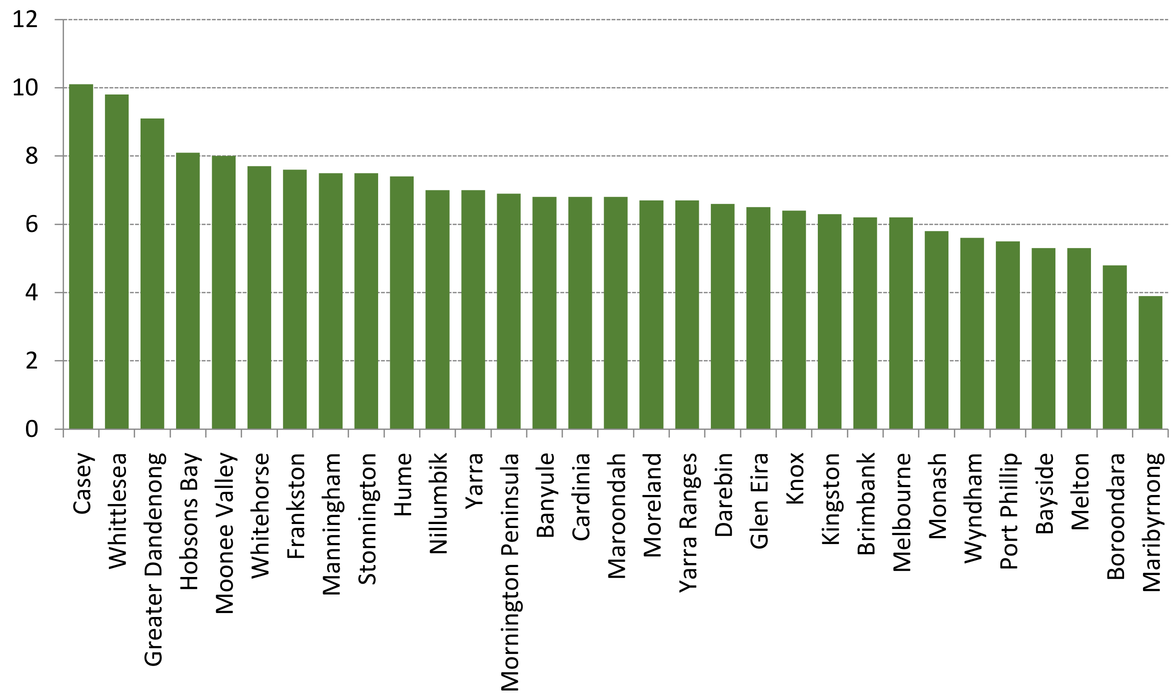
Source: https://www2.health.vic.gov.au/about/reporting-planning-data/gis-and-planning-products/geographical-profiles).

4.12.2 Cardiovascular disease: Per cent reporting (Table 3.1 indicator 11.2)

Cardiovascular disease refers to all diseases and conditions involving the heart and blood vessels. The main types of cardiovascular disease in Australia are coronary heart disease, stroke and heart failure/cardiomyopathy. Cardiovascular disease accounted for nearly 28 per cent of all deaths in Australian in 2016, also accounting for 490,000 hospitalisations in 2014/15. In 2012/13 the associated cost amounted to $5billion or 11.1 per cent of total health expenditure related to hospital admissions– the largest share of health expenditure of any disease group (AIHW 2017). There is thus a heavy cost burden for this disease, which also accounted for 17 per cent of the total burden of disease in 2017, the largest single contributor (Alston et al. 2017). Higher rates of hospitalisation and death for this disease occur for people in lower socio-economic groups, Aboriginal and Torres Strait Islander peoples, and those living in regional and remote areas (ABS 2016b).

Table 4.24 shows that the three highest reporting rates for cardio matters in Melbourne are found in outer suburbs (Casey, Whittlesea and Greater Dandenong) but Melton and Wyndham are towards the bottom of the range. This may suggest that location is not a factor in this indicator but the correlation between reporting of heart disease and travel time from Melbourne is significant at the 10 per cent level (r=.326; p=.073), suggesting outer suburban residents are somewhat more likely to be higher reporters than their inner urban counterparts. The correlation between reporting of heart disease and car use for the journey to work is also significant at the 10 per cent level (r=.302; p=.099), whereas that between reporting heart disease and public transport use for the journey to work is negative and also significant at the 10 per cent level (r=-.310; p=.090). The data on both obesity and heart disease reporting are thus both suggestive that high rates of growth in outer urban areas will tend to increase reporting of obesity and heart problems.

Figure 4.24: People reporting heart disease, by LGA (%)

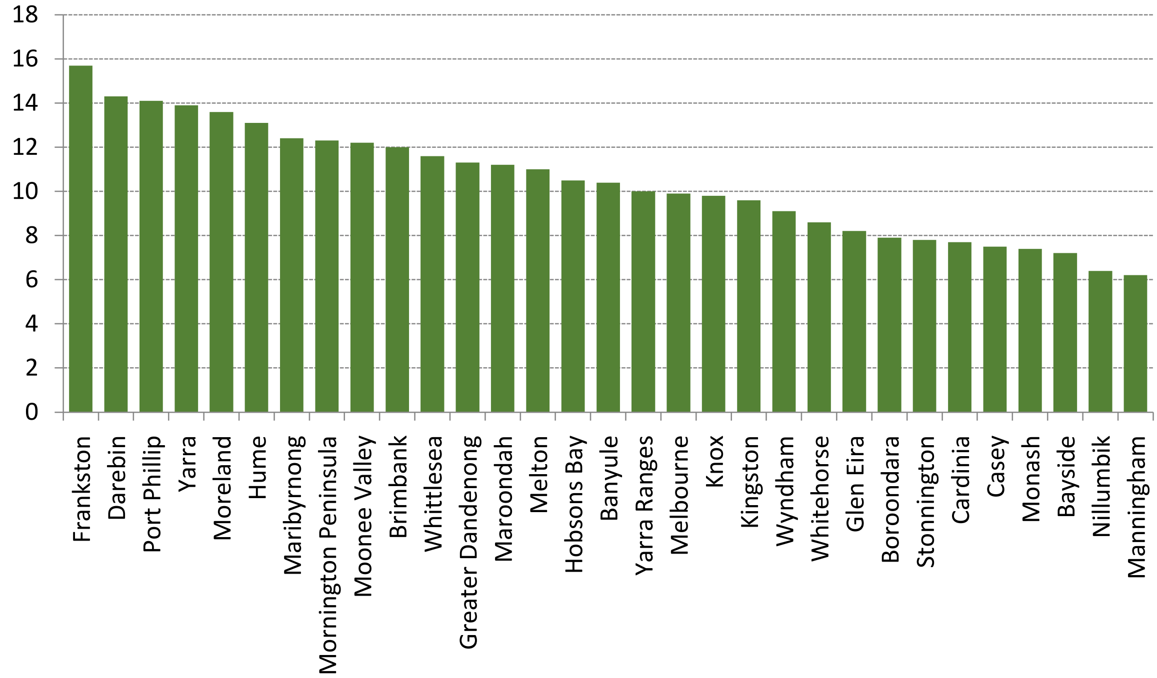


Source: https://www2.health.vic.gov.au/about/reporting-planning-data/gis-and-planning-products/geographical-profiles).

4.12.3 Mental health – registered clients per 1000 population (Table 3.1 indicator 11.3)

The Greater Melbourne LGAs with the highest number of registered mental health clients per 1000 population are Frankston, Darebin, Port Phillip, Yarra and Moreland, while the lowest rates are in Manningham, Nillumbik, Bayside and Monash and Casey (Figure 4.25). Areas that have the highest rates of registered mental health clients per 1000 population tend to be areas with low SEIFA IRSD ratings (r=.-0.565; p=.001). These are also areas where people have a lower level of trust in their neighbours (r=-0.363; p=.045). There is no significant correlation between mental health clients per 1000 population and distance or travel time from Melbourne or with the rate of population growth.

Figure 4.25: Registered mental health clients per 1,000 population



Source: https://www2.health.vic.gov.au/about/reporting-planning-data/gis-and-planning-products/geographical-profiles).

4.13 Some spatial correlations

A number of the variables for which data was assembled at LGA level show quite strong spatial associations, particularly with respect to differences in travel time to (central) Melbourne (which is highly correlated with distance to Melbourne). For example, at a 10 per cent level of significance or better, as travel times from an LGA to central Melbourne increases, population densities (r=-.827; p=.000) and job densities decrease (r=-.565; p=.001), median house prices decline (r=-.635; p=.000) and open space per resident increases (r=.536; p=.002) but:

- capital stock per person declines (r=-.376; p=.037), the proportion of higher educated people declines (r=-.873; p=.000), the proportion of jobs that are high-tech declines (r=-.648; p=.000) and LGA productivity declines (r=-.399; p=.026);
- trust in others declines (r=-.351; p=.053);
- the proportion of people living near public transport declines (r=-.802; p=.000) and public transport use for the journey to work also declines (r=-.893; p=.000);
- car use increases for the journey to work (r=.807; p=.000) and the proportion of commutes that are longer than 2 hours increases (r=.586; p=.001); and
- reports of heart disease increase (r=.326; p=.073) and so do reports of obesity (r=.668; p=.000).

These associations suggest that cheaper housing and better access to open space, which may attract people to outer suburban living, comes at a price, commonly associated with the lower population and job densities at greater distances from central Melbourne. With such a high proportion of population growth still happening on the fringe, these associations should sound warning bells. They are one reason why the Ministerial Advisory Committee on Plan Melbourne Refresh, of which one of the current authors was a member, recommended minimum densities of 25 dwellings per hectare for new fringe development, well above current density levels but in line with new greenfield standards in Toronto (for example).

Some other notable associations, some of which link to those noted above, include the following:

- higher LGA productivity levels are associated with higher population and job densities (r=.469; p=.008 and r=.375, p=.038 respectively), stronger social networks (r=.361; p=.046), higher levels of trust (r=.544; p=.002), people feeling safer on streets alone (r=.605; p=.000) and lower levels of child vulnerability (r=-.507; p=.004);
- higher population densities are associated with higher productivity (r=.469; p=.008), people feeling safer on streets alone (r=.425;p=.017) and being more trusting of others (r=.512; p=.003), a smaller proportion of commutes that are longer than 2 hours (r=.731; p=.000), less people reporting to doctors for obesity (r=.759; p=.000) and a lower percentage of children who are vulnerable on one or more domains (r=-.341; p=.061); and
- higher job densities are associated with higher productivity (r=.375; p=.038), people feeling safer on streets alone (r=.323; p=.076), people trusting others more (r=.394; p=.097) (although these safety and trust associations are not as strong as for population density), smaller proportions of people having commutes of 2 hours or more (r=-.051; p=.004), smaller numbers reporting obesity (r=-.396; p=.001),and a higher proportion of people within 400 metres walk of open space (r=.353; p=.052).

In light of these results, there must be serious questions marks about an urban growth pattern that finds 57.5 per cent of population growth occurring in Melbourne's outer suburbs (as defined in this report), as occurred between 2011 and 2016.

5. Some recent projections of future infrastructure and service needs

5.1 Scope

This section of the report summarises estimates of Melbourne infrastructure and service condition and future needs that have been recently presented by Infrastructure Australia (2018) and Infrastructure Victoria (2016). The resources available to these organisations and quality of their work demands that their findings be considered as part of the current analysis.

5.2 Infrastructure Australia

IA (2018) explores three future land use development scenarios for Melbourne and how these might impact a range of societal outcomes. All scenarios start from the assumption that, in 2046, Melbourne will have a population of 7.3 million (+2.8m on 2015), with 3.9 million jobs (+1.6m from 2015) and that the location of existing population and employment does not change between the three alternative development scenarios. The three scenarios are:

1. the **Expanded Low Density scenario** – where 40 per cent of the population growth is located in greenfield outer urban growth areas, focussed in the western, northern and southern subregions, the highest proportion of outer area growth of the three but still below the share of growth that was located in outer areas between 2011 and 2016. Remaining growth is distributed around established areas, focussed on existing centres and transport hubs, with higher density in places like Fisherman's Bend. This scenario retains the main elements of the current economic structure, with the outer growth areas attracting population-serving jobs but other jobs tending to centralise;
2. the **Centralised High Density scenario** – population and employment growth is mainly located within 15 kms of the centre, along tram and train routes. 80 per cent of population growth is in existing areas, new housing mainly being in centres along existing PT routes. Employment growth is mainly focussed in the inner city; and
3. the **Rebalanced Medium Density scenario** – this scenario reflects some of the employment cluster focus of Plan Melbourne, with job growth being closer to population growth. 70 per cent of population growth is within established areas, loaded more heavily towards infill development in the west. The remaining 30 per cent is assumed to be primarily low-density greenfield development, primarily in the west, north-west and north.

A number of major transport network improvements are built into each scenario, most being common to all but with some relatively small differences. For example, the low-density development scenario includes some outer south-eastern transport improvements (mainly road) that are not in the other scenarios, which focus growth away from the east/south. Some of IA's (2018) main conclusions (in italics) from its scenario analysis, of relevance to the current report, are summarised below, with Table 5.1 summarising the main differences between the three scenarios and relative to the 2015/16 base year.

Under all scenarios, private vehicle use and road congestion increase (IA 2018A, p. 38), even after substantial additions to the road network. The Rebalanced Medium Density scenario is the least congested and Centralised High Density scenario the most congested. However, as Levine et al. (2012) have shown, increased congestion under higher density settlement patterns need not necessarily imply poorer accessibility. Projected VKMs are highest under the Expanded Low Density scenario. These VKT relativities, associated with varying land use development patterns, broadly mirror those identified in our analysis in Section 6.3 below, when discussing future congestion growth in Melbourne.

The public transport network is used most efficiently when population and employment are increased in inner-Melbourne (IA 2018A, p. 40). The rail network, with infrastructure additions included, has the lowest relative congestion levels under this scenario but the tram network is most congested under this scenario. The development scenarios that load most growth in the west need additional supportive PT infrastructure and service.

Expanded public transport networks and increased inner-city densities result in better accessibility outcomes for Melbourne (IA 2018A, p. 44). The IA analysis shows that the proportion of jobs accessible within 60 minutes by PT increases from a low 24.5 per cent in 2015 to a marginally higher 25.2-28.9 per cent in 2046, with the highest proportion in that year being for the Centralised High Density Development scenario. However, the IA analysis shows that the per cent of jobs accessible within 30 minutes by car or PT does not improve to any appreciable extent by 2046, as compared to 2015. Also, the per cent of jobs accessible by car within 60 minutes falls by about 10 percentage points under each scenario, as compared to 2015. Thus whilst PT job accessibility might be better under the increased inner density development scenario than under the other two scenarios, all three scenarios remain relatively poor for PT in 2046 and car accessibility deteriorates over the period, against the 60 minute benchmark. In short, 30 years of continuing high population growth is not good news for access to jobs, even after the considerable transport investment embedded in each scenario.

The spatial distribution of jobs remains unequal across all scenarios (IA 2018A, p. 45). IA's analysis suggests that the sprawl scenario (Low Density scenario) has the lowest aggregate accessibility scores of the three scenarios but improves access in the west and southeast.

Suburban employment centres can improve accessibility, particularly for drivers (IA 2018A, p. 46). Developing jobs centres in the west, under the Rebalanced Medium Density scenario, would support more equitable outcomes in terms of an employment accessibility criterion. This is in line with the thinking that led to Melbourne's National Employment and Innovation Clusters.

Environmental performance of the transport network is strongest under a centralised city structure (IA 2018A, p. 48). This is the weakest section of the IA work, since it makes the extreme assumption that fuel efficiency over time does not change, which is untenable in light of Australia's climate change commitments. The differences between the three scenarios are minimal, reflecting car VKT differences, with the Centralised High Density scenario having the lowest VKT and hence lowest CO2 emissions.

Across all three scenarios, access to existing hospitals declines, particularly in the outer suburbs (IA 2018A, p. 48). This conclusion is not surprising, since IA assumes no new social infrastructure.

Demand for hospitals increases in all scenarios and is particularly strong in the northern and western suburbs (IA 2018A p. 49). This again reflects assumptions about the distribution of population growth, juxtaposed against no increase in social infrastructure spending. The IA conclusion is pretty obvious: *These results illustrate the need to deliver adequate infrastructure to support the needs of communities as they grow* (IA 2018A, p. 50).

Across all scenarios, demand for schools increases substantially which demonstrates the need for integrated planning for new and upgraded facilities (IA 2018A, p.50). The Centralised High Density scenario provides the highest level of access and distributes demand most efficiently for tertiary education (IA 2018A p.52).

Across all scenarios access to green space decreases significantly for outer growth areas (IA 2018A, p. 55) and Demand for green space increases for all areas across all scenarios, most significantly in inner-city and outer growth areas (IA 2018A, p. 56). These conclusions are important, since they draw attention to the important role played by access to green space for sustaining Melbourne's liveability. Our own analysis in Section 4.10 suggests that current levels of access to natural areas and public open space are generally relatively high in outer areas, which may reduce pressures of further growth, but low in inner areas. The increasing focus on a more compact city inevitably puts pressure on public access to scarce green space in existing built-up areas, where costs of land provision are high and innovative alternatives are increasingly being pursued for green open space (e.g. green roofs).

Table 5.1 Infrastructure Australia scenario results for Melbourne (2046)

Key statistics	Reference case (2015/16)	Expanded low density	Centralised high density	Rebalanced medium density
Transport performance				
Road congestion	5%	7%	9%	**6%**
PT mode share	14%	21%	**22%**	21%
Access to jobs in 30 minutes				
Car	22%	18%	17%	**18%**
PT	2%	3%	**4%**	3%
Access to jobs in 60 minutes				
Car	64%	53%	53%	**54%**
PT	24%	25%	**29%**	26%
Access to hospitals				
% of population with access	87%	78%	**82%**	80%
Access to schools				
% of population with access	95%	86%	**90%**	87%
Access to green space				
% of population with access	38%	31%	**33%**	32%

Source: IA (2018b), p. 7.

In addition to a range of proposal related to urban governance and planning practices, the main recommendations of the IA (2018a, b) report relate to governments:

- using existing infrastructure more efficiently;
- increasing investment in mass transit and ensuring it is accessible;
- introducing a road user charging scheme for heavy and light vehicles (as part of demand management strategies);
- adopting a more place-based approach to planning and delivering infrastructure;
- promoting development of employment centres well serviced by PT;
- improving access to jobs, health services, education and green space; and
- reducing GHG emissions, in line with national commitments, while increasing resilience to climate change.

These conclusions accord with our own. The IA report does not, however, explore the extent to which slowing population growth and/or an accelerated program of regional growth might reduce some of the costs of rapid growth in Melbourne (or Sydney).

5.3 Infrastructure Victoria

Infrastructure Victoria is the state government's independent adviser on infrastructure needs. IV's most comprehensive such advice is set out in its report on a 30 year infrastructure strategy (Infrastructure Victoria 2016). Transport forms a major focus of that strategy, the findings on transport priorities drawing inter alia on detailed analysis undertaken for IV by KPMG Arup Jacobs (2016). Stanley and Brain (2016) also advised IV on that strategy, particularly with respect to National Employment Clusters. Some of the base data and future projections that underpinned this work are relevant to the current study.

IV (2016) works from a 2046 projection that Victoria's population at that time will be almost 9.5 million and KPMG Arup Jacobs (2016) suggests a Melbourne population of 7.2 million at that time (from a base of 4.1 million in 2011 and with a 2031 projection of 5.9 million).

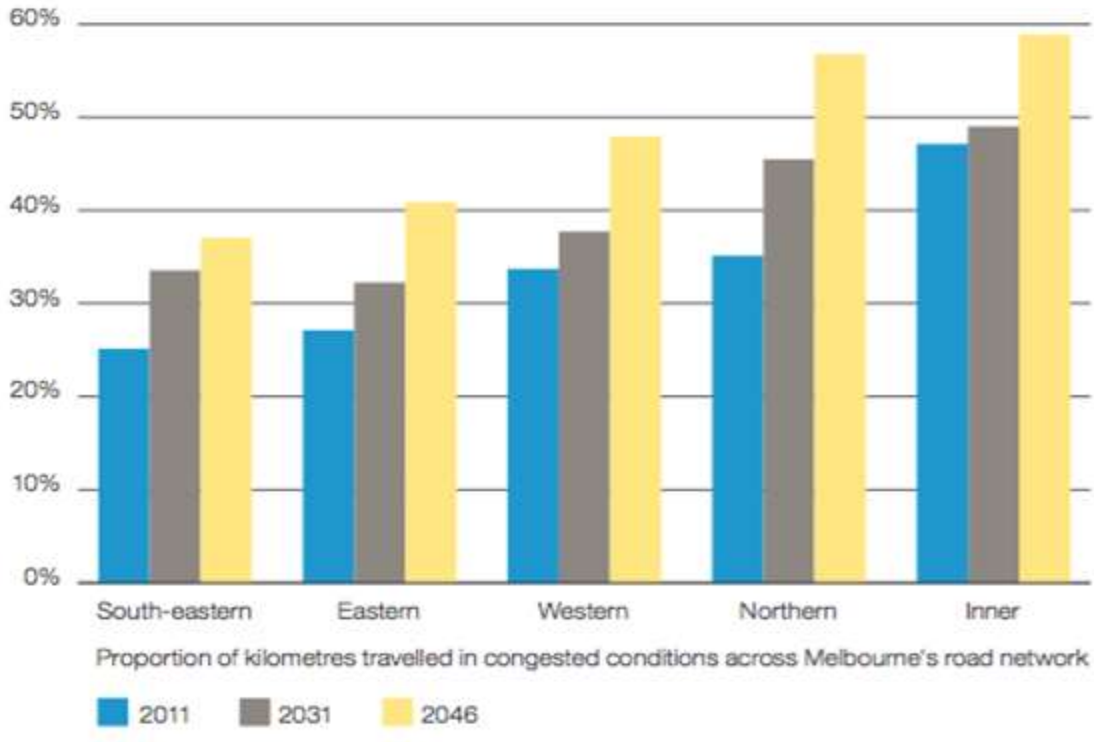
In terms of assessing transport project and policy options, IV defines a future base or reference case, against which major improvement options are compared. The base case includes projects such as Western Ring Road upgrade, Western Distributor, level crossing removal, Mordialloc Bypass, Westall Rd extension, Monash and Calder Freeway upgrades, bus network enhancements, 10 car trains operating on Melbourne Metro, Melton electrification and high capacity rail signalling on some lines.

Figure 5.1 shows that traffic congestion is projected to worsen to 2031 and 2046 on all segments of the road network under the base case, despite the major spend on roads, with the inner, northern and western areas having the worst projected congestion levels throughout. Various major road and rail network improvements are assessed against this case, as are major transport technological changes (e.g., autonomous vehicles, network traffic management) and road pricing options (cordon and distance-based pricing), together with packages of such options (see KPMG Arup Jacobs 2016 for details). IV's main conclusion from this assessment process is that (IV 2016, p.32):

> *"… if we had to nominate the top three most important actions for government to take in the short to medium term, we would choose:*
>
> 1. *Increasing densities in established areas and around employment centres to make better use of existing infrastructure.*
> 2. *Introducing a comprehensive and fair transport network pricing regime to manage demands on the network.*
> 3. *Investing in social housing and other forms of affordable housing for vulnerable Victorians to significantly increase supply*."

Major transport projects, per se, are seen against the land use and pricing contexts within which they operate, which is a significant statement in terms of effective transport strategy ('doing the right things'). However, network pricing remains a political no-no.

Figure 5.1: Projected congestion on Melbourne's road network



Source: V 2016, sourced from KPMG Arup Jacobs 2016.

Specific transport infrastructure projects, beyond those included in the base case, to ease road traffic congestion and/or contribute to achievement of other objectives set by IV are listed in Table 5.2. It should be noted that some of the projects listed are variants of the same project, so the totals cannot be added. Also, IV has not recommended that some of the projects listed should be priorities for government (e.g., Rowville and Doncaster Heavy Rail). Nonetheless, the projects listed suggest a capital pipeline of $40-70b, beyond the cost of the significant projects already embedded in the base case (e.g. Melbourne Metro 1). Rail rolling stock requirements add a billion dollars or so (unescalated) to this total and additional operating plus maintenance costs a further few hundreds of millions of annual dollars. Adding these costs, without double counting North East Link, suggests a current total transport infrastructure pipeline approaching $100b. The recently announced costs for the North East Link, at $16.5b, add $10b to the upper project cost estimate for this project shown in Table 5.2. This suggests that the final costs for projects like those in the table, once delivered, could be much higher than indicated.

Table 5.2	Infrastructure projects and capital costs as considered by Infrastructure Victoria: 2016 prices, unescalated	
Project	**Lower project costs**	**Upper project costs**
Eastern Freeway to CityLink Connection (inc. dependent infrastructure upgrades)	$6.337b	$8.238b
Eastern Freeway to CityLink Connection (without dependent projects)	$6.031b	$7.840b
North East Link (inc. dependent infrastructure upgrades)	$4.572	$6.858b
North East Link (without dependent projects)	$4.373b	$6.560b
Outer Metropolitan Ring Road	$8.689b	$13.033b
City Loop Reconfiguration (with Wallen electrification)	$3.148b	$4.911b
Melbourne Metro 2	$13.871b	$20.806b
Melbourne Airport Heavy Rail Link	$2.102b	$3.153b
Doncaster Hill Heavy Rail Line	$2.590b	3.885b
Rowville Heavy Rail Line	$4.849b	$7.795b
City Loop Reconfiguration (without Wallen electrification)	$1.789b	$2.832b
Melbourne Metro 2 (Newport to Parkville only)	$8.448b	$12.672b

Source: KPMG Arup Jacobs 2016.

5.4 Comment

Both the IA analysis and IV's work recognise the importance of close land use transport integration and the pursuit of a more compact settlement pattern in Melbourne if the strains of population growth are to be managed; however, many externalities are not included in the report. Neither follow this through in a comprehensive way to propose integrated packages of measures to deal with the problems they identify, both concentrating on major infrastructure projects to the exclusion of packages of integrated small measures (e.g. place-making), which may have an equally beneficial or better impact in triple bottom line terms. While these opportunities are recognised they are not followed through to concrete proposals to bridge the land use/transport integration gap.

The current lack of a published transport strategy for Melbourne is a major concern in this regard. Both of the State's major political parties seem to have confused a series of major transport projects with a transport strategy. Preparation of a long term transport strategy, to complement *Plan Melbourne 2017-2050*, should be a high priority for Melbourne and Victoria. Rectifying the lack of a transport focus on developing population and job opportunities in middle Melbourne, including the NEICs, and on delivering 20 minute neighbourhoods should form a major focus of this strategy, given the analysis of Section 4 of this report.

IA and IV both recognise the importance of massive infrastructure investment, particularly in land transport, in coming years, and of the difficulty of containing road congestion costs. Both also understand that reforming road pricing, to achieve more efficient use of the existing transport infrastructure base and provide better signals for network change, is also a key mechanism to manage network congestion. Pricing reform provides an opportunity to better link land use and transport decision making, since it will (inter alia) reduce the encouragement of further urban sprawl that is provided by the construction of new, or widening of existing, urban freeways. In the absence of road pricing reform, which currently has no support at a political level in Victoria, the massive catch-up investment program that is taking place on major roads will quickly become a driver of further urban sprawl and increased long term congestion, not the congestion-busting panacea that proponents contend (see Duranton and Taylor 2011), while compounding environmental and social costs.

Finally, neither IA nor IV directly questions the rate of Melbourne's population growth. It might be argued, however, that the kind of assessments that their respective work embodies is a necessary precursor to asking such questions. The current report is a contribution to this discussion.

6. Population growth: The economic impact

6.1 Introduction

The debate around the role of population growth in driving economic growth focuses on the overseas migration component of population growth. The views of the proponents for high immigrants range from the non-economic perspective that Australia requires a high immigration rate to enhance its relative standing and security in the world geo-political structure (which played an important role in the 1950s and 1960s in justifying high immigration), to the economic argument that high immigration allows a higher growth in GDP per capita because it allows the capture of high productivity growth from greater economies of scale and scope. Indeed, one of authors of this study in P.J. Brain, et. al. "*Population, Immigration and the Australian Economy*", Croom Helm, London, 1979, argued that high migration rates did allow high per capita GDP growth because of the unlocking of economies of scale and scope. The argument was qualified in that high immigration rates were a necessary but not sufficient condition for higher per capita economic growth. Other policy instruments had to be used to ensure that higher per capita GDP growth rates were to be achieved compared to the low immigration alternatives. Particularly important in this regard was industry development policies and exchange rate policy to ensure that the capital stock is installed to allow the increase in the available workforce to be employed at its potential productivity level.

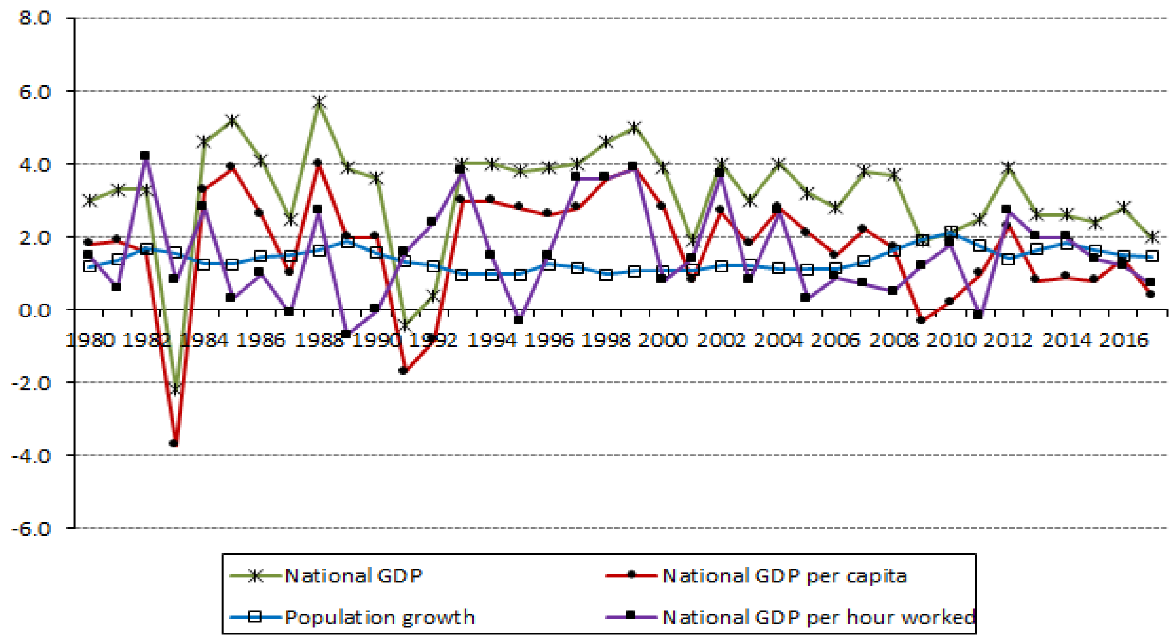
In recent years the rate of Australia's productivity growth and per capita GDP growth has declined. Indeed, the evidence from Figure 6.1 appears to indicate, at the national level, that there is an inverse relationship between population growth and economic growth. Between 1980 and 2000 the average GDP per capita growth rate was 2.01 per cent per annum while the average population growth was 1.31 per cent per annum. Over the same period the GDP per hour worked average annual growth rate was 1.74 per cent per annum. Over the 2000 to 2017 period the average annual growth rate in GDP per capital fell to 1.4 per cent per annum while the population average annual increased to 1.45 per cent per annum. The average annual growth rate in GDP per hour worked fell to 1.37 per cent per annum.

However, no definitive conclusions can be drawn from this analysis as the issue of what would have been the alternative outcome if population growth had been lower would need to be addressed. That is, in terms of the counterfactual, if the population growth had been lower would per capita GDP growth and productivity growth also have also been lower.

It is almost impossible to answer this question without a regional analysis. A regional analysis allows enable the identification of those regions where the increase in the population in general and the increase in the working age population in particular, that is, those aged 18 to 64, has not been employed at the potential indicated by the outcome levels prevailing in nearby regions.

The case study for this analysis will be the Victorian Local Government Areas (LGAs) in general, and the Melbourne metropolitan region LGAs in particular.

Figure 6.1: Australia – Productivity and per capita GDP growth



6.2 Estimates of population not productively engaged: Melbourne Metropolitan LGA – 1992 to 2017

A region will have a segment of its population that is not fully exploiting its economic potential if:

(i) Its income from economic activity is below benchmarks prevailing in nearby regions; and

(ii) Its income from economic activity is declining relative to the benchmarks achieved in nearby regions.

6.2.1 Resident gross regional product

In the NIEIR regional data base the variable which best represents the ability of residents to claim income from economic activity is resident gross regional product. Resident gross regional product is:

(i) total wage and salary income received by residents no matter from what region the work effort takes place;

(ii) mixed income from businesses;

(iii) distribution from value added in the form of interest and dividends received by residents irrespective of the jurisdiction that the value added is generated; and

(iv) imputed rental income.

All values are for fiscal years ending expressed in terms of chain volume measures (cvm), that is, in terms of 2015-16 prices.

The core measure for the analysis of this report is resident gross product divided by working age population. If this measure is low and declining it's an indication that there is a significant proportion of the population that has limited attachment to the workforce (unemployed, out of workforce or casual employment) and only has the capacity to secure employment at low $ per hour rates.

6.2.2 Victorian Local Government Areas: Changes in the distribution of income from economic activity

Table 6.1 shows, for 1992 and 2017, the resident gross product per capita of LGA working age population expressed as a ratio to the Victorian average.

The overall impression is one of increasing inequality in the distribution of income from economic activity. The Melbourne region inner and middle LGAs generally had high resident gross product per working age population compared to the Victorian average in 1992 and, in the main, either increased the ratio to the Victorian average by 2017 or produced an outcome close to the initial position, as indicated by the outcomes for the LGAs of Banyule, Bayside, Boroondara, Glen Eira, Hobsons Bay, Kingston, Manningham, Monash, Moonee Valley, Moreland, Port Phillip, Stonningham, Whitehorse and Yarra. These LGAs make up 75 per cent of Victorian LGAs with a resident gross product working age per capita population greater than the Victorian average in 2017. Half of the above listed LGAs were above the Victorian average in 1992 and in general increased their outcomes compared to the Victorian average. Bayside increased its ratio compared to the Victorian average from 60 per cent above to 89 per cent above, while Boroondara went from 57 per cent to 61 per cent between 1992 and 2017.

The inner and middle Melbourne region LGAs which in 2017 had a higher ratio than the Victorian average but not in 1992 displaced outer Melbourne region LGAs, or non-metropolitan regions, which in 1992 had a per capita resident gross product value greater than the State average.

Wyndham has gone from a per capita resident gross product in 1992, which was 13 per cent above the Victorian average, to being 18 per cent below. There is a similar outcome in Casey and Melton. Non-metropolitan LGAs which have gone from above the Victorian average in 1992 to significantly below the Victorian average in 2017 include Wellington, West Wimmera, Swan Hill, South Gippsland, Moyne, Loddon and Corangamite.

The overall outcome is one of a significant increase in the capture of Victorian economic activity in the inner and middle LGAs of the Melbourne region. Collectively the 14 inner and middle Melbourne region LGAs listed above captured 41.4 per cent of total Victorian resident gross product in 1991 compared to 40.4 per cent in 2018. However, because of lower population growth the average ratio of the 14 LGAs of the Victorian average working age per capita resident gross product increased from 13 per cent above in 1992 to 27 per cent above in 2017.

Indeed, the evidence for metropolitan LGAs is that there is a clear inverse relationship between population growth and per capita income growth. Figure 6.2 for metropolitan LGAs plots the relationship between the 1992 to 2017 change in the resident gross product per capita of working age population as a per cent above or below the Victorian average and the annual average growth rate in the working age population. For example, from Table 6.1, for Casey the change in the per capita resident gross product relative to the mean is -36 per cent, or -21 minus 15. The working age population growth for Casey was 4.2 per cent per annum.

Figure 6.2 indicates that up to an increase of around 2 per cent in the working age population growth there is no relationship between population growth and the change in the per capita resident gross product, relative to the mean. However, after a 2 per cent per annum working age population growth there is a clear inverse relationship. From Figure 6.2, there are seven metropolitan LGAs with a population growth of 3 per cent or more. They are Cardinia, Casey, Hume, Melbourne, Melton, Whittlesea and Wyndham. These are the LGAs of interest for this study. The case of Melbourne can be ignored because of its relatively poor economic performance which can be explained by the influence of the 20 to 24 age group for educational purposes.

For the six LGAs of interest the implication is that population growth above 2 per cent per annum for the 1992 to 2017 period was largely "surplus to requirements". By "surplus of population" is meant part of the population did not, prima facie, appear to capture significant economic benefits from economic activity. That is, after the initial construction impact of population growth, Victoria's economic activity would have been largely, unaffected if they were not there. From Table 6.2, this suggests a surplus of working age population of 319,000 and, by applying the LGA population to working age population ratio the total population surplus to requirements is 505,000.

This estimate only focuses on the six extreme LGAs. There are other LGAs in Table 6.1 where there is clearly an element of surplus population. Taking this into account, a reasonable estimate of metropolitan Melbourne surplus population would be of the order of 800,000 in 2017 or a Metropolitan excess working age population of approximately 500,000.

The importance of the 800,000 population surplus to requirements, that is, not significantly economically engaged, would imply that the Australian population annual growth rate could have been 1.3 per cent per annum over the period 1992 to 2017 instead of 1.4 per cent, with little impact on the growth of GDP per capita or GDP per hour worked. This would be reduced towards a 1.2 per cent or below population growth if a similar analysis for other States revealed similar pockets of surplus population.

For non-metropolitan LGAs the evidence is the reverse of what is the case for the metropolitan LGAs. As Figure 6.3 indicates, the evidence is that the higher the growth in working age population, the greater the improvement in per capita resident gross product as a per cent of the Victorian average. This is particularly the case where the working age population growth is negative or low.

The question that stands out from this analysis is how much better off would the Victorian economy have been if the 319,000 working age population increase in the six fringe metropolitan LGAs had distributed to non-metropolitan LGAs. This is the question for Stage Two of this study.

The next question to be addressed is what could have been done over the 1992 to 2017 period to ensure that an outcome for the 319,000 working age population in the six LGAs would have been closer to the national average outcome.

The next step is to estimate the resources that, if applied over the 1992 to 2017 period, would have rendered the identified surplus working age population fully productive.

Figure 6.2: Metropolitan Melbourne: Change in deviation of resident gross product per capita of working age population and average annual working age population growth

Figure 6.3: Change in deviation of resident gross product per capita of working age population and average annual working age population growth – NON-METROPOLITAN

Table 6.1	Resident gross product per capita of working age population and working age population growth (per cent deviation from State average)				
	Resident gross product per capita of working age population (% of Victorian average)		Average annual growth in working age population (%)	Catchment resident gross product per capita of working age population ($cvm ths)	
	1992	2017	1992-2017	1992	2017
Alpine (S)	-13	-11	-0.2	44.1	63.8
Ararat (RC)	-26	-22	-0.4	37.3	55.5
Ballarat (C)	-23	-14	1.2	39.6	60.5
Banyule (C)	4	15	0.3	51.8	74.1
Bass Coast (S)	-9	-10	1.8	46.7	62.9
Baw Baw (S)	-1	-11	1.5	49.2	60.1
Bayside (C)	60	82	0.7	56.6	82.0
Benalla (RC)	-17	0	0.0	42.7	66.9
Boroondara (C)	57	61	0.8	55.0	78.1
Brimbank (C)	-21	-29	1.4	50.0	69.2
Buloke (S)	-10	-25	-1.8	45.5	55.6
Campaspe (S)	-1	-15	0.3	50.0	59.6
Cardinia (S)	7	-5	4.1	52.2	68.0
Casey (C)	15	-21	4.2	53.4	71.5
Central Goldfields (S)	-35	-37	-0.3	34.9	49.8
Colac-Otway (S)	-13	-15	0.0	45.0	63.2
Corangamite (S)	22	-14	-0.8	60.7	61.4
Darebin (C)	-24	0	0.9	50.9	73.6
East Gippsland (S)	-23	-16	0.5	38.9	58.7
Frankston (C)	-11	-9	1.2	52.8	73.8
Gannawarra (S)	-7	-16	-1.2	47.2	61.1
Glen Eira (C)	17	32	1.1	55.6	79.8
Glenelg (S)	-17	-18	-0.6	42.1	58.3
Golden Plains (S)	-6	-11	2.2	43.4	62.4
Greater Bendigo (C)	-18	-18	1.3	41.3	57.6
Greater Dandenong (C)	-32	-31	0.8	52.4	74.4
Greater Geelong (C)	-12	-10	1.2	45.5	62.3
Greater Shepparton (C)	-9	-20	0.8	46.4	56.3
Hepburn (S)	-23	-10	0.4	42.2	64.7
Hindmarsh (S)	-10	-14	-1.1	45.3	63.8
Hobsons Bay (C)	-6	11	0.9	52.3	72.6
Horsham (RC)	-7	-10	0.4	46.9	63.6
Hume (C)	-11	-29	2.9	49.3	67.1
Indigo (S)	-14	-3	0.6	46.0	68.1
Kingston (C) (Vic.)	-4	14	0.9	53.7	77.7
Knox (C)	0	-1	0.9	52.7	75.1
Latrobe (C) (Vic.)	-15	-20	-0.1	43.6	56.7
Loddon (S)	9	-36	-1.2	55.3	47.1
Macedon Ranges (S)	9	14	1.7	46.2	62.7
Manningham (C)	9	25	0.0	52.8	76.0
Mansfield (S)	-1	-7	1.2	47.7	60.2
Maribyrnong (C)	-30	-3	1.9	51.7	72.6
Maroondah (C)	0	10	0.8	52.6	75.8

Table 6.1	Resident gross product per capita of working age population and working age population growth (per cent deviation from State average) – continued				
	Resident gross product per capita of working age population (% of Victorian average)		Average annual growth in working age population (%)	Catchment resident gross product per capita of working age population ($cvm ths)	
	1992	2017	1992-2017	1992	2017
Melbourne (C)	29	-14	6.0	53.1	74.2
Melton (C)	4	-24	6.0	50.4	67.3
Mildura (RC)	-13	-25	0.7	43.8	52.4
Mitchell (S)	-7	-17	2.2	46.4	56.8
Moira (S)	5	-7	0.4	51.9	68.1
Monash (C)	-7	6	0.5	53.4	76.0
Moonee Valley (C)	1	19	0.8	51.1	72.1
Moorabool (S)	-1	-7	1.9	47.5	62.6
Moreland (C)	-24	0	1.1	50.4	72.1
Mornington Peninsula (S)	14	15	1.4	52.3	72.2
Mount Alexander (S)	-20	-17	0.6	42.5	61.6
Moyne (S)	22	-10	-0.1	56.9	62.7
Murrindindi (S)	-5	-8	0.2	51.8	72.3
Nillumbik (S)	24	22	0.8	51.0	72.3
Northern Grampians (S)	-10	-17	-0.9	45.3	60.0
Port Phillip (C)	32	43	1.9	54.7	77.2
Pyrenees (S)	-24	-36	0.0	37.8	53.5
Queenscliffe (B)	22	76	-1.0	46.0	66.0
South Gippsland (S)	9	-17	0.3	55.2	58.9
Southern Grampians (S)	-16	-9	-0.7	42.4	65.1
Stonnington (C)	68	62	1.2	55.3	78.0
Strathbogie (S)	-9	-11	0.2	46.3	58.8
Surf Coast (S)	23	26	2.7	51.7	72.5
Swan Hill (RC)	1	-20	-0.1	50.8	56.7
Towong (S)	-8	-15	-0.7	46.6	63.5
Wangaratta (RC)	-13	-15	0.2	43.9	61.8
Warrnambool (C)	-13	-14	1.0	46.3	61.0
Wellington (S)	6	-10	0.1	53.5	63.3
West Wimmera (S)	16	-10	-1.8	58.1	67.9
Whitehorse (C)	2	14	0.6	53.3	76.7
Whittlesea (C)	-16	-22	3.1	49.3	68.4
Wodonga (C)	-4	-14	1.5	48.1	64.5
Wyndham (C)	13	-18	5.6	51.8	69.0
Yarra (C)	7	35	1.6	53.6	76.8
Yarra Ranges (S)	-6	-2	0.6	51.2	73.0
Yarriambiack (S)	-5	-28	-1.6	48.1	53.3

Table 6.2	Six metropolitan LGAs: The impact of 2 per cent working age population growth – 1992 to 2017			
	Working age population 2017	Working age population if constrained to 2 per cent population growth from 1992 2017	Surplus working age population 2017	Surplus of population 2015
Cardinia (S)	63150	38273	24876	40758
Casey (C)	207028	121336	85692	135958
Hume (C)	138074	110871	27203	42895
Melton (C)	93726	35639	58088	92483
Whittlesea (C)	136963	103868	33095	52272
Wyndham (C)	155723	65984	89739	140872
Total	**794665**	**475972**	**318692**	**505239**

6.2.3 The drivers of regional economic growth

The ALGA/NIEIR "*State of the Regions 2017-18*" report identified eight drivers of regional economic growth for non-primary product. That is, gross regional product excluding agriculture and mining gross product. The drivers consisted of four core drivers, or 'pillars', of regional growth. They are:

(i) non-dwelling capital stock;

(ii) knowledge creation capacity;

(iii) supply chain strength; and

(iv) skill employed.

The other drivers are:

(i) autonomous technological change;

(ii) agriculture gross product;

(iii) mining gross product; and

(iv) residual or unexplained technological change.

The autonomous technological change is the rate of change that is exogenous to the region and is relatively costless. In economics this is sometimes referred to as 'manna from heaven' technological change.

In terms of the definition of the pillar drivers the available non-dwelling capital stock is self-explanatory. Knowledge creation capacity is place of work hours worked for four ANZSIC 2-digit industries. They are Professional, scientific and technical services, Computer system design and related services, Tertiary education and research and Hospitals.

Supply chain strengths for an LGA is the sum of intermediary supply (the intermediary row total for a specific industry from the LGA input-output table plus the column total for the same industry on the impacts from other industries into the industry.

Skills uses the ABS measurement of skill intensity for each of the ASCO occupation groups weighted by the share of each occupation in the total on a place of work basis.

The individual LGA values of the pillars will have significant spillover impacts on nearby LGAs. This is particularly the case for knowledge creation capacity, supply chain strength and capital stock. A significant new facility in one LGA will generate income from households in nearby LGAs. The catchments are derived by assigning weights based on travel times. The weight declines to zero after a 60 minute travel time. For example, assume that for LGA X is 40 minutes travel time away. Thus, in compiling the catchment for LGA X, LGA Y might receive a 0.4 weight for the variable under consideration.

For the productivity drivers to be useful for the task at hand, which is to calculate the resources required to render the identified surplus working age population fully productive, it is necessary to decompose the empirical contribution of each pillar. This is done by applying a pooled time series cross section regression equation across all Australian LGAs from 1991.3 to 2016.2. The independent variables are the seven drivers (excluding the unexplained), while the dependent variable is non-primary gross regional product per capita of working age population. All variables are in terms of an LGA's catchment. The equation was in long-linear form.

For three of the pillars the elasticities of non-primary gross regional product growth was estimated at between 0.22 and 0.26 while the fourth pillar, namely knowledge creation capacity, had an elasticity of 0.52.

Table 6.3 shows the value of each of the four pillars or drivers for each of the catchment Melbourne metropolitan LGAs for 1992 and 2017. Table 6.4 shows the ratio of the pillar value compared to the value of the peer LGA or, except for one instance, Melbourne City. The change in pillar values, especially relative to the peer LGA, is the key explanation of the outcome for per capita resident gross product. Those LGAs which had large falls in the values of their catchment pillars relative to the peer LGA are the same LGAs with the largest fall in their pillar values. Casey, for example, from Table 6.3, increased its catchment value for non-primary GRP per capita of working age population from $\$_{cvm}$50,000 to $\$_{cvm}$82,000. However, over the same period Melbourne City increased its value from $\$_{cvm}$73,000 per capita to $\$_{cvm}$140,000. This meant that Casey (from Table 6.4) went from 69 per cent of Melbourne City's per capita value in 1992 to 59 per cent by 2017. The reasons for this were:

(i) Casey's non-dwelling capital stock installed per capita fell from 74 per cent of Melbourne City's value in 1992 to 70 per cent in 2017;

(ii) Casey's knowledge creation capacity fell from 58 per cent of Melbourne City's in 1992 to 50 per cent by 2017; and

(iii) Casey's supply chain strength fell from 70 per cent of Melbourne City's in 1992 to 56 per cent by 2017.

There was a minor fall in related skills employed relative to the peer LGA, or Hobsons Bay catchment.

6.2.4 The contribution of the four pillars to regional economic growth

Using the estimated elasticities in conjunction with the driver value changes between 1992 and 2017, Table 6.5 calculates the percentage point contribution of each driver to overall per capita non-primary GRP growth, while Table 6.6 profiles the percentage contribution to total growth. The skills productivity driver growth typically contributes between 3 to 5 percentage points to growth with a percentage contribution of between 4 and 6 per cent. Capital stock growth ranges between a 12 and 19 percentage points which, as a percentage of overall growth, ranges between 17 and 35 per cent. The impact of the knowledge generation capacity driver ranges, in percentage point terms, between -1.7 to 0.33. Ignoring the negative contribution from Mitchell, this translates into a percentage contribution of between 30 and 45 per cent. Supply chain strength is an important driver, ranging up to 17 percentage points contribution, or 19 per cent. Not unexpectedly the contribution of agriculture and mining is small for the metropolitan LGAs.

Overall the contribution of the drivers from the six LGAs of interest is not dissimilar to most other LGAs. One stand-out feature is that the unexplained technological change component is highly negative compared to the average for other LGAs. For Cardinia, for example, the negative unexplained component is a third of overall growth. For the LGAs that performed well over the period, in terms of high per capita non-primary GRP growth, the unexplained residual is either positive or a relatively small negative.

This means that even though those drivers for the six LGAs of interest were in line with their population growth, their increasing uncompetitiveness, in terms of the better performing LGAS (as indicated by the fall in their relative driver values over the period) means that the pillar productivity driver instruments were relatively ineffective in driving growth.

The strong conclusion is that for fast population growing LGAs with relatively small initial capacity the growth in the pillars of productivity growth has to be significantly faster than the working age population growth if these regions are to offset their initial competitive disadvantages and if these disadvantages are do not increase over time.

This issue will now be explored.

Table 6.3	Metropolitan Melbourne LGAs: The values of the four CATCHMENT pillars of regional economic growth – 1992 and 2017									
	Catchment non-primary GRP per capita of working age population ($cvm ths)		Catchment non-dwelling capital stock installed per capita of working age population ($cvm ths)		Knowledge generating potential – hours worked per capita of working age population (number)		Supply chain strength ($cvm ths)		Skills employed within catchment (index)	
	1992	2017	1992	2017	1992	2017	1992	2017	1992	2017
Banyule (C)	52.02	96.6	67.0	123	162	264	47	87	0.78	0.91
Bayside (C)	57.56	106.7	72.1	131	171	289	54	99	0.78	0.91
Boroondara (C)	57.34	106.4	71.9	132	179	299	53	98	0.77	0.90
Brimbank (C)	57.55	102.4	77.5	130	164	265	52	92	0.79	0.92
Cardinia (S)	43.82	62.2	63.1	102	101	127	42	55	0.66	0.72
Casey (C)	50.38	82.0	66.2	112	136	203	47	74	0.71	0.80
Darebin (C)	54.07	101.2	69.9	126	167	278	49	91	0.79	0.92
Frankston (C)	49.97	85.3	65.4	117	133	210	47	76	0.69	0.77
Glen Eira (C)	57.14	105.4	71.9	130	174	290	53	98	0.78	0.90
Greater Dandenong (C)	53.14	95.1	69.4	127	146	239	49	85	0.76	0.87
Hobsons Bay (C)	63.34	112.4	85.9	142	186	301	58	103	0.80	0.94
Hume (C)	56.42	100.5	79.5	131	154	241	51	89	0.80	0.93
Kingston (C) (Vic.)	53.34	95.1	67.1	124	144	238	49	86	0.78	0.91
Knox (C)	51.03	92.2	67.1	124	144	238	47	82	0.77	0.90
Manningham (C)	51.89	98.1	66.1	126	158	268	47	89	0.78	0.91
Maribyrnong (C)	64.20	117.2	83.3	143	194	321	58	107	0.79	0.91
Maroondah (C)	50.37	93.2	66.0	126	147	247	46	83	0.78	0.90
Melbourne (C)	72.82	139.6	89.6	161	233	403	66	129	0.78	0.91
Melton (C)	58.53	96.7	80.7	125	165	245	53	87	0.68	0.76
Monash (C)	55.29	100.6	70.6	129	164	271	51	91	0.78	0.90
Moonee Valley (C)	59.49	110.1	78.2	135	177	296	54	100	0.78	0.91
Moreland (C)	57.18	106.6	74.4	131	172	288	52	97	0.79	0.92
Mornington Peninsula (S)	44.64	64.0	60.0	104	85	119	43	55	0.69	0.75
Nillumbik (S)	46.96	85.8	63.6	117	137	221	42	76	0.79	0.92
Port Phillip (C)	64.91	118.7	85.8	144	200	334	61	111	0.78	0.90
Stonnington (C)	60.45	111.5	77.1	137	187	312	56	104	0.77	0.90
Whitehorse (C)	52.94	97.8	67.0	126	160	267	48	88	0.78	0.91
Whittlesea (C)	50.16	88.7	70.9	119	147	226	45	78	0.80	0.93
Wyndham (C)	63.25	102.8	87.7	134	179	264	57	93	0.77	0.90
Yarra (C)	61.52	117.4	77.0	141	196	339	56	108	0.78	0.90
Yarra Ranges (S)	41.24	71.4	55.8	110	106	169	38	63	0.75	0.86

Table 6.4	Metropolitan Melbourne LGAs: The values of the four catchment pillars of regional economic growth COMPARED TO PEER LGA – 1992 and 2017									
	Catchment non-primary GRP per capita of working age population ($cvm ths)		Catchment non-dwelling capital stock installed per capita of working age population ($cvm ths)		Knowledge generating potential – hours worked per capita of working age population (number)		Supply chain strength ($cvm ths)		Skills employed within catchment (index)	
	1992	2017	1992	2017	1992	2017	1992	2017	1992	2017
Banyule (C)	71.4	69.2	74.8	76.7	69.3	65.4	70.9	67.0	97.6	97.6
Bayside (C)	79.0	76.4	80.5	81.4	73.2	71.8	81.4	76.6	97.4	97.7
Boroondara (C)	78.8	76.2	80.3	82.3	76.8	74.1	79.7	75.8	96.3	96.2
Brimbank (C)	79.0	73.4	86.5	81.0	70.5	65.7	78.4	71.3	98.7	98.2
Cardinia (S)	60.2	44.6	70.5	63.4	43.2	31.5	62.7	42.5	81.9	76.6
Casey (C)	69.2	58.8	73.9	69.9	58.4	50.4	70.4	56.9	88.7	85.4
Darebin (C)	74.2	72.5	78.0	78.5	71.4	68.8	73.7	70.6	98.3	98.3
Frankston (C)	68.6	61.1	73.0	73.0	57.0	52.0	70.0	58.7	86.0	82.6
Glen Eira (C)	78.5	75.6	80.3	81.1	74.4	71.8	80.3	75.4	96.5	96.5
Greater Dandenong (C)	73.0	68.1	77.5	79.0	62.4	59.2	73.7	65.6	94.4	92.7
Hobsons Bay (C)	87.0	80.5	95.9	88.4	79.7	74.6	87.1	79.5	100.0	100.0
Hume (C)	77.5	72.0	88.8	81.8	66.1	59.9	76.4	68.7	99.5	99.6
Kingston (C) (Vic.)	73.2	68.2	74.9	77.1	61.6	59.0	74.3	66.2	97.3	97.4
Knox (C)	70.1	66.0	74.9	77.4	61.8	59.1	70.5	63.7	96.3	95.9
Manningham (C)	71.3	70.3	73.8	78.4	67.7	66.5	71.3	68.6	96.8	96.8
Maribyrnong (C)	88.2	84.0	93.0	88.7	83.3	79.7	87.9	82.9	97.8	97.4
Maroondah (C)	69.2	66.8	73.7	78.7	63.0	61.4	69.3	64.5	96.6	96.6
Melbourne (C)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	97.3	97.1
Melton (C)	80.4	69.3	90.1	78.1	70.8	60.8	79.8	67.5	84.9	81.2
Monash (C)	75.9	72.1	78.8	80.5	70.1	67.1	76.6	70.4	96.6	96.2
Moonee Valley (C)	81.7	78.9	87.3	84.2	76.0	73.5	81.4	77.4	97.3	97.1
Moreland (C)	78.5	76.4	83.1	81.4	73.6	71.4	78.2	74.7	98.3	98.2
Mornington Peninsula (S)	61.3	45.9	66.9	64.7	36.2	29.5	64.0	42.7	86.1	80.1
Nillumbik (S)	64.5	61.5	71.0	72.8	58.8	54.9	63.8	58.5	98.2	98.2
Port Phillip (C)	89.1	85.1	95.8	89.9	85.9	82.8	91.1	85.8	96.6	96.5
Stonnington (C)	83.0	79.9	86.0	85.2	80.2	77.4	84.7	80.2	96.3	96.2
Whitehorse (C)	72.7	70.1	74.8	78.7	68.6	66.3	72.6	68.2	97.0	97.1
Whittlesea (C)	68.9	63.5	79.2	74.0	62.9	56.0	67.8	60.6	99.0	99.1
Wyndham (C)	86.9	73.6	97.9	83.5	76.7	65.4	85.9	72.1	96.1	95.9
Yarra (C)	84.5	84.2	85.9	87.6	84.2	84.0	84.9	83.8	96.4	96.2
Yarra Ranges (S)	56.6	51.2	62.3	68.5	45.6	41.9	56.9	48.5	93.6	91.5

Table 6.5 Metropolitan Melbourne LGAs: The contribution of the drivers to regional catchment non-primary GRP growth – 1992 to 2017

	Percentage point contribution to non-primary GRP per capita of working age population (per cent)								
	Autonomous	Catchment skills	Catchment capital stock – per working age population	Knowledge creation workers	Catchment supply chain strength	Agriculture gross product in catchment	Mining catchment gross product per capita of working age population	Residual tech. change	Non-primary product per capita of working age population
Banyule (C)	14.5	4.3	17.1	29.1	15.1	2.8	2.2	0.6	85.7
Bayside (C)	14.5	4.3	16.6	31.7	14.9	3.3	2.6	-2.7	85.3
Boroondara (C)	14.5	4.2	17.0	30.6	15.2	2.9	2.3	-1.3	85.5
Brimbank (C)	14.5	4.1	14.3	28.3	14.0	2.6	2.6	-2.5	78.0
Cardinia (S)	14.5	2.4	13.2	12.7	6.6	1.6	4.3	-13.2	42.1
Casey (C)	14.5	3.2	14.6	23.2	11.0	2.1	3.3	-9.1	62.8
Darebin (C)	14.5	4.3	16.5	30.6	15.4	2.9	2.3	0.7	87.2
Frankston (C)	14.5	3.1	16.3	26.9	11.9	2.5	3.8	-8.3	70.7
Glen Eira (C)	14.5	4.3	16.6	30.6	14.9	3.1	2.4	-1.9	84.5
Greater Dandenong (C)	14.5	3.7	16.9	29.5	13.5	2.6	2.8	-4.5	78.9
Hobsons Bay (C)	14.5	4.3	13.9	28.6	14.1	3.0	2.6	-3.5	77.4
Hume (C)	14.5	4.3	13.9	26.4	13.7	1.8	2.5	1.1	78.2
Kingston (C) (Vic.)	14.5	4.3	17.2	30.1	13.5	2.9	2.8	-6.8	78.4
Knox (C)	14.5	4.2	17.3	30.0	13.8	2.6	2.4	-4.1	80.6
Manningham (C)	14.5	4.3	18.1	31.9	15.5	2.8	2.2	-0.2	89.1
Maribyrnong (C)	14.5	4.1	14.9	30.1	15.0	2.9	2.6	-1.5	82.5
Maroondah (C)	14.5	4.3	18.3	31.3	14.7	2.6	2.2	-2.8	85.0
Melbourne (C)	14.5	4.2	16.3	33.1	16.6	3.0	2.6	1.4	91.6
Melton (C)	14.5	3.0	12.1	22.9	12.2	2.3	2.8	-4.6	65.2
Monash (C)	14.5	4.2	16.9	30.1	14.3	2.7	2.6	-3.4	81.9
Moonee Valley (C)	14.5	4.2	15.2	30.8	15.2	2.7	2.5	0.1	85.1
Moreland (C)	14.5	4.2	15.7	31.0	15.3	2.8	2.4	0.4	86.4
Mornington Peninsula (S)	14.5	2.2	15.3	19.5	6.2	2.0	4.8	-21.1	43.4
Nillumbik (S)	14.5	4.3	17.0	28.4	14.2	2.5	2.2	-0.4	82.7
Port Phillip (C)	14.5	4.2	14.4	30.6	15.0	3.2	2.5	-1.5	82.9
Stonnington (C)	14.5	4.2	16.0	30.7	15.1	3.0	2.4	-1.5	84.5
Whitehorse (C)	14.5	4.3	17.9	30.7	14.9	2.8	2.3	-2.6	84.8
Whittlesea (C)	14.5	4.3	14.3	25.3	13.6	2.6	2.4	-0.2	76.8
Wyndham (C)	14.5	4.2	11.6	22.5	12.0	2.7	2.8	-7.9	62.5
Yarra (C)	14.5	4.2	16.9	32.9	16.2	3.1	2.4	0.7	90.9
Yarra Ranges (S)	14.5	3.6	19.1	27.3	12.3	2.0	1.7	-7.5	73.1

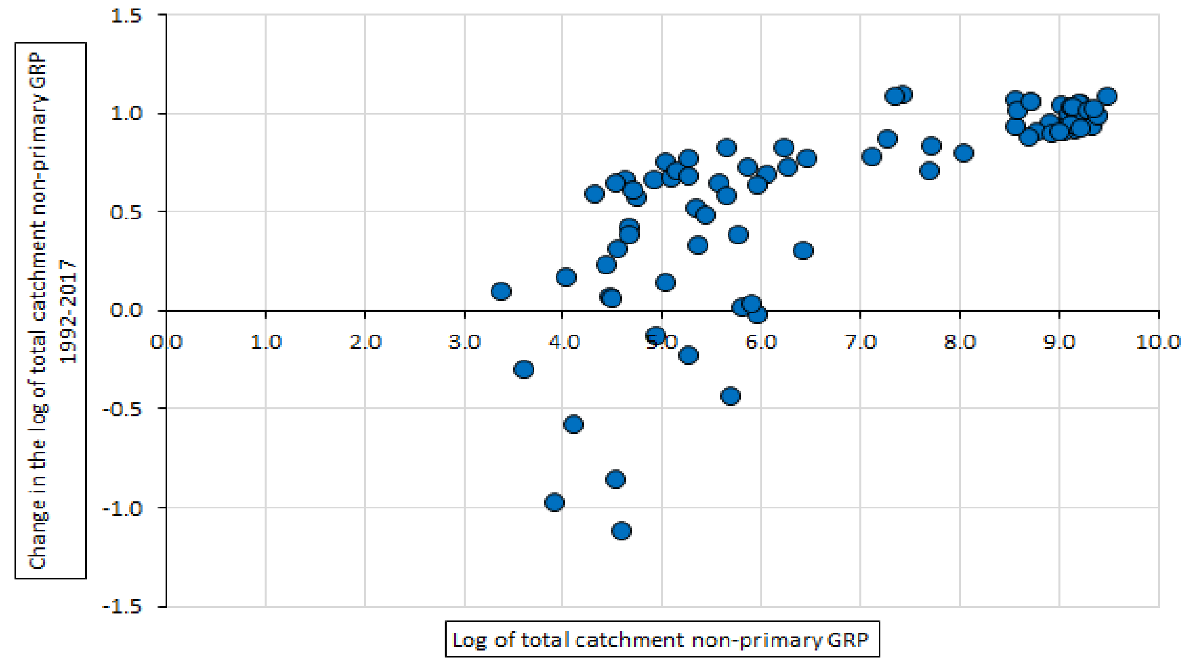
Table 6.6	Metropolitan Melbourne LGAs: The percentage contribution of the growth drivers to regional catchment non-primary GRP growth – 1992 to 2017								
	Percentage point contribution to non-primary GRP per capita of working age population (per cent)								
	Autonomous	Catchment skills	Catchment capital stock – per working age population	Knowledge creation workers	Catchment supply chain strength	Agriculture gross product in catchment	Mining catchment gross product per capita of working age population	Residual tech. change	Non-primary product per capita of working age population
Banyule (C)	16.9	5.0	19.9	34.0	17.6	3.3	2.6	0.7	100.0
Bayside (C)	17.0	5.1	19.5	37.2	17.5	3.9	3.0	-3.2	100.0
Boroondara (C)	17.0	5.0	19.9	35.8	17.8	3.4	2.7	-1.5	100.0
Brimbank (C)	18.6	5.3	18.4	36.3	18.0	3.4	3.3	-3.2	100.0
Cardinia (S)	34.5	5.7	31.3	30.3	15.6	3.8	10.3	-31.4	100.0
Casey (C)	23.1	5.1	23.3	36.9	17.5	3.3	5.2	-14.4	100.0
Darebin (C)	16.6	4.9	18.9	35.1	17.7	3.3	2.6	0.8	100.0
Frankston (C)	20.5	4.4	23.0	38.1	16.9	3.5	5.3	-11.7	100.0
Glen Eira (C)	17.1	5.0	19.6	36.2	17.6	3.7	2.9	-2.2	100.0
Greater Dandenong (C)	18.4	4.7	21.4	37.4	17.1	3.3	3.5	-5.8	100.0
Hobsons Bay (C)	18.7	5.5	17.9	37.0	18.3	3.8	3.3	-4.5	100.0
Hume (C)	18.5	5.5	17.7	33.8	17.6	2.2	3.2	1.4	100.0
Kingston (C) (Vic.)	18.5	5.5	21.9	38.4	17.2	3.6	3.6	-8.7	100.0
Knox (C)	18.0	5.2	21.5	37.2	17.2	3.2	2.9	-5.1	100.0
Manningham (C)	16.3	4.8	20.4	35.8	17.4	3.1	2.5	-0.2	100.0
Maribyrnong (C)	17.6	5.0	18.1	36.5	18.1	3.6	3.1	-1.9	100.0
Maroondah (C)	17.1	5.0	21.5	36.8	17.2	3.0	2.6	-3.3	100.0
Melbourne (C)	15.8	4.6	17.8	36.1	18.1	3.3	2.8	1.5	100.0
Melton (C)	22.2	4.6	18.5	35.2	18.6	3.6	4.3	-7.0	100.0
Monash (C)	17.7	5.1	20.7	36.7	17.5	3.4	3.1	-4.1	100.0
Moonee Valley (C)	17.0	4.9	17.9	36.2	17.9	3.2	2.9	0.1	100.0
Moreland (C)	16.8	4.9	18.2	35.9	17.8	3.2	2.8	0.5	100.0
Mornington Peninsula (S)	33.4	5.2	35.3	45.0	14.3	4.6	11.0	-48.7	100.0
Nillumbik (S)	17.5	5.2	20.6	34.3	17.2	3.0	2.7	-0.5	100.0
Port Phillip (C)	17.5	5.1	17.4	36.9	18.1	3.8	3.0	-1.8	100.0
Stonnington (C)	17.2	5.0	19.0	36.3	17.9	3.5	2.9	-1.7	100.0
Whitehorse (C)	17.1	5.1	21.1	36.2	17.6	3.3	2.7	-3.1	100.0
Whittlesea (C)	18.9	5.6	18.6	32.9	17.7	3.4	3.2	-0.2	100.0
Wyndham (C)	23.2	6.7	18.6	36.0	19.1	4.4	4.5	-12.6	100.0
Yarra (C)	15.9	4.6	18.6	36.2	17.8	3.4	2.6	0.8	100.0
Yarra Ranges (S)	19.8	5.0	26.2	37.4	16.9	2.8	2.3	-10.3	100.0

6.2.5 The importance of initial conditions in driving future growth

The explanation of the outcomes in Table 6.6 for the six LGAs of interest in this study lies in understanding the importance of initial conditions, or the initial scale of economic activity, in explaining future economic growth.

Figure 6.4 shows the relationship between initial non-primary gross product in 1992 and the growth in non-primary gross product over the next 25 years. The relationship is positive. That is, the higher the initial level of economic activity the higher will be future growth. This conclusion is based on analysis is at LGA level but we drew the same conclusion from the finer level (SA2) analysis in Section 4.2 above.

Figure 6.4: Victorian LGAs: Total catchment non-primary GRP versus growth in total catchment non-primary GRP



One reason for this positive impact is the relationship between initial scale and future productivity growth, or the growth in non-primary GRP per hour worked as indicated by Figure 6.5. Productivity is non-primary product per hour worked. For Victorian LGAs a strong positive relationship is illustrated in Figure 6.5 between initial scale in productivity in 1992 and the growth in productivity between 1992 and 2017. The regression result of productivity growth versus initial scale from the data in Figure 6.5 is given by:

$$ln(Prod_{i,2017}) – ln(Prod_{i,1992})$$
$$= -0.176 + 0.070 (ln(cnpg_{i,1992})$$
$$(3.5) \quad (9.7)$$

$R^2 = 0.54$

Where:

$Prod_i$ = Non-primary GRP per hour worked for Victorian LGA i.

$cnpg_i$ = Non-primary GRP for LGA i.

The 0.07 coefficient translates the initial economic activity advantage into the expected growth over 25 years. As a sensibility test, it is encouraging that this value is close to the .093 value calculated in Table 4.3 for what is the same elasticity, albeit that the spatial scales and time periods for the two estimates are somewhat different.

Table 6.7 shows catchment non-primary gross product for 1992 and 2017. In 1992 the Boroondara catchment had an 80 per cent scale advantage over Casey. This meant that over the next 25 years the Boroondara catchment could have been expected to grow its non-primary productivity by 5.6, just above Casey's productivity level. Success breeds success. In 2017 the scale gap has widened to 90 per cent, increasing the future differential of productivity growth over the next 25 years to 6.3 per cent. A similar relationship exists between all six LGAs of interest and the LGAs that performed above average over the 1992 to 2017 period.

To neutralise this natural tendency for increasing inequality in regional outcomes, additional productivity growth driver resources have to be allocated to offset the initial lower capacity in high population growth regions to force more equal outcomes and to prevent an increasing segment of the population in those regions becoming disconnected from economic activity.

The reason for this is straight-forward. Established capacity in regions with strong productivity drivers will have a competitive advantage on firms in regions with poor productivity drivers. In the growth context the situation is aggravated by the fact that new capacity will have to be established. Irrespective of the quality of the productivity growth drivers newly established capacity has limited resources to enhance productivity in early years because of the importance of the repayment of investment funding costs in the early years of operation. Accordingly, the tendency is to export goods and services from established competitive regions to fast growing regions rather than establish capacity in the fast population growing regions labour market catchments. The scale of the export supply catchments for many industries are far greater than regional labour market catchments', especially in the age of advanced communication technologies.

Further, the established business in the regions with quality productivity drivers have higher productivity and, therefore, higher free cash flow to support a higher level of capacity expansion investment effort and, therefore are in a better position to gain market share from businesses in low productive regions.

One mechanism that in the past supported the expansion of capacity in the labour market catchment of high population growth regions, was access to labour resources. However, in an age where the quality of skills has become more important businesses have learnt that by maintaining high wages for skills which they can afford they can attract the appropriate skills to their labour markets. This involves increasing dwelling prices and rents in inner and middle suburbs, which forces out low skilled workers to the fringe areas.

Figure 6.5: Victorian LGAs – Initial scale and future productivity growth

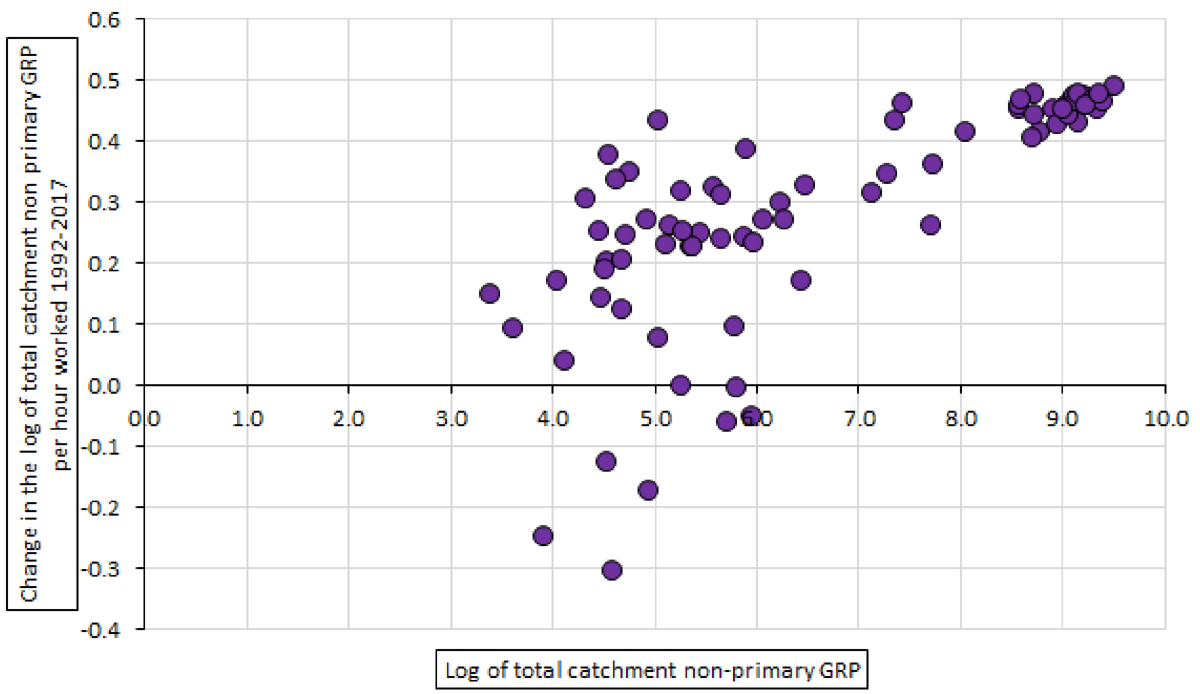


Table 6.7	Catchment non-primary gross product ($cvm million)	
	1992	2017
Banyule (C)	35591	93503
Bayside (C)	29501	76265
Boroondara (C)	46398	121917
Brimbank (C)	33413	94435
Cardinia (S)	8990	20723
Casey (C)	25781	64008
Darebin (C)	36092	97685
Frankston (C)	24066	58103
Glen Eira (C)	37687	98371
Greater Dandenong (C)	37654	93803
Hobsons Bay (C)	36598	102820
Hume (C)	24410	70520
Kingston (C) (Vic.)	30153	73605
Knox (C)	34101	84028
Manningham (C)	36642	94291
Maribyrnong (C)	40326	115141
Maroondah (C)	32292	80038
Melbourne (C)	52914	156908
Melton (C)	20910	60757
Monash (C)	44827	114329
Moonee Valley (C)	39372	111974
Moreland (C)	37518	105703
Mornington Peninsula (S)	8856	18049
Nillumbik (S)	20836	53167
Port Phillip (C)	43535	120174
Stonnington (C)	47443	127735
Whitehorse (C)	40564	102164
Whittlesea (C)	21137	58191
Wyndham (C)	24243	69807
Yarra (C)	46022	127547
Yarra Ranges (S)	12357	27341

6.2.6 The additional resources required for zero surplus population by 2017

The next question that needs to be answered is, what are the additional resources, over 1992 and 2017, in terms of drivers of productivity growth that would have needed to be provided in order to achieve a zero surplus population in the six LGAs of interest by 2017?

The calculations for this estimate are laid out in Table 6.8. The first column shows resident gross product per capita of working age population for 2017. A desirable target for 2017 for these LGAs is set in terms of achieving a resident gross product per capita of the working age population for the six LGAs equal to the Victorian average outcome for 2017. This was just under $\$_{cvm}$70,000. Accordingly, column 2 of Table 6.8 shows the desirable increase in per capita resident product for the six LGAs, while column 3 multiplies column 2 by the working age population to obtain the desired increase in resident gross product in $\$_{cvm}$ million. Column 4 shows the rate of resident gross product to non-primary gross product, while column 5 shows the desired increase in catchment gross non-primary product. This is obtained by dividing column 3 by column 4 and multiplying by 2. The '2' factor can be justified from two perspectives.

Firstly, in order to achieve the desired increase in the LGA resident gross product, the catchment non-primary gross product will have to expand in proportion as it will be impossible to confine impacts of additional productivity driver resources to one LGA.

Secondly, this is in keeping with the more general estimate of surplus population of 800,000. Many of the remaining estimates of surplus population outside the six LGAs of interest will be concentrated in nearby LGAs. Thus, the additional resource requirement estimates will be on a Melbourne-wide requirement basis. Also, from Figure 6.6, the elasticity of gross resident product to gross regional product is indicated at around 0.5, which would justify the two parameter adjustment. This reflects the leaking of income from value added to other regions and in particular high income regions. That is, to achieve local area demand outcomes, over provision of resources is required.

Column 6 profiles the catchment non-primary gross regional product estimate for the six LGAs. Column 7 shows the desirable increase in catchment non-primary gross regional product in percentage terms, while column 8 shows the catchment capital stock installed. Column 9 shows the desirable increase in capital stock installed if this is the only productivity gross pillar to achieve the desired resident gross product outcome. The last column shows the $\$_{cvm}$ million increase in capital stock. This sums to $\$_{cvm}$188 billion.

The $\$_{cvm}$188 billion will have to be discounted for overlaps between the six LGA catchments. Firstly, Cardinia is excluded because this would be fully included in the Casey catchment. For the remaining LGAs an estimate of the average travel time weight applied to each other's indicator values is approximately 0.33. Therefore to adjust for the overlap values in the catchment capital stock requirements from Table 6.8 the five LGA total is discounted by 0.33. This gives a final estimate of $\$_{cvm}$126 billion.

A plausibility check on the $\$_{cvm}$126 billion estimate can be undertaken. For Melbourne as a whole, in 2017 the non-dwelling capital cost per hour worked was $90. This means that to employ 505,000 workers at 1500 hours per year would require $\$_{cvm}$70 billion. This is under the estimate of $\$_{cvm}$126 billion. However, the $\$_{cvm}$70 billion estimate includes the scale effects of lower capital costs per hour worked in the high capacity regions. From the non-catchment LGA data five of the LGAs have a capital stock per hour worked significantly greater than the average with the highest being 42 per cent higher for Cardinia. Adjusting the $\$_{cvm}$70 billion by a third brings the estimate to $\$_{cvm}$93 billion. The balance of $\$_{cvm}$33 billion is required to offset the disadvantages of the region in terms of the capital stock currently installed in the region is well below the levels required to offset the diseconomies of scale and scope of the regions compared to the higher capacity regions as well as relatively low values for the other three pillar productivity drivers.

The other pillar productivity drivers could have been used in the calculations of Table 6.8. However, they all involve substantial outlays of resources, whether they be operating expenses for hospitals, universities and research institutions, or the provision of grant substantial subsidies and investment grants to strengthen the supply chain strengths within the six LGA catchments, or to embark on an extensive training and education programs. It is unlikely that the total cost will differ significantly if more of the burden was assigned to the other drivers. That is in practice all four drivers would have to be employed with the weights assigned to each driver for a region depending on the under provision of particular driver resources. It is likely however that the total cost will not differ significantly from the one driver calculation.

The $cvm126 billion does include both private and public capital with the dominant share being the public sector for infrastructure capital.

The $cvm126 billion can also be regarded as the backlog expenditure required over 2017 to 2031 to ensure that all the population increase over 1992 to 2017 is fully engaged in productive economic activity.

Figure 6.6: Victorian LGAs: Catchment gross regional product versus resident gross product

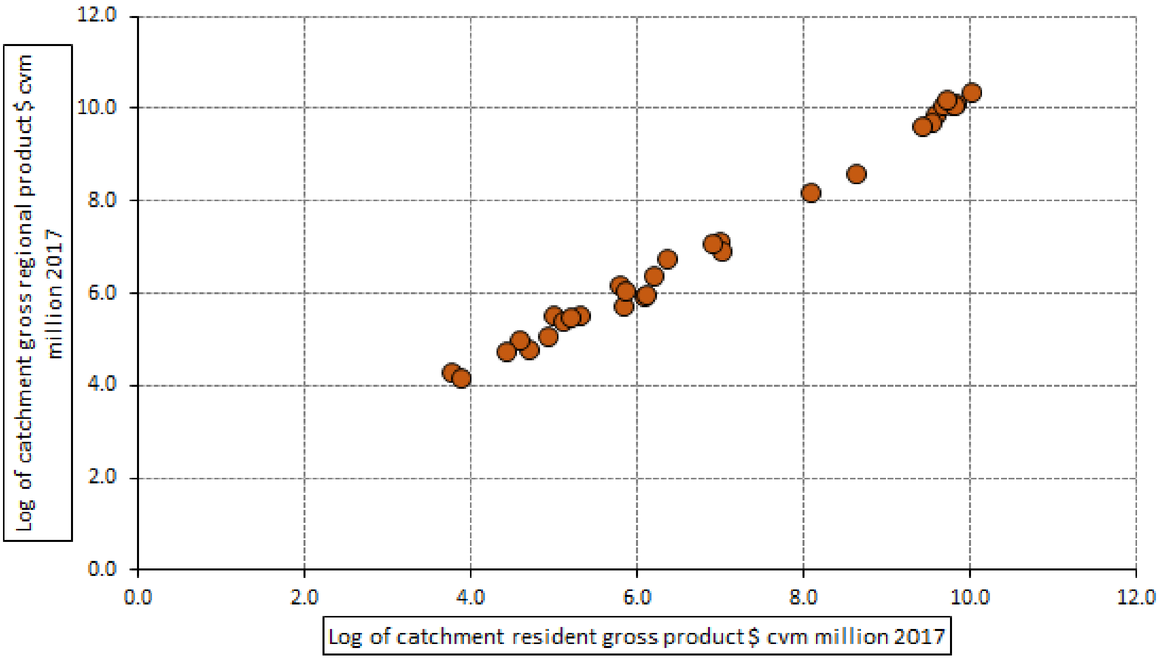


Table 6.8	The six metropolitan LGAs: Resource requirements to achieve desirable outcomes for resident gross regional product – 1992 to 2017									
	Resident gross regional product per capital of working age population ($cvm ths)	Resident gross regional product per capital of working age population ($cvm ths – difference from Victorian average)	Desirable increase in resident gross regional product ($cvm million)	Ratio of resident gross product to total gross product	Desirable increase in catchment resident gross regional product ($cvm million)	Catchment non-primary gross product ($cvm millions)	Desirable per cent increase in catchment non-primary gross regional product (per cent)	Catchment capital stock installed ($cvm millions)	Per cent increase in catchment capital stock to achieve desirable increase in resident gross product - capital stock only	Increase in capital stock ($cvm million)
Cardinia (S)	66.0	3.7	233	1.1	440.5	20722.8	2.1	33919.8	8.5	2874.8
Casey (C)	55.4	14.3	2960	0.9	6894.8	64007.6	10.8	87647.4	48.5	42543.8
Hume (C)	49.3	20.4	2812	0.7	8503.5	70519.9	12.1	92175.4	55.3	50995.4
Melton (C)	52.7	17.0	1593	0.7	4628.9	60756.5	7.6	78790.4	32.8	25876.3
Whittlesea (C)	54.4	15.3	2098	0.8	5496.6	58190.8	9.4	78040.1	41.8	32604.9
Wyndham (C)	57.3	12.4	1934	0.7	5821.2	69806.6	8.3	91161.1	36.3	33104.3

6.2.7 Resource requirements: Future population increase – 2017 to 2031

Table 6.9 shows the latest working age population projections from the Victorian Government for 2031. The following assumptions are made.

Firstly, current trends in policy settings to 2031 duplicate the outcome over the last two decades. That is, the resource inputs required to ensure the population increase is fully economically engaged falls short in proportion to the outcomes over the last 25 years.

Secondly, as the previous analysis was largely framed in absolute population terms with the absolute increases in population being greater in the future than in the past, the 2 per cent threshold adopted for the 1992 to 2017 period would be too high if extended to 2031. The threshold for the period to 2031 is therefore set at 1.5 per cent per annum. That is, for a working age population growth greater than 1.5 per cent per annum in an LGA is likely to provide population surplus to requirements.

From Table 6.9, this gives an estimate of surplus population by 2031 of 382,000, or 357,000 if allowance is made for the fact that the increase in working age population between 2016 and 2017 has been included in the historical analysis. The total surplus population would be 567,000.

On the basis that 319,000 surplus working age population build up over the 1992 to 2017 period, which required $cvm126 billion, it is therefore likely to ensure that all the working age population increase reaches their full potential by 2031, an additional $cvm141 billion will have to be allocated over the next 14 years.

Table 6.9	Metropolitan LGAs: Working age population – 2016 and 2031			
	Working age population (ths)		Metropolitan LGAs: Working age population (per cent)	Current trends surplus working age population (ths)
	2016	2031	2016 and 2031	2031
Banyule (C)	76.1	82.0	0.50	0.00
Bayside (C)	57.5	63.2	0.64	0.00
Boroondara (C)	107.9	117.1	0.55	0.00
Brimbank (C)	125.1	131.9	0.35	0.00
Cardinia (S)	55.8	88.2	3.10	23.78
Casey (C)	182.3	245.7	2.01	19.43
Darebin (C)	100.8	123.1	1.34	0.00
Frankston (C)	82.7	86.3	0.29	0.00
Glen Eira (C)	92.1	102.7	0.73	0.00
Greater Dandenong (C)	96.1	114.4	1.17	0.00
Hobsons Bay (C)	58.5	63.0	0.50	0.00
Hume (C)	121.0	165.3	2.10	15.54
Kingston (C) (Vic.)	94.6	106.3	0.78	0.00
Knox (C)	96.2	98.7	0.17	0.00
Manningham (C)	68.9	75.2	0.59	0.00
Maribyrnong (C)	59.4	84.8	2.40	12.23
Maroondah (C)	68.1	75.6	0.70	0.00
Melbourne (C)	105.1	166.7	3.12	45.45
Melton (C)	82.7	157.8	4.41	84.74
Monash (C)	115.6	130.6	0.81	0.00
Moonee Valley (C)	75.4	86.4	0.91	0.00
Moreland (C)	112.6	139.7	1.45	0.00
Mornington Peninsula (S)	83.1	90.0	0.53	0.00
Nillumbik (S)	38.2	35.6	-0.47	0.00
Port Phillip (C)	81.4	100.1	1.39	0.00
Stonnington (C)	74.3	87.5	1.10	0.00
Whitehorse (C)	100.9	113.6	0.79	0.00
Whittlesea (C)	124.0	176.9	2.40	25.37
Wyndham (C)	136.7	205.6	2.76	42.48
Yarra (C)	67.2	82.1	1.34	0.00
Yarra Ranges (S)	90.3	91.2	0.07	0.00

6.2.8 Metropolitan LGAs: The impact of increasing congestion – 2031

The cost impacts considered above occurred at a time when there was a degree of redundancy, that is, excess capacity, in the metropolitan Melbourne transport infrastructure. By the beginning of the second decade of this century this was no longer the case. As a result, the expectation is that congestion costs, that is, increased travel times for road transportation, is expected to accelerate in terms of its rate of growth over the next 15 years.

In a report by Infrastructure Victoria, "*Five Year Focus: Immediate Actions to Table Congestion*", April 2018, it is estimated the average increase in travel times over the next 15 years will be of the order of 20 per cent, with significantly higher increases than the average concentrated in the outer Northern, Eastern and Western regions. The inner regions have the smallest increases.

These estimates take account of current projects included in the forward estimates as well as the government population growth projections. The question, therefore, becomes, what will be the impact on metropolitan region productivity if these increases in travel times occur, and who would have to bear the increase in investment to neutralise the expected increase in congestion costs?

The data for these calculations is given in Table 6.10. The first four columns of this table show the percentage change in the catchment value of the four pillars of productivity growth in 2031 as a result of the increase in travel times compared to current travel times. This is based on an average metropolitan-wide increase in road travel costs for the metropolitan region of 20 per cent, and for outer Western, Northern and Eastern travel times increasing by between 25 to 30 per cent overall. The inner LGAs have relatively small declines in catchment productivity chain values. The outer regions have the largest percentage decline in their catchment productivity driver and the middle LGAs somewhere between the two extremes. The relative change in travel times is partly based on the relative increase in population by LGA as per Table 6.10.

Given the empirical estimates of the non-primary gross regional product per capita of working age population used in this study, column five of Table 6.10 provides estimates of the decline in per capita non-primary gross regional product in 2031 as a result of the travel time increases. The maximum decline is 27 per cent for Casey. The other five LGAs of interest also have relatively high declines in non-primary gross regional product. For example, Hume's decline is 17 per cent.

Staying consistent with the previous methodology, the capital stock is chosen as the benchmark for calculating the resources required to offset the decline in productivity from enhanced congestion costs. The additional capital stock estimates are shown in the last column of Table 6.10 and they total $\$_{cvm}$217 billion. The estimates in the table are discounted for catchments containing the same item of capital stock. The discount factor is set at 70 per cent because of the generally widespread increase in capital stock required across the LGAs. The discount point is less than the 87 per cent discount rate justified by the ratio of total Victoria-wide LGA capital stock to the use of catchment capital stock for all Victorian LGAs. This is because the distribution of capital stock in Table 6.10 is not uniform across the LGAs. There is still a higher concentration in the capital stock required in the six LGAs of interest. The appropriate discount factors should be subject to further examination by the relevant State agencies, such as Infrastructure Victoria.

This capital requirement of $\$_{cvm}$217 billion is about double the total cost of the set of transport infrastructure projects identified in Table 5.2 and other projects included in the discussion of that table, suggesting that current thinking has a fair way to go in terms of tackling congestion, particularly if congestion pricing is ignored as a political opportunity. It is not difficult to identify the kinds of projects where the additional capital amounts in the $\$_{cvm}$217 billion would have been spent in order to minimise the increase in congestion costs over the next 15 years. This would largely have to be on rail transport infrastructure. On current trends, by 2050 the expectation is that the population of Melbourne will be approaching the size of London with an extensive underground system and regional rail links but at a much higher density level than in Melbourne. The Melbourne comparison with Paris would be even more unfavourable. In order for Melbourne to approach a population size that approaches London or Paris substantial additional rail transport infrastructure investment will be required and a much greater emphasis must be placed on urban infill to support the densities that are needed to support such transport infrastructure.

Melbourne is currently undertaking an expansion of its underground with the 9 kilometre and 5 stations Melbourne Metro project at a cost of $11 billion which is due to be completed by the mid-2020s. However, if Melbourne had:

(i) commenced this project in the 1980s;

(ii) extended the inner city underground by another 5 to 10 stations by 2018;

(iii) developed an additional 3 major suburban rail lines, such as the Doncaster rail line, up to 90 kilometres with an additional 40 to 45 stations, a significant proportion of which would have had to be underground because of poor planning over the last century;

(iv) duplicated and extended existing railway lines;

(v) constructed select lateral rail, light rail or bus rapid transit links in the Eastern and South Eastern suburbs, such as to serve the National Employment and Innovation Clusters; and

(vi) constructed major parking infrastructure around stations,

this would have taken the majority share of the $\$_{cvm}$217 billion estimate. It would have required the additional transport infrastructure investment expenditure of $6 billion a year since 1980. Investment in place making infrastructure, to support densification, would also be an appropriate use of the requisite funds.

The important point, if Melbourne had done this by building rail capacity well ahead of demand, it would have changed the shape of the city development with increased population in inner and middle suburbs that would have significantly reduced the 1992 to 2017 population rate of growth for the fringe LGAs and would have given Melbourne greater options of where to place population growth from 2017 to 2031.

More importantly, with the assistance of other investments in transport infrastructure over 2017 to 2031 and the adoption of road pricing, it would have contained the increase in travel times over 2017 to 2031 to modest levels that would produce relatively minor economic cost.

The reduction in the redundancy of the transport infrastructure system began around 1980 with the rise of the economic philosophy of neoliberalism. One tenet of the philosophy was that the role of government had grown too extensive and needed to be contracted. The level of redundancy in the transport infrastructure system was used as an example of inefficient government practice. The focus of government should be to bring the transport infrastructure system to low excess capacity utilisation rates by unleashing the role of market forces.

The general adoption of neoliberalism, particularly over the 1980 to 2010 years was a costly error. Sustainable efficient growth requires a high degree of redundancy in transport infrastructure systems to ensure that the distribution of metropolitan population is efficient and to give investors confidence they can secure appropriate workers from labour market catchments, not only currently but in 20 years' time.

Table 6.10	Metropolitan LGAs: Travel time increases – 2017 to 2031					
	Per cent change in catchment productivity driver				Per cent impact on catchment non-primary product per capita of working age population	Additional capital stock required to neutralise increased congestion costs
	Catchment non-dwelling capital stock installed per capita of working age population	Knowledge generating potential – hours worked per capita of working age population	Supply chain strength	Skills employed within catchment		
Banyule (C)	-1.5	-0.3	-2.6	-1.6	-1.6	2.2
Bayside (C)	-0.8	-0.7	-3.9	-1.2	-1.8	2.0
Boroondara (C)	-2.4	-0.9	-4.1	-1.2	-2.3	4.1
Brimbank (C)	-2.4	-1.8	-4.6	-3.5	-3.6	4.9
Cardinia (S)	-0.9	-14.1	-44.6	-20.3	-24.4	19.1
Casey (C)	-6.1	-18.1	-41.6	-22.4	-27.0	48.0
Darebin (C)	-2.4	-0.9	-2.2	-0.6	-1.8	2.8
Frankston (C)	-0.5	-2.2	-1.2	-1.1	-1.8	1.6
Glen Eira (C)	-2.0	0.0	-1.1	-0.2	-0.8	1.2
Greater Dandenong (C)	-2.1	-3.3	-8.1	-5.1	-5.5	9.2
Hobsons Bay (C)	-0.5	-2.4	-3.3	-1.8	-2.6	4.0
Hume (C)	-2.2	-9.1	-31.1	-14.6	-16.9	27.9
Kingston (C) (Vic.)	-2.2	-3.2	-1.1	-1.3	-2.8	3.3
Knox (C)	-1.8	-0.5	-4.9	-1.2	-2.2	2.7
Manningham (C)	-5.1	-5.6	-6.4	-5.4	-7.2	10.8
Maribyrnong (C)	-13.0	-11.4	-4.0	-10.0	-12.9	32.0
Maroondah (C)	-8.9	-18.2	-14.4	-13.5	-18.5	30.0
Melbourne (C)	-8.1	-24.8	-24.5	-19.6	-25.6	108.5
Melton (C)	-10.4	-24.2	-15.6	-17.2	-23.3	50.2
Monash (C)	-5.0	-2.2	-4.6	-1.5	-3.9	7.1
Moonee Valley (C)	-0.3	-11.3	-13.6	-8.9	-11.6	22.3
Moreland (C)	-13.2	-51.2	-41.0	-35.4	-48.0	153.3
Mornington Peninsula (S)	-2.5	-24.7	-13.2	-13.1	-20.2	8.8
Nillumbik (S)	-3.8	-6.1	-8.1	-5.7	-7.5	5.9
Port Phillip (C)	-10.3	-9.3	-6.7	-9.3	-11.5	25.1
Stonnington (C)	-13.1	-36.7	-25.1	-25.3	-34.4	105.9
Whitehorse (C)	-5.6	-5.9	-6.4	-5.7	-7.5	12.8
Whittlesea (C)	-0.6	-7.3	-6.4	-4.5	-6.7	8.5
Wyndham (C)	-15.4	-1.9	-4.4	-0.2	-6.2	9.7
Yarra (C)	-3.5	-20.5	-30.2	-18.5	-23.5	63.3
Yarra Ranges (S)	-11.1	-9.5	-4.2	-8.0	-11.0	5.6

6.2.9 Metropolitan Melbourne: Population growth and the cost of achieving an efficient economy

The three major cost components allowing metropolitan Melbourne to accommodate the Victorian Government's population target over the 2017 to 2031 period is shown in Table 6.11.

(i) Limiting the increase in travel times to modest levels.

(ii) Integrating into the mainstream economy that part of the population increase over the 1992 to 2017 period that was economically marginalised, particularly in the six LGAs of interest.

(iii) Preventing a repeat of the 1992 to 2017 increase in that part of the population that is economically marginalised for the 2017 to 2031 period when high rates of population growth are projected to be sustained

Table 6.11 Metropolitan Melbourne 2031: The cost of changing to an efficient economy

	$\$_{cvm}$ **billion**
Backlog costs of population increase, 1992-2031	126
Costs of ensuring population increases 2017-2031 can achieve their full economic potential	141
Costs of reversing the reduction in the redundancy in transport infrastructure, 1980-2017	163
Total	**430**

In Table 6.11 the $\$_{cvm}$217 billion has been reduced to $\$_{cvm}$163 billion to capture those projects currently included in the forward estimates or that are likely to be included and form part of the $\$_{cvm}$217 billion.

Further discounting required. While it is true that the first two estimates in Table 6.11 were prepared using constant travel times there is little doubt that some of the projects included in the $\$_{cvm}$267 billion estimate would be also included in the $\$_{cvm}$163 billion calculation. Without extensive micro analysis it is difficult to know. However a reasonable adjustment would be 25 per cent and a conservative adjustment would be 50 per cent. For this report the $\$_{cvm}$163 billion estimate is further discounted by a third to give a total of $\$_{cvm}$109 billion and therefore an overall net expenditure outlay of $\$_{cvm}$376 billion.

The first two estimates include direct private sector investment in commercial infrastructure that will be undertaken because the public sector expenditures will create the profitable opportunities to justify the expenditures. That is part of the required investment will be leveraged from public sector investments in infrastructure, operating expenses for schools and hospitals, enhanced education and training and investment grants. Currently the Victorian economy the share of public investment to total non-dwelling investment is 30 per cent which is an underestimate of the effective level because of PPP partnership transferring investment to the private sector. If all of the gross $\$_{cvm}$163 billion is assigned to the public sector and 30 per cent of the net balance is also assigned to the public sector or, $64 billion ((376- 163)*0.3) then the total public sector commitment would be $\$_{cvm}$227 billion.

This would require an additional $15 billion annually to 2031, which would not be possible without bipartisan agreement. It will require that current tax reductions planned at the Federal level for the early 2020s be cancelled and acceptance that the national tax burden will have to rise. If this cannot be agreed upon then there is little point in targeting the maintenance of population growth at current rates, as a substantial part of that increase will be surplus to requirements, not only on the basis of past practices but also because the problem will be enhanced by the rapid increase in congestion costs in those regions where much of the increase in population is assumed to reside.

6.2.10 The economic benefits from population growth: Foreign born versus Australian born

The remaining question is, who benefits from population growth? That is, do foreign born, recent foreign arrivals or Australian born receive a disproportionate share of the economic activity?

Using 2016 Census information, which shows the income status (low, medium and high incomes) by individuals by foreign born and Australian born and by residency in 2011 by:

(i) same LGA;

(ii) other LGAs in Melbourne;

(iii) non-metropolitan LGAs;

(iv) interstate LGAs; and

(v) overseas regions,

allows the distribution of resident gross product to the Australian born and overseas born in each LGA to be calculated. This is shown in Table 6.12. Table 6.12(c) shows the per capita income ratios of foreign born in each group to the Australian born. Table 6.11 shows the LGA ratios to the metropolitan average. Table 6.12 shows the foreign born outcome for each LGA to the overall Australian born outcome for Metropolitan Melbourne as a whole.

In general the results indicate:

(i) in general foreign born have a lower per capita resident gross product than Australian born;

(ii) recent foreign born arrivals do particularly poorly compared to either arrival foreign born or Australian born; and

(iii) given the relativities, the outcome for foreign born largely depends on the performance in a region to generate resident gross product.

The data suggests that a high burden of the costs of a poor performing region falls on the foreign born and in particular the newly arrived foreign born. However, the data, in conjunction with the above analysis, is not inconsistent with the view that a lower level of population in the six LGAs of interest would improve the per capita resident gross product outcomes for the Australian born in those regions by allowing increased hours of work per capita of working age population. That is there average income would rise. This strong conclusion, given the methodology of the analysis cannot be assumed to apply to most of the other LGAs because it would have to be proven that the Australian born forced out of the better performing regions by rising house prices partly driven by the influx of foreign born would have achieved the same $ per hour productivity and total hours of work per capita. This analysis lies outside the scope of this scope of this study.

Table 6.12(a) Foreign born income earners: Share of resident gross product – 2017						
	Existing residents 2011	Residents from other Melbourne LGAs 2011-2016	Residents from elsewhere Victoria 2011-2016	Residents from other Australia 2011-2016	Residents from overseas 2011-2016	Total
Banyule (C)	15.6	4.4	0.1	0.4	3.6	24.2
Bayside (C)	17.1	4.7	0.1	0.8	4.9	27.7
Boroondara (C)	18.3	5.7	0.2	1.0	6.1	31.2
Brimbank (C)	37.4	5.0	0.3	0.7	7.1	50.4
Cardinia (S)	11.3	6.2	0.4	0.3	2.1	20.4
Casey (C)	28.0	7.7	0.4	0.8	5.3	42.1
Darebin (C)	18.8	5.0	0.2	0.9	7.1	32.1
Frankston (C)	16.5	3.9	0.2	0.4	2.5	23.5
Glen Eira (C)	22.1	6.8	0.2	1.0	7.6	37.7
Greater Dandenong (C)	42.7	8.2	0.3	0.9	11.6	63.9
Hobsons Bay (C)	19.2	5.2	0.2	0.7	5.4	30.7
Hume (C)	24.8	5.1	0.4	0.8	5.5	36.7
Kingston (C)	20.2	6.2	0.1	0.6	5.1	32.3
Knox (C)	22.3	6.0	0.2	0.5	3.3	32.2
Manningham (C)	27.9	6.3	0.1	0.7	5.4	40.5
Maribyrnong (C)	21.5	7.5	0.4	1.3	8.7	39.4
Maroondah (C)	14.6	5.3	0.1	0.3	3.3	23.5
Melbourne (C)	16.2	7.7	0.5	3.1	28.2	55.7
Melton (C)	21.6	6.6	0.3	0.9	3.8	33.2
Monash (C)	30.2	8.1	0.4	1.2	11.1	51.0
Moonee Valley (C)	16.0	4.7	0.2	0.7	4.8	26.4
Moreland (C)	18.6	5.0	0.2	1.2	7.9	32.9
Mornington Peninsula (S)	14.1	3.0	0.2	0.4	1.6	19.2
Nillumbik (S)	12.1	2.9	0.1	0.3	1.6	16.9
Port Phillip (C)	14.8	6.3	0.3	1.7	11.3	34.3
Stonnington (C)	13.9	6.1	0.2	1.5	10.2	31.9
Whitehorse (C)	21.8	7.5	0.2	0.9	7.8	38.2
Whittlesea (C)	23.4	6.6	0.3	0.9	5.7	36.8
Wyndham (C)	25.8	9.7	0.6	2.1	9.0	47.2
Yarra (C)	12.6	5.6	0.3	1.4	8.9	28.8
Yarra Ranges (S)	13.0	2.7	0.1	0.2	1.3	17.3
Melbourne region	**20.6**	**6.0**	**0.3**	**1.0**	**7.0**	**34.9**

Table 6.12(b) Australia born income earners: Share of resident gross product – 2017						
	Existing residents 2011	Residents from other Melbourne LGAs 2011-2016	Residents from elsewhere Victoria 2011-2016	Residents from other Australia 2011-2016	Residents from overseas 2011-2016	Total
Banyule (C)	58.7	13.0	1.2	2.1	0.8	75.8
Bayside (C)	54.2	13.4	0.9	2.4	1.4	72.3
Boroondara (C)	50.8	12.2	1.4	2.9	1.5	68.8
Brimbank (C)	41.5	6.1	0.7	0.9	0.3	49.6
Cardinia (S)	56.0	18.9	2.7	1.7	0.3	79.6
Casey (C)	46.3	9.3	1.0	1.1	0.3	57.9
Darebin (C)	47.4	13.9	1.8	3.3	1.5	67.9
Frankston (C)	58.5	14.6	1.2	1.7	0.6	76.5
Glen Eira (C)	46.1	11.9	0.9	2.3	1.2	62.3
Greater Dandenong (C)	29.0	5.8	0.4	0.6	0.3	36.1
Hobsons Bay (C)	52.4	11.5	1.6	2.8	1.0	69.3
Hume (C)	52.7	7.1	1.9	1.3	0.4	63.3
Kingston (C)	51.5	12.8	0.9	1.7	0.9	67.7
Knox (C)	55.5	10.1	0.8	1.1	0.4	67.8
Manningham (C)	48.2	9.0	0.5	1.1	0.6	59.5
Maribyrnong (C)	37.9	14.8	2.4	4.0	1.5	60.6
Maroondah (C)	57.4	16.2	1.0	1.3	0.6	76.5
Melbourne (C)	20.3	13.4	2.5	6.1	2.0	44.3
Melton (C)	51.8	11.2	1.9	1.6	0.3	66.8
Monash (C)	38.5	7.8	0.9	1.2	0.6	49.0
Moonee Valley (C)	54.2	13.4	2.0	2.8	1.2	73.6
Moreland (C)	45.2	13.9	2.0	4.3	1.7	67.1
Mornington Peninsula (S)	63.2	12.6	1.5	2.8	0.7	80.8
Nillumbik (S)	66.8	13.5	0.8	1.4	0.6	83.1
Port Phillip (C)	37.7	16.8	2.2	6.1	2.8	65.7
Stonnington (C)	42.3	15.5	1.9	6.0	2.3	68.1
Whitehorse (C)	48.6	10.0	0.9	1.5	0.7	61.8
Whittlesea (C)	48.8	11.0	1.5	1.5	0.4	63.2
Wyndham (C)	42.7	6.1	1.4	2.2	0.4	52.8
Yarra (C)	36.4	21.1	2.4	7.9	3.3	71.2
Yarra Ranges (S)	67.0	12.5	1.2	1.5	0.5	82.7
Melbourne region	**47.9**	**12.0**	**1.4**	**2.6**	**1.1**	**65.1**

Table 6.12(c)	Ratio of average gross resident product for foreign born income earners to Australian born: Share of resident gross product – 2017 (per cent)						
	Existing residents 2011	Residents from other Melbourne LGAs 2011-2016	Residents from elsewhere Victoria 2011-2016	Residents from other Australia 2011-2016	Residents from overseas 2011-2016	Total	Residents from overseas 2011-2016 to average for Australian born
Banyule (C)	95.3	93.9	109.1	95.5	69.7	92.3	76.90
Bayside (C)	101.4	99.4	123.2	110.9	84.7	99.8	92.90
Boroondara (C)	97.5	95.5	129.3	105.6	61.7	90.3	67.62
Brimbank (C)	88.9	86.0	95.2	84.8	65.5	85.3	70.28
Cardinia (S)	96.5	95.1	88.7	82.9	74.6	94.0	77.67
Casey (C)	98.7	92.9	93.2	93.4	79.9	94.5	75.76
Darebin (C)	78.7	89.8	117.6	108.8	61.3	78.8	70.48
Frankston (C)	96.7	97.2	114.9	113.0	71.9	95.9	87.73
Glen Eira (C)	96.3	95.4	104.3	102.8	67.0	90.7	72.69
Greater Dandenong (C)	99.0	98.9	95.4	94.7	72.1	93.8	76.72
Hobsons Bay (C)	84.8	94.0	88.5	91.3	70.7	85.9	83.26
Hume (C)	86.9	92.6	90.4	80.4	67.8	84.3	67.53
Kingston (C)	92.0	94.2	94.3	102.7	71.0	91.0	81.46
Knox (C)	98.7	95.0	114.9	95.6	74.1	96.3	78.64
Manningham (C)	92.9	92.7	98.2	86.6	67.1	88.9	68.44
Maribyrnong (C)	80.3	89.3	113.2	109.8	55.6	77.7	63.36
Maroondah (C)	94.7	95.0	84.1	93.7	59.7	90.5	68.86
Melbourne (C)	84.6	86.2	105.9	99.1	56.4	69.3	57.07
Melton (C)	98.7	91.0	98.2	88.7	73.3	94.7	79.05
Monash (C)	97.6	98.6	159.5	121.7	65.0	89.9	66.32
Moonee Valley (C)	80.1	91.4	102.5	107.4	66.7	81.7	75.95
Moreland (C)	79.1	92.2	114.0	111.0	64.1	80.1	74.21
Mornington Peninsula (S)	97.2	96.4	95.0	106.0	82.0	97.0	95.68
Nillumbik (S)	102.7	104.2	164.8	108.0	86.5	102.0	90.11
Port Phillip (C)	91.5	98.9	116.0	101.2	81.4	92.1	88.62
Stonnington (C)	90.4	95.8	120.0	104.0	71.6	87.8	78.39
Whitehorse (C)	92.7	94.4	107.0	108.3	58.5	85.9	62.75
Whittlesea (C)	87.5	92.8	102.0	94.7	74.0	85.9	70.90
Wyndham (C)	101.2	100.3	102.9	94.4	76.7	96.7	78.87
Yarra (C)	75.6	92.4	126.8	105.1	77.9	82.4	85.80
Yarra Ranges (S)	96.7	95.4	105.0	110.1	70.0	95.5	80.47
Melbourne region	**89.5**	**89.7**	**98.1**	**91.8**	**58.8**	**86.6**	**75.86**

Table 6.13(a)	Foreign born income earners: Share of resident gross product (per cent of Melbourne region average) – 2017					
	Existing residents 2011	Residents from other Melbourne LGAs 2011-2016	Residents from elsewhere Victoria 2011-2016	Residents from other Australia 2011-2016	Residents from overseas 2011-2016	Total
Banyule (C)	75.7	72.8	54.9	40.0	51.7	69.2
Bayside (C)	82.8	78.6	44.4	85.7	70.0	79.3
Boroondara (C)	88.5	94.8	77.4	98.4	86.1	89.3
Brimbank (C)	181.0	82.8	121.3	72.5	100.3	144.4
Cardinia (S)	54.9	103.8	146.8	33.7	30.4	58.4
Casey (C)	135.5	127.8	141.1	85.1	74.5	120.5
Darebin (C)	91.1	84.0	85.8	93.4	101.2	91.9
Frankston (C)	79.9	64.7	68.3	42.5	35.4	67.2
Glen Eira (C)	107.0	113.8	64.4	97.4	108.6	107.9
Greater Dandenong (C)	207.1	137.3	139.6	90.9	165.2	182.9
Hobsons Bay (C)	93.0	86.0	76.7	71.1	77.3	87.9
Hume (C)	120.3	84.4	176.3	85.6	77.8	105.0
Kingston (C)	98.0	103.9	56.4	60.0	72.5	92.5
Knox (C)	108.0	99.9	66.4	48.0	46.8	92.2
Manningham (C)	135.2	105.2	54.5	74.7	76.5	115.9
Maribyrnong (C)	104.3	124.9	140.5	128.7	123.6	112.7
Maroondah (C)	70.7	88.6	32.3	30.5	46.2	67.4
Melbourne (C)	78.5	128.1	195.1	317.2	400.5	159.6
Melton (C)	104.8	109.6	133.2	88.3	54.4	95.2
Monash (C)	146.6	134.6	143.7	125.9	157.4	146.1
Moonee Valley (C)	77.4	78.2	64.2	73.7	68.3	75.5
Moreland (C)	89.9	83.9	83.5	122.3	111.8	94.1
Mornington Peninsula (S)	68.1	49.3	64.6	42.2	23.1	55.0
Nillumbik (S)	58.8	47.7	20.0	26.0	22.1	48.3
Port Phillip (C)	71.5	105.2	106.3	168.6	160.2	98.2
Stonnington (C)	67.3	101.8	86.1	155.0	144.5	91.4
Whitehorse (C)	105.8	124.5	66.5	95.3	111.0	109.5
Whittlesea (C)	113.3	109.7	136.9	88.0	80.3	105.5
Wyndham (C)	125.2	161.6	248.2	209.5	127.8	135.2
Yarra (C)	60.8	92.6	102.5	146.9	127.0	82.4
Yarra Ranges (S)	62.9	45.4	41.7	23.6	18.5	49.7
Melbourne region	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 6.13(b) Australia born income earners: Share of resident gross product (per cent of Melbourne region average) – 2017						
	Existing residents 2011	Residents from other Melbourne LGAs 2011-2016	Residents from elsewhere Victoria 2011-2016	Residents from other Australia 2011-2016	Residents from overseas 2011-2016	Total
Banyule (C)	122.3	108.0	86.5	81.4	77.2	116.5
Bayside (C)	113.1	111.1	64.2	89.6	135.7	111.1
Boroondara (C)	105.9	101.2	98.1	111.8	146.6	105.7
Brimbank (C)	86.7	50.9	48.1	33.8	32.6	76.2
Cardinia (S)	116.7	157.1	189.8	65.0	31.8	122.3
Casey (C)	96.5	77.1	68.2	42.8	27.5	89.0
Darebin (C)	98.9	115.1	130.4	125.5	142.1	104.3
Frankston (C)	122.0	120.9	87.5	63.3	57.2	117.6
Glen Eira (C)	96.1	98.7	61.2	87.8	112.3	95.8
Greater Dandenong (C)	60.4	48.6	29.2	22.2	30.9	55.5
Hobsons Bay (C)	109.2	95.8	115.3	107.7	91.1	106.5
Hume (C)	109.9	59.2	131.4	49.1	34.7	97.3
Kingston (C)	107.3	106.1	62.4	65.0	82.1	104.0
Knox (C)	115.7	83.9	56.1	41.3	33.7	104.2
Manningham (C)	100.6	74.9	36.6	43.2	58.6	91.5
Maribyrnong (C)	79.1	123.2	167.4	152.4	141.3	93.2
Maroondah (C)	119.7	134.3	73.5	49.0	53.6	117.5
Melbourne (C)	42.4	111.0	177.2	231.3	190.6	68.0
Melton (C)	108.0	92.7	135.0	61.8	26.4	102.6
Monash (C)	80.3	64.6	60.6	46.2	61.6	75.3
Moonee Valley (C)	113.0	111.6	140.6	107.0	115.8	113.2
Moreland (C)	94.3	115.3	142.9	162.8	163.2	103.1
Mornington Peninsula (S)	131.9	104.6	108.8	104.9	62.3	124.1
Nillumbik (S)	139.3	112.6	54.6	52.7	58.9	127.7
Port Phillip (C)	78.6	139.9	157.7	233.0	267.7	101.0
Stonnington (C)	88.3	129.2	131.2	228.5	220.9	104.6
Whitehorse (C)	101.3	83.5	67.1	56.7	66.2	94.9
Whittlesea (C)	101.8	91.0	105.5	57.4	36.9	97.1
Wyndham (C)	89.0	50.6	102.3	82.9	36.2	81.1
Yarra (C)	76.0	175.4	173.7	299.6	316.8	109.5
Yarra Ranges (S)	139.8	103.7	83.3	55.4	45.7	127.0
Melbourne region	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 6.14	Ratio of average gross resident product for foreign born income earners to total average for Australian born across all metropolitan LGAs: Share of resident gross product – 2017 (per cent)					
	Existing residents	**Residents from other Melbourne LGAs**	**Residents from elsewhere in Victoria**	**Residents from other Australia**	**Residents from overseas**	**Total**
Banyule (C)	91.9	109.3	97.2	105.6	76.7	92.0
Bayside (C)	143.5	165.0	206.9	183.1	136.5	146.6
Boroondara (C)	135.4	153.3	141.7	158.9	96.2	128.6
Brimbank (C)	61.6	73.1	72.3	65.3	50.0	60.6
Cardinia (S)	82.0	87.4	72.6	69.1	67.1	81.2
Casey (C)	71.8	77.5	67.8	74.7	56.4	70.4
Darebin (C)	79.0	107.4	97.5	109.2	73.0	81.7
Frankston (C)	75.8	88.0	83.1	90.3	70.6	77.2
Glen Eira (C)	113.8	134.9	110.7	138.2	89.2	111.2
Greater Dandenong (C)	63.5	79.6	64.1	68.1	51.0	62.4
Hobsons Bay (C)	85.1	118.3	99.2	111.5	87.5	90.4
Hume (C)	60.4	74.3	67.5	61.1	47.8	59.7
Kingston (C) (Vic.)	89.8	111.3	96.8	117.3	82.7	92.4
Knox (C)	81.9	91.7	95.4	85.2	66.8	81.8
Manningham (C)	96.4	111.6	100.2	104.5	72.8	94.5
Maribyrnong (C)	87.5	116.7	113.4	128.6	72.3	88.7
Maroondah (C)	87.3	102.3	78.5	94.0	65.7	86.3
Melbourne (C)	120.8	128.5	107.5	121.9	78.8	95.7
Melton (C)	70.3	72.1	67.9	63.9	57.3	68.6
Monash (C)	94.0	110.6	113.2	107.6	64.8	87.8
Moonee Valley (C)	88.1	120.7	113.6	131.6	86.8	93.3
Moreland (C)	80.8	112.9	109.7	116.5	78.8	85.1
Mornington Peninsula (S)	83.1	93.9	81.1	95.6	83.7	84.9
Nillumbik (S)	101.9	119.0	163.4	119.1	91.6	103.7
Port Phillip (C)	144.7	173.7	175.5	169.7	145.1	150.8
Stonnington (C)	147.4	174.2	171.8	184.9	131.9	147.8
Whitehorse (C)	93.4	110.6	83.5	111.3	64.5	88.3
Whittlesea (C)	65.8	78.2	74.0	73.4	54.3	65.8
Wyndham (C)	81.1	89.5	83.3	80.3	64.2	78.7
Yarra (C)	116.1	158.2	171.5	171.6	137.1	131.7
Yarra Ranges (S)	77.2	88.8	80.4	91.8	65.7	77.9
Melbourne region	**85.4**	**105.2**	**92.1**	**107.4**	**75.9**	**86.6**

7. Population growth and its effects on some other KPIs

7.1 Scope

This section of the report moves from productivity to consider a range of other KPIs from Table 3.1 and considers their future performance under sustained high population growth, drawing on the findings of Section 4. We focus primarily on indicators that our analysis in Section 4 suggests are correlated with population growth and/or the distribution of this growth, including where that analysis suggests that there may be equity consequences in terms of access to urban opportunities, such as jobs, natural areas and open space, and thus personal and broader societal consequences.

7.2 Congestion costs and influencing factors

7.2.1 Future congestion costs

BITRE (2015) data was used in Section 4.3 to estimate average and marginal congestion costs for Melbourne in 2015. Given the very high population growth rate that is currently being experienced in Melbourne and is projected in VIF, we use the BITRE *high VKT growth scenario*, which sees Melbourne's population increase to 6.09m in 2030, with a projected road traffic volume of 61.59bvkms and avoidable congestion costs of $13.16b, to derive implicit marginal congestion costs over the 2015-2030 period. This population growth projection, associated with the BITRE *high VKT scenario*, produces average congestion cost in 2030 of 21.4c/vkm, almost double the level of 2015. Implicit (averaged) marginal congestion costs over the 15 year period are 40c/vkm, reflecting the increasingly steep slope of the congestion cost curve.

Regional development strategy is one possible policy option to help tackle congestion costs, since shifting some population growth to regional areas could substantially reduce the burden of congestion costs. Over the next 15 years, for example, with 2015 *average congestion costs* at 11.4c/vkm, and *marginal congestion costs* over the period to 2030 averaging around 40c/vkm under the high growth scenario, marginal congestion costs in Melbourne could conservatively be reduced by around 15c/vkm, if VKT growth could be kept to a low rate. For 1 million population growth diverted from Melbourne to regional Victoria, about half of whom would otherwise each be making 2 car trips/day in Melbourne of ~10 kms trip length, this congestion cost saving could be worth around $800 million a year to Victorians over the 15 year period to 2030 (congestion costs created in regional Victoria would be an offset but should be minimal).

Interestingly, and optimistically, if average congestion costs could be held at the 2015 figure of 11.4c.vkm, rather than increasing to 21.4c/vkm by 2030 as in the BITRE high vkt scenario, 10c/vkm would be saved across the *total projected traffic volume,* implying savings in 2030 of $6.2b. This shows the massive potential benefits available from containing growth in congestion costs.

It is interesting to compare the potential $6.2b saving in projected annual congestion costs in 2031 (in 2010 prices), if congestion was to be kept at current levels, with our $$_{cvm}$163 billion estimate (in 2015-16 prices) in Section 2.6.8 of the additional capital stock required to offset the projected travel time increases in Infrastructure Victoria's analysis of congestion in coming years. We increase the $6 billion by 15 per cent to $7.1 billion, to give approximately equal real price levels (2015-16 prices) for the comparison. Spending $163 billion to save $7 billion in congestion costs suggests about a 4.4 per cent return on investment in that year, which could be possibly doubled when it is recognised that there will be benefits beyond just travel time savings from a well-planned transport infrastructure program (e.g. productivity improvements – with our analysis of the public transport contribution to productivity improvements summarised in Table 4.2 and discussion thereof – safety benefits, social inclusion, GHG emission reductions, improved health, etc.). A real return of about 7 to 8 per cent is in the right ball park for an effective investment program. Ideally, however, road pricing reforms should be in place before such an investment program is contemplated.

7.2.2 Land use transport policy impacts on growth in car traffic volumes

The analysis and discussion in Section 4.3 suggested that land use transport policy can affect growth in road traffic volumes and, by implication, affect the level of congestion costs. The independent variables from the models in Tables 4.5 and 4.6 were used to explore the broad implications of the following population growth scenarios for Melbourne.

- **Scenario 1:** Melbourne's population increases by 1 million people (24.3 per cent), which would broadly take it from 2011 to 2021 in terms of population projections in Victoria in Future (DELWP 2016), with this increase all happening at 2011 densities and no other independent variables changed. This scenario might be labelled *continued urban sprawl.*
- **Scenario 2:** Melbourne's population increases by 1 million people, with all this increase being taken up by population density and job densities increasing at the same rate (24.3 per cent) (i.e. no further sprawl). This is a *partial SmartGrowth* scenario.
- **Scenario 3:** As in Scenario 2 but with PT mean travel times reduced by 10 minutes and car mean travel times increased by 5 minutes. This is the partial SmartGrowth scenario backed up by transport policy to achieve mode shift from car to PT, making it a *SmarterGrowth* scenario.

The projected effect of these scenarios on AM peak car and PT trip numbers for the typical SA2 are set out in Table 7.1. The scenarios show the way future population growth tends to increase demand for car travel, even if the projected car mode share declines marginally. This effect is strongest in Scenario 1, the *urban sprawl* scenario, where AM peak car trips are projected to grow by 26.3 per cent. Increasing density (*Partial SmartGrowth*) reduces this rate of growth in car use to 23.1 per cent, as shown by Scenario 2. Improving PT travel speeds and allowing car speeds to continue to decline, as they have been doing for over a decade in Melbourne, and catering for population growth by increasing density (*SmarterGrowth*), is where the largest relative gains in PT use are achieved but that Scenario 3 still projects 16.3 per cent more AM peak car trips in 2031 than in 2011 for the typical SA2 in a Melbourne with one million more people in total. PT use is projected to be 50.1 per cent higher under this scenario than in the 2011 base case but is only projected to be 19.8 per cent higher than the base level in Scenario 1, which implies a declining mode share if all growth is sprawling at low density. The high-density growth Scenario 2 shows a PT mode share that increases only slightly over the base case, to 13.1 per cent (from 12.8 per cent).

Table 7.1 Testing future scenarios and their effect on AM peak car and PT trip rates at SA2 level

Scenario	Modelled SA2 car trips (motorised mode share)	Modelled SA2 PT trips
2011 base case	6893 (87.2%)	1009 (12.8%)
Scenario 1	8703 (87.8%)	1209 (12.2%)
Scenario 2	8487 (86.9%)	1281 (13.1%)
Scenario 3	8020 (84.1%)	1515 (15.9%)

Source: Authors' estimates.

The analysis outlined above did not have the benefit of data on public transport service density (e.g., perhaps measured as available PT service kilometres per square kilometre), as another possible explanatory variable of PT use in Table 4.6. However, in some separate analysis one of us has undertaken on 15 Canadian and US public transport systems, population and PT service density alone explain three quarters of the variation in unlinked bus trips per capita across the 15 cities, with service density highly significant (p=.000). In log format, the elasticity of per capita unlinked bus patronage with respect to service density is 0.7, suggesting that a doubling of bus service kilometres would lead to a 70 per cent increase in unlinked bus trips per capita. This suggests that faster rates of growth in PT use, than implied by Table 7.1, would be achieved in Melbourne if PT service densities were increased. For example, as a rough exercise to dimension scale, increasing PT service densities by 50 per cent and applying the North American bus elasticity to all modes (not just bus) suggests that per capita PT patronage would increase by 35 per cent. Population growth is already included in the projections of Table 7.1 but adding per capita increases of this scale would lift the PT patronage numbers at SA2 level to over 2000 in Scenario 3, more than double the 2011 figures. This service density effect would thus be larger than the projected increase from the increased population and job densities, faster PT travel times and slower car travel times embedded in Scenario 3. If all this increase was achieved via mode shift from car, the increase in car trips from 2011 would be reduced by over 40 per cent in Scenario 3. Mode shift will not provide all the increase but will make an important contribution to slowing the rate of growth in car use.

An important implication of this analysis is that slowing the growth in AM peak car use, to ease congestion cost pressures (and other external costs of road traffic), requires increasing densities, improvements to PT services *and* constraints on car use, such as road user charges that better reflect the social costs caused by (peak) road use (Stanley and Hensher 2017). Further analysis by Stanley, Ellison, Loader and Hensher (2017), using Sydney as a case study, suggested that increasing fuel costs by 25 per cent, to bring these costs more into line with the social costs of city road use, would only result in a six per cent reduction in car trips but that this would be associated with a substantially greater effect on VKT, with a reduction of approximately 25 per cent. The Sydney work used modelling that allowed residential location decisions to change with major changes to the transport network, producing higher response elasticities than from the more traditional transport demand modelling used in the Melbourne analysis reported above. The Sydney model has not been estimated for any other Australian city.

7.3 Educational achievement

7.3.1 Child developmental delays

Section 4.10 found a significant correlation between the rate of an LGA's population growth and the percentage of children living in that LGA who are vulnerable on one or more developmental domains. It also found significant negative correlations between child developmental vulnerability and a number of social capital type indicators at LGA level and an LGA's SEIFA IRSD index. A simple multiple regression model, in which child developmental vulnerability was expressed as a function of population change from 2011 and 2016 and an LGA's SEIFA IRSD rating, as estimated in Table 7.2, achieved an adjusted R^2 of 0.80.

This simple model was used to predict the effect of population growth from 2016 to 2031, as projected in VIF, on child developmental vulnerability, with the SEIFA ratings left unchanged. The model predicts an increase in the unweighted average percentage of children, at LGA level, with one or more developmental vulnerabilities of three percentage points (from 18.4 to 21.6). Because of the inclusion of population growth in the model, the largest increases in vulnerability percentages occur in the fastest growing LGAS, which are Melton, Cardinia, Maribyrnong, Wyndham, Hume, Whittlesea, Casey and Melbourne. As pointed out elsewhere, the application of these simple correlation models does not prove causation but does raise potential concerns that need attention under a high growth outlook. In this case, child developmental vulnerability is the issue to watch, with outer growth suburbs a concern because of their projected high population growth rates.

Table 7.2 Child developmental vulnerability, population change and socioeconomic status at LGA level

Model	Unstandardised Coefficients B	Unstandardised Coefficients Std. Error	Standardised Coefficients Beta	t	Sig.
(Constant)	105.947	10.115		10.474	0.000
Population change 2011-16 (%)	0.165	0.045	0.310	3.647	0.001
SIEFA SIEFA index	-0.087	0.010	-0.765	-9.003	0.000

Coefficients[a]

Note: a. Dependent Variable: Child development vulnerability on at least one aspect.
Source: Authors.

7.3.2 Year 9 literacy and numeracy

The discussion in Section 4.11 showed significant correlations between Year 9 literacy and numeracy standards at LGA levels and a number of variables, including the LGA SEIFA index and, in the case of literacy, distance from Melbourne. Rate of population increase was not significantly correlated with Year 9 literacy or numeracy achievement.

A regression model was developed to explore to relationship for Year 9 literacy standards met, as a function of the SEIFA IRSD index and distance from Melbourne. Table 7.3 shows the resulting equation, where the SEIF IRSD variable is significant at the 1 per cent level and distance at a 5.5 per cent level. Variation in the two variables included in the model explains 66.5 per cent of the variation in Year 9 literacy achievement. Year 9 literacy rates increase with SEIFA rating but decrease with distance from Melbourne. As with child developmental vulnerability, with which Year 9 literacy standards are highly correlated, increasing population numbers at increasing distances from Melbourne should be seen as a risk factor for Year 9 literacy achievement.

Table 7.3 LGA level Year 9 literacy achievement

Model	Unstandardised Coefficients B	Unstandardised Coefficients Std. Error	Standardised Coefficients Beta	t	Sig.
(Constant)	40.803	7.726		5.282	0.000
SEIFA IRSD index	0.052	0.007	0.758	7.021	0.000
Distance to Melbourne	-0.048	0.024	-0.216	-2.000	0.055

Coefficients[a]

Source: Authors.

7.4 Accessibility

Figures 4.10(a) and (b) showed morning peak access to jobs within 30 minutes travel time by car and public transport in 2017 at LGA level, rating this as high, medium or low. A similar analysis was done for 2031, as shown in Figures 7.1 for car and 7.2 for public transport. The 2017 access levels are shown for comparison purposes. Figure 7.1 shows 2031 improving job access for parts of the west, north and south-east, as compared to 2017, linked to the road improvements in the intervening period. Figure 7.2 shows improved PT access for parts of the north and south-east but with PT accessibility still far below that by car, at LGA level. Given that road congestion levels are projected to increase, job dispersal must be a key contributor to the improved accessibility by car.

Figure 7.1: Access to jobs within 30 minutes by car – 2017 and 2031

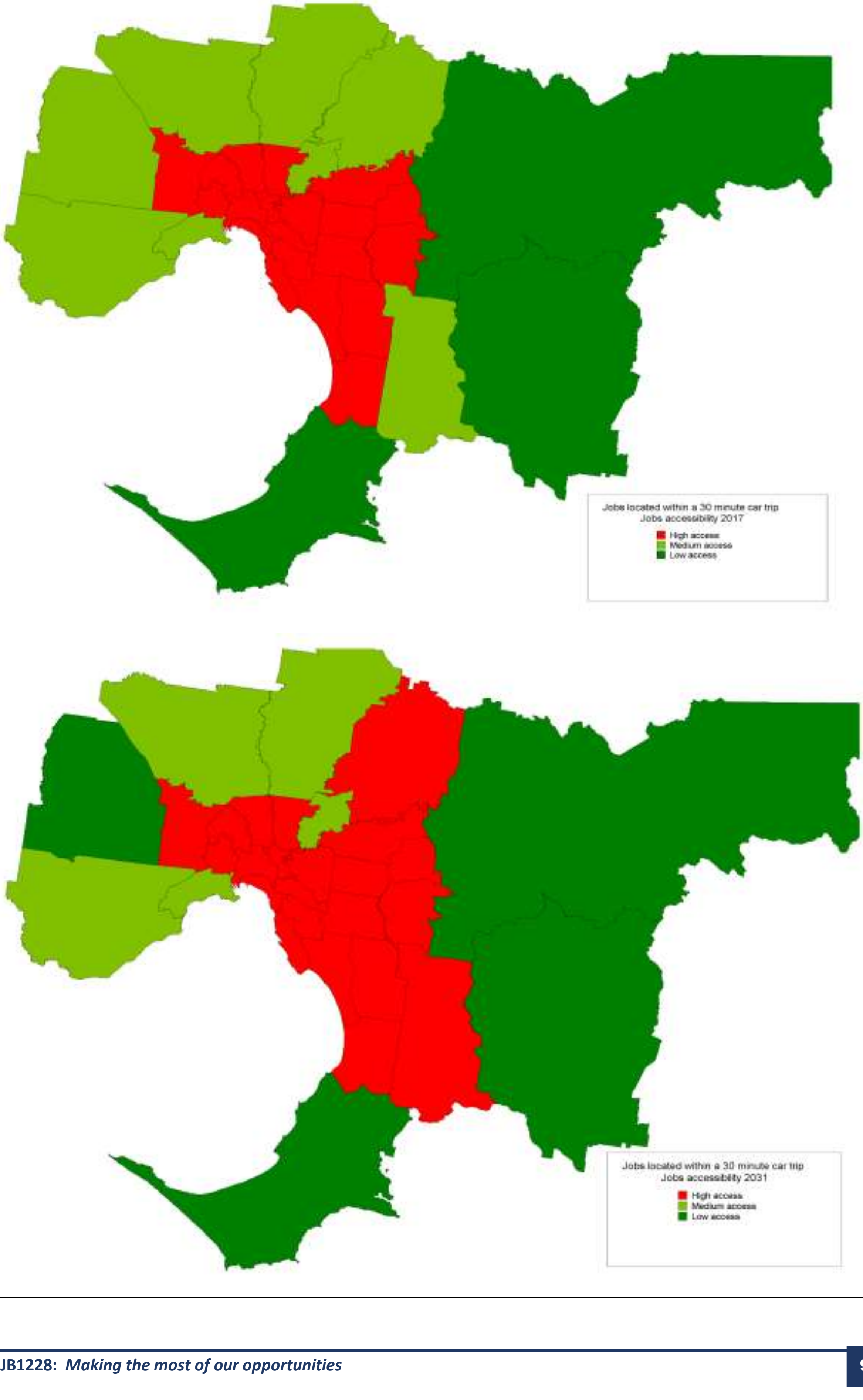
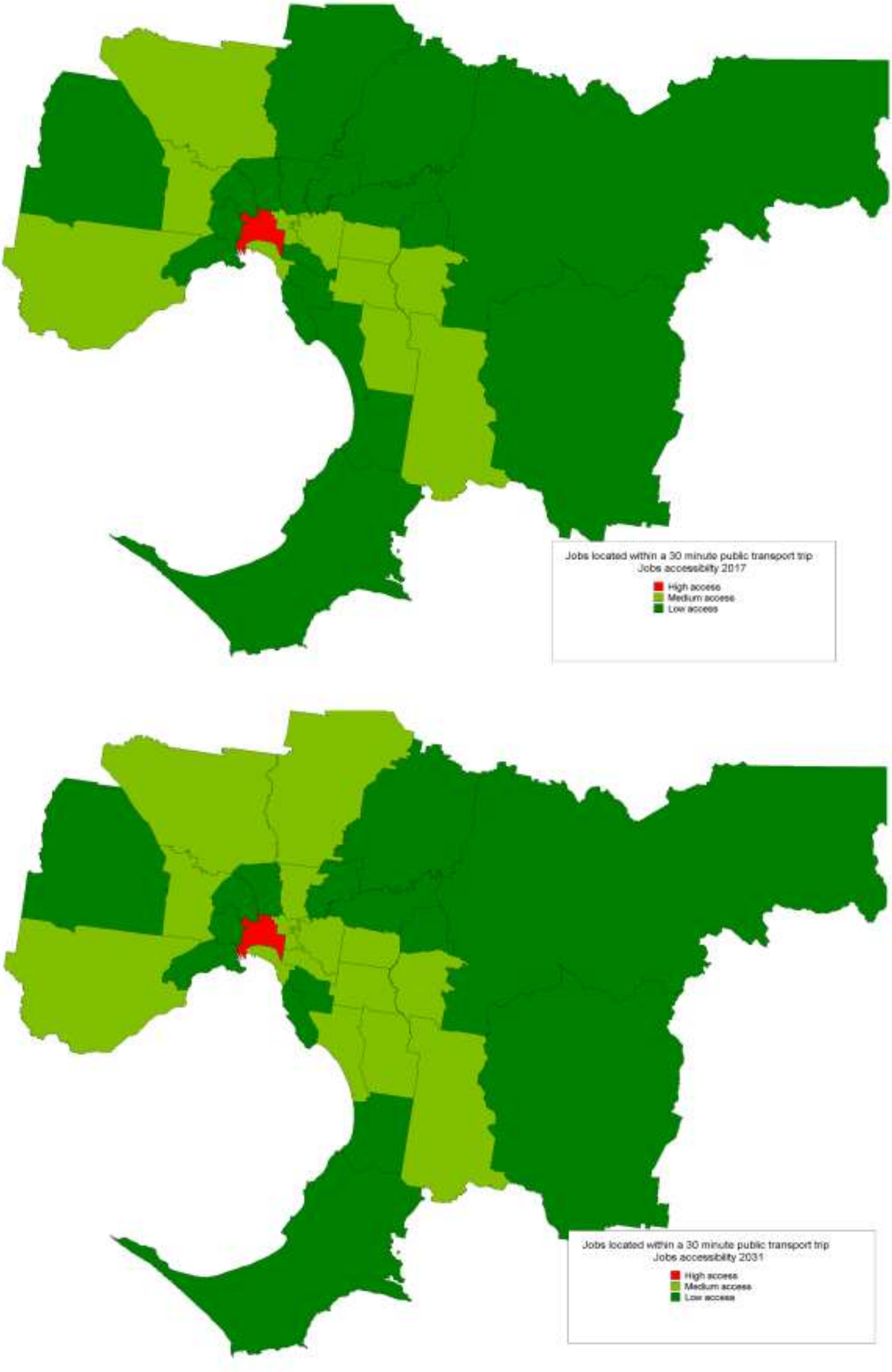


Figure 7.2: Access to jobs within 30 minutes by public transport – 2017 and 2031



7.5 Greenhouse gas emissions

Road transport

Section 4.7 pointed out that road transport accounts for about 15 per cent of total Australian GHG emissions and that emissions from the sector are on the rise. Section 6.3 drew on BITRE's (2015) *high VKT scenario* for Melbourne traffic growth, which assumes high population growth. That resulted in a projected road traffic volume of 61.59bvkms in 2030, some 73 per cent higher than 2005 levels. Against this background scenario, what might be required to achieve reductions in GHG emissions from Melbourne road transport that are in line with the national commitment to achieve reductions of 26-28 per cent on 2005 levels by 2030?

The analysis by Stanley, Ellison, Loader and Hensher (2017) indicates that reducing road transport GHG emissions at this rate requires both *technological changes*, that reduce emissions intensities per motorised kilometre travelled, and *behaviour changes*, that reduce vehicle use. They conclude that mandatory emissions standards, in line with European standards, should be implemented in Australia as a matter of urgency, to drive reduction in emissions intensities. Their analysis suggests that alignment with European standards for emissions intensity (grams CO_2/vkm) could deliver reductions for cars/light vehicles of around 56 per cent on 2005 levels by 2030 and 40 per cent for heavy vehicles, depending on how quickly new emission standards permeate the vehicle fleet. If traffic volumes increase by around 73 per cent between 2005 and 2030, as implied in the BITRE (2015) high VKT scenario, and emissions per vehicle kilometre reduce by just over half for cars/light vehicles and 40 per cent for heavy vehicles/trucks (say 45 per cent overall), then emissions in 2030 will be around 95 per cent of 2005 levels, with a further reduction of around 20 per cent in VKT required to be 26-28 per cent below 2005 levels in 2030.

What opportunities exist to slow growth in Melbourne's VKT, such that traffic volumes in 2030 are only about 80 per cent of those projected in the BITRE (2015) high VKT scenario? Slowing the rate of population growth is an obvious possibility, given the unitary elasticity of car trip volumes with respect to population noted in Section 4.3 (i.e. doubling population doubles car trips). Beyond changing population numbers, reducing VKT requires a combination of:

1. **reducing motor vehicle trip lengths**. Land use planning to achieve more compact urban form is important in this regard but is not happening to a sufficient extent under the current surge of population growth, as illustrated in Section 1.1. Building additional road capacity, as is currently taking place, has an adverse effect, because it will add to motor vehicle trip rates and trip lengths, as amply demonstrated by Duranton and Taylor (2011), a key reference that seems to have escaped most Melbourne politicians, transport planners and transport policy makers;
2. **reducing the motor vehicle mode share for passenger movement and increasing the shares for public transport and active travel (walking and cycling).** For public transport, this requires improved offerings in terms of frequencies, spans, operating speeds, reliability, fare levels, etc. The current major building program for heavy rail, with related investments (e.g. signalling, trains) is supportive but the neglect of local travel opportunities in outer suburbs is a negative. Walking and cycling have both been relatively neglected in Melbourne land use transport planning and should be given much higher priority. More compact development, along the 20 minute neighbourhood line, with a conscious focus on active travel, is key to progress in this regard (as well as achieving many social benefits);

3. **increasing car occupancy rates,** which are very low and declining. Pricing road use to better reflect the costs imposed on wider society is the simplest and most direct way to encourage higher vehicle occupancy rates, while also supporting progress on the preceding two policy directions; and

4. **improving road freight efficiency** (e.g. capacity utilisation). Pricing is also a key here.

This set of measures recognises that urban transport cannot be detached from desired land use futures, being linked through the vital integrating concept of accessibility. A focus on reducing VKT implies an important shift from the traditional transport planning focus on **mobility** to a focus on **accessibility**, in line with the now widely agreed proposition that the main purpose of transport is access to opportunities, rather than movement per se. As Levine et al. (2012, p.158) point out:

> *"If the purpose of transportation is not movement but access, then increased mobility is desired only to the extent that such a change also increases accessibility over time*."

Levine et al. find that denser metropolitan areas have slower travel speeds but greater origin-destination proximity. Lower travel speeds reduce accessibility but proximity increases it. They conclude that the proximity effect dominates, such that denser urban areas are more accessible. Slower rates of growth in VKT thus need not imply lower levels of accessibility. This is strongly supportive of arguments for more compact Australian cities.

Scenario 3 in Stanley, Ellison, Loader and Hensher (2017) included elements that could reduce AM peak car/light vehicle VKT by up to about 15 per cent beyond projected outcomes from an urban growth path that involved only continued low density development (freight was not part of that analysis). This outcome would require all population growth to be accommodated by higher densities, a dramatic and unrealistic change from current patterns. It would also require improvements in public transport service levels, including service densities (happening for heavy rail services at present but not for light rail or bus), and some slowing of road travel speeds, relative to PT speeds (less likely given the current road investment surge).

As noted in Section 7.2.2, Stanley, Ellison, Loader and Hensher (2017) also undertook some analysis for Sydney, where they include feed-back effects from transport improvements to residential location decisions. That analysis showed the importance of road pricing reform for reducing VKT, by looking at the effects of road users being charged costs that more accurately reflect the wider social costs of their travel choices. Although increasing fuel costs by 25 per cent (to bring the wider social costs of road use more into line with the associated social costs) only resulted in a reduction in car *trips* of 6 per cent, this policy had a substantially greater estimated effect on *VKT,* with an estimated reduction of approximately 25 per cent. In association with mandatory emissions intensity standards along European lines, this would go a long way to achieving the required reductions in car use required to cut motorised vehicle emissions by 26-28 per cent by 2030.

Stanley, Ellison, Loader and Hensher (2017, p. 87) conclude that:

> *"... to reduce greenhouse gas emissions, land use planning in Australia's cities needs to increase the priority accorded to urban infill, substantially increasing development densities on the urban fringe, orienting development patterns to support the emergence of a small number of knowledge-based suburban clusters, and 20 minute neighbourhoods across the whole city. At the same time, increased priority for a larger mode share for active transport and public transport is required. The significant and increasing dependence on urban private toll-road initiatives in the largest cities is a challenge that would need to be overcome here. Setting high mode share targets for active and public transport, as Vancouver has done, and supporting this with plans to deliver on those targets, is a transparent and accountable way to approach this mode switch challenge. A target of around over 40 per cent of city trips in 2030 to be by active or public transport would be a good start, generating benefits of lower congestion, a lower road toll, cleaner air and improved health, as well as lower GHG emissions."*

It would also improve social outcomes. Road pricing reform should be an early priority to help drive such changes. Targets for constrained growth in VKT should form part of the next update of *Plan Melbourne*, with associated targets for mode shares for PT and active transport. A focus on VKT is a significant target within Vancouver's thinking, the region's long term transport strategy (Translink n.d.; Translink 2013) articulating a target that 50 per cent of all trips by 2045 will be made by walking, cycling or public transport (the share was 27 per cent in 2011) and that the distance people drive will be reduced by one-third. Melbourne should adopt a long term transport strategy, consistent with *Plan Melbourne 2017-2050*, and it should include targets for VKT growth that are consistent with GHG emission reduction targets.

7.6 Greening and open space

7.6.1 Access to green cover

Figure 4.13 showed current levels of green cover across Melbourne. We have no basis for projecting this into future years. That figure makes it clear, however, that rapid population growth in Wyndham, Melton and Hume will put increasing numbers of people in locations where green cover is already at relatively low levels, suggesting that increasing green cover should be an early priority in these areas in particular, because of establishment lead times. Discussion in the following two sub-sections is also relevant to green cover.

7.6.2 Access to natural areas

In line with UK thinking, Section 4.10.2 suggested possible targets or *standards* of everyone being within 500 metres of accessible woodland of at least 0.75 ha in size and 1ha of Local Nature Reserve per 1000 population being available (two of the three types of natural area that some UK standards encompass). That section suggested that 2/31 LGAs in Greater Melbourne did not meet this standard in 2016, with total population of around 260,000 affected. How would population growth affect this outcome and what might it cost to meet the 'standard'?

Using the population projections from VIF, there would be 6 LGAs that do not meet these standards for provision of conservation areas, natural or semi-natural areas at 2031 (Glen Eira, Maribyrnong, Melbourne, Moreland, Stonnington and Yarra). All these LGAs are in inner Melbourne, as defined in Section 1, or immediately adjacent thereto. Bringing each of the 6 LGAs up to the standards in 2031 would require an additional 406ha of conservation areas, natural or semi-natural areas to be added (the 2016 shortfall was 283 ha across 2 LGAs). With careful attention to location, it might be possible to reduce this total requirement marginally. The level of development of the 6 LGAs is such (2016 average gross densities of between 10-20 dwellings/ha) that a substantial component of the land provision for such natural areas will need to come at the cost of residential development (i.e. knocking some dwellings over) and will carry a hefty price tag. Median dwelling prices and gross densities as at 2016 were used to obtain a rough estimate of the relevant property acquisition cost to provide the additional natural areas. The estimated acquisition cost to cover the shortfall at 2016 was $5.6b, rising to $7.6b to cover the gap for 6 LGAs in 2031. The relevant cost would probably be considerably greater for 2031 because:

- densities will increase over time, as infill accelerates;
- property prices are likely to continue increasing in real terms, compounded by these density increases (but perhaps offset somewhat by declining dwelling size); and

- the cost of works to demolish property and establish the natural areas would need to be added.

Conversely, some economies may be available through conversion of street space, waterways and linear transport corridors to urban forest. Benefits would be gained through the opportunity to achieve a range of goals by removing car space on roads and replacing these with linear parks with walking and cycling options.

7.6.3 Access to other open space

Section 4.8.3 noted the Australian open space standard of 2.83ha/1000 population, pointing out that some 15 inner/middle urban LGAs, out of a total of 31 in Greater Melbourne, are currently below this standard or benchmark. These LGAs had a total population of 2.1 million in 2016, before considering any future population increase.

After projected population growth is taken into account, 21of 31 LGAs fall short of the 2.83ha/1000 population benchmark by 2031, including some outer urban LGAs which met the standard in 2016 (Whittlesea and Wyndham). The additional open space requirement to meet 2.83ha/1000 residents across the 21 LGAs totals 3820ha, or almost ten times the requirement for additional conservation, natural and semi-natural areas (2030ha). Whitehorse, Stonnington, Glen Eira, Bayside and Boroondara have the largest projected shortfalls, all being areas with high property prices where adding open space would come at a high price. If a similar approach to costing this additional land requirement is used as for projected additional conservation/natural/semi-natural area requirements (hectare shortfall multiplied by 2016 dwelling density and 2016 property prices), the property acquisition cost for additional open space would be $45 billion (in constant 2016 prices). For similar reasons as elaborated in Section 7.6.2, this cost is likely to be an underestimate. Adding open space and conservation, natural and semi-natural areas would, of course, improve the extent of urban green cover.

7.7 Social capital

7.7.1 Trust people in general and trust people in the neighbourhood

Analysis in Sections 4.9.1 and 4.9.2 suggested that there was no significant correlation between an LGA's rate of population growth from 2011 to 2016 and the proportion of LGA residents who believe that others can be trusted but that there is a significant negative association between an LGA's population growth rate and LGA residents' trust of neighbours. A simple multiple regression model was developed in Section 4.9.2, to suggest the way in which LGA population, LGA population growth rate from 2011-2016 and LGA SEIFA IRSD index influence trust in neighbours. Population and population growth rate were both negative influences in the resulting model (set out in Table 4.7), whereas the IRSD index contributed positively.

The model was used to suggest how a larger Melbourne population at LGA level, as reflected in the VIF projections for 2031, and the population growth rate by LGA between 2016 and 2031, also as per VIF, might affect the level of trust of neighbours, assuming no change in LGA SEIFA IRSD ratings. Because of the negative coefficients on both population and population growth, the predicted rating on trust of neighbours falls for every LGA. The average LGA score (unweighted by LGA size) on trust of neighbours was 70.7 in the base year, this being estimated to fall to 64.8 in 2031, should relationships as estimated in the regression model hold into the future. The largest predicted falls in this trust measure were in the fast growing LGAs: Melton, Wyndham, Cardinia, Casey, Whittlesea and Hume. By the nature of the model, the smallest adverse impacts were felt in smaller LGAs (by population size) with low growth rates, such as Nillumbik. Correlation does not mean causation but this result should be seen as a cautionary signal for governments to work on the level of trust among neighbours during a period of strong population growth, or risk reducing valuable social capital.

7.7.2 Networks

Section 4.9.3 identified a number of statistically significant correlations involving number of people spoken to yesterday. Perhaps the most interesting, in terms of the purposes of the current paper, was the correlation with LGA productivity (GRP per hour worked – based on GRP measured as estimated LGA gross value added of all resident producers at market prices, plus taxes less subsidies on imports, rather than an LGA catchment level assessment, as used in much of Section 6), more people spoken to yesterday was associated with stronger LGA productivity (r= .562; =p=.001). This network measure was also significantly correlated with trust in others in general and trust people in your neighbourhood, while a significant negative correlation was identified between social networks and population growth rate between 2011 and 2016 (relevant correlation coefficient and significance levels are detailed in Section 4.9.3).

Given the report's interest in productivity, population growth and the way social variables might affect productivity growth, the association between social networks (measured by the number of people spoken to yesterday), trust others and productivity (value added/hour worked) at LGA level was explored using multiple regression, with productivity the dependent variable (GRP per hour worked). NIEIR research has shown that productivity in Melbourne and Sydney declines with increasing distance/travel time from the centre, so travel time to Melbourne was added to the model in Table 7.4, to see if it is a significant contributor. Travel time to Melbourne is a better fit in log form and the other variables work equally well in that format, so a log model was estimated. The estimated coefficient values shown in Table 7.4 are thus directly interpretable as elasticities. The Adjusted R^2 value for this model is .459.

Travel time from an LGA to Melbourne has a negative impact on LGA productivity that is significant at the 5 per cent level, while the elasticity of productivity with respect to population change is .063, which is in line with expectations. It implies that doubling the rate of LGA population growth will increase productivity at LGA level by 6.3 per cent but there is a negative productivity influence when this growth happens at greater travel time from central Melbourne. Trust in others is not significant but number of people spoken to yesterday is, at a 1 per cent level.

Table 7.4 LGA productivity linked to social outcomes (2031)

Coefficients[a]

Model	Unstandardised Coefficients B	Unstandardised Coefficients Std. Error	Standardised Coefficients Beta	t	Sig.
(Constant)	-6.165	3.329		-1.852	0.075
Travel time to Melb in logs	-0.073	0.034	-0.369	-2.130	0.043
Pop change 2011 to 2016 in logs	0.063	0.027	0.401	2.355	0.026
Trust others in logs	0.149	0.117	0.251	1.280	0.212
People talked to yesterday in logs	3.828	1.350	0.555	2.835	0.009

Note: a. Dependent Variable: Productivity in logs
Source: Authors.

The model in Table 7.4 was used to predict how projected population growth between 2016 and 2031 would affect productivity levels (value added/hour worked) by LGA, using the elasticity value on population growth of 0.063. The largest predicted increases are, of course, associated with the fastest rates of population increase. For example, Melbourne's (City's) productivity (GRP/hr worked) is predicted to increase by 3 per cent, Wyndham by 2.9 per cent, Whittlesea by 2.4 per cent, Cardinia by 2.2 per cent and Melton by 2.1 per cent. The model suggests, however, that productivity levels in outer urban LGAs are dampened by longer travel times to Melbourne, reflecting the much more detailed analysis of Section 6. Outer urban LGA productivity will also be dampened by the impact of the smaller numbers of people talked to yesterday in outer urban LGAs (see Section 4.9.3), given the significant correlation this variable has with productivity at LGA level, which suggests social network development as a focus area for raising outer urban productivity levels.

7.8 Health

7.8.1 Obesity

Obesity reporting at LGA level is highly correlated with LGA distance from central Melbourne (r=.711; p=.000), per cent journey to work by car (r=.728; p=.000) and having a commute of at least 2 hours (r=.623; p=.000). These latter 3 variables are also highly correlated with each other. Obesity reporting is also associated with an LGA's SEIFA IRSD rating, higher ratings being associated with lower reporting rates (r=-.459; p=/001). In terms of seeking to explore how population growth might impact on obesity reporting, we estimated a simple model that predicted LGA level obesity reporting rates with LGA distance from Melbourne and SEIFA IRSD rating. Distance from Melbourne will pick up some of the influence of mode choice, with higher rates of car use for the journey to work at more distant locations being associated with higher obesity reporting rates. Table 7.5 sets out the model that was estimated (Adjusted R^2 = .58). Reporting rates increase with increasing LGA distance from Melbourne but reduce with an increasing SEIFA IRSD rating.

Table 7.5 Obesity reporting rate mode

Coefficients[a]					
Model	Unstandardised Coefficients B	Unstandardised Coefficients Std. Error	Standardised Coefficients Beta	t	Sig.
(Constant)	48.854	13.851		3.527	0.001
Distance to Melbourne	0.230	0.043	0.645	5.348	0.000
SEIFA IRSD index	-0.036	0.013	-0.329	-2.728	0.011

Note: a. Dependent Variable: Obesity report %.
Source: Authors.

The predicted reporting rates by LGA from this model were multiplied by the increase in LGA population as embedded in the VIF 2031 projections, by LGA level, to estimate the predicted increase in absolute numbers reporting. The total is 270,000 additional people reporting in 2031, with the largest increases predicted for Wyndham, Melton, Casey, Whittlesea and Hume, each with predicted increases exceeding about 25,000. This outcome should be interpreted as a *potential risk from growth* if something is not done to:

- reduce obesity levels across the entire population; and/or
- slow the rate of outer urban population growth; and/or

- reduce car use for the journey to work in outer municipalities; and/or
- improve the SEIFA IRSD ratings of outer urban LGAs.

7.8.2 Cardiovascular disease

The same independent variables as were considered for obesity were also considered for reporting of cardiovascular disease but none were significant at the 5 per cent level. Distance from Melbourne and the per cent using car for the journey to work were both significant at the 10 per cent level, and were significantly correlated with each other at the 1 per cent level. The correlation between reporting cardiovascular disease and rate of population change was very weak. Cardiovascular disease was thus not seen as worthy of further examination in terms of seeking conclusions about Melbourne's population growth.

7.8.3 Mental health

Section 4.11.3 found there is no significant correlation between mental health clients per 1000 population and distance or travel time from Melbourne or with the rate of population growth.

8. Conclusions

8.1 Getting our ducks in a row

A new report prepared for the Property Council of Australia has argued that (Property Council of Australia and The Business of Cities 2018, p. 8):

> "*Our work finds that – while Australian cities have many strengths and are highly regarded internationally – they are not well equipped to face the remainder of this 'metropolitan century'. Australian cities continue to attract population growth that surpasses the capacity of their infrastructure systems, housing supply and metropolitan governance. They have been less well serviced by high capacity infrastructure, less co-ordinated and less well managed than others around the world*."

This conclusion, from a research team led by UK based Professor Greg Clark, mirrors the tenor of the findings of the current report, as it relates to the Melbourne growth experience but our findings are more critical and encompass some investigation areas that were not covered in the work for the Property Council, such as social capital, child development and open space.

Before summarising our main conclusions on how continuing fast population growth will impact some key performance indicators for Melbourne, we draw attention to the VIF (2016) population projections for 2031, on which our analysis is based. Those projections imply continuing rapid population growth in outer urban LGAs, as defined in the current report, with their total share of population growth *increasing* slightly as compared to the share achieved over the 2011-16 period. In other words, they implicitly project a slight increase in the rate of urban sprawl. We find this somewhat astonishing. The projections imply major failure of the policy intent that is embedded in the land use development directions of both *Plan Melbourne* and *Plan Melbourne 2017-2050*, for Melbourne to become a more compact city. Alternatively, the projections may suggest that the land use planning projections have not been integrated with the land use planning and policy making process, which suggests a failure in governance. Either way, Melbourne's planners and politicians should be working much harder to develop a strong integrated vision of a more compact Melbourne, which reflects the intentions of the State Government's adopted land use plan, the fundamental principles of which have bi-partisan support.

We have not attempted to cover more than a handful of indicators in terms of looking at the potential effects of continuing high population growth for Melbourne, sufficient (we believe) to make the case that this is a huge public policy issue for the residents, the State and for Australia more broadly, which needs serious debate. Our analysis suggests that productivity benefits from rapid population growth in recent times have been largely illusory and need to be offset against significant environmental and social costs. We are not arguing that Melbourne's population should stop growing but that the current high rate of population growth is not sustainable and a policy discussion needs to take place about just what a sustainable future Melbourne looks like, in terms of population growth and its distribution, and the future role of regional Victoria.

The major problem in the current growth experience is the excessive burden being carried by outer Melbourne, its residents and those who fund urban expansion. Slowing the rate of population increase and getting a much higher share of that increase located in existing built-up areas, particularly inner and middle Melbourne, with higher densities for greenfield development on the fringe, is fundamental. Regional Victoria can play a significant role in helping to absorb increased population numbers. A follow-up report will discuss this matter.

8.2 Productivity

International migration has been the major driver of population growth. In order to maximise the benefits from high levels of migration, which in economic terms are measured by higher per capita growth rates in GDP than would have eventuated with lower levels of migration, it is necessary to ensure that the increased working age population is engaged in economic activity to its potential. Population growth by itself does not guarantee this outcome. This can only be ensured if adequate resources are provided to the increased population, sufficient to achieve higher levels of productivity. In evaluating Melbourne Metropolitan LGA economic performance since 1992, it is clear that insufficient resources were provided to achieve this outcome. This was particularly the case for the outer metropolitan LGAs.

The study has estimated that the 'excess in working age population', with little or no connection to increased economic activity, had reached about half a million by 2017. Our analysis that investigated the role of key productivity drivers, has concluded that there was underinvestment of the order of $cvm126 billion at 2015-16, in terms of what would have been required to remove the 'excess working age population'. This represented underinvestment in:

1. Transport infrastructure capital stock;
2. Commercial capital stock;
3. Community capital stock (e.g. hospitals and schools);
4. Industrial development;
5. Skills development; and
6. Knowledge creation investment.

If this investment had taken place, the 'excess working age population' would have been removed.

Looking to 2031, if the same trends prevail as over the last two to three decades, the additional shortage of investment expenditure will be of a similar order of magnitude to the 2015-16 level, or an extra $cvm141 billion, representing an additional increase in the 'excess working age population' of around 350,000.

This situation has been compounded by the reduction in excess capacity that had been available in Melbourne's transport infrastructure system, reflected in growing congestion levels on roads and public transport. This is likely to get worse in coming years. To neutralise the impact of transport underinvestment since 1980, and minimise the growth in future congestion costs, it is estimated that an additional gross $163 billion transport infrastructure spending will be needed to 2031. Section 5 identified transport infrastructure projects totalling around $100b, showing that much more remains to be done, assuming the projects in the $100 billion can be delivered at the costs shown. On a net basis the total requirement of the public sector whether financed on off balance sheet is about an additional $cvm15 billion annually above projected expenditure rates to 2031.

In sum, the total levels of additional investment expenditure required to remove excess working population numbers and mitigate increased congestion costs sum to around $376 billion, of which $227 billion will the responsibility of the public sector. Even to make a reasonable dent on providing the required level of resources, government expenditures and tax rates, together with user charges, would need to increase significantly. If this cannot receive bipartisan support, the only alternative is a substantial reduction in the migration rate and/or a major increase in decentralised growth. A follow-up report will explore this matter in more detail. The choice is simple. If the current population do not want to take the short run reduction in living standards to provide the resources the migrants of the future need to be fully productive, and therefore to receive the long-run benefits of high population growth, then the migration rate should be lowered to the level compatible with the level of resources the nation is willing to provide.

Assuming that the Victorian results apply to the other States and assuming that the electorate votes not to forgo the proposed company and post 2021 income tax reductions, then the analysis suggests that total net immigration should be no more than 100,000 to 140,000 annually over the next 15 years

8.3 Other outcome areas

Congestion levels and associated costs will remain under continued pressure if population growth rates remain high, even with a major infrastructure development program. If congestion levels could be kept at around current levels, annual congestion benefits of around $6-7 billion are available by 2031 (lower in the nearer future). *Plan Melbourne 2017-2050* (DELWP 2017) provides a good land use framework for Melbourne's long term planning but it needs a complementary long term transport strategy, rather than just a list of major projects. Congestion mitigation should be a primary objective of the long term transport strategy, with pricing instruments as well as land use transport and related infrastructure investments used to pursue this objective.

Continued high population growth will make it very difficult for the road transport sector to make a proportionate contribution to the national 2030 GHG emissions reduction target of 26-28 per cent below 2005 levels. Getting road transport emissions down at this rate will require early implementation of mandatory emissions standards along European lines and also taking about 20 per cent off projected 2030 levels of VKT.

Mitigating both congestion costs and GHG emissions thus requires slowing VKT growth, which needs a range of complementary measures, such as:

- land use policies and programs that more proactively support the compact settlement patterns that are embedded in Plan Melbourne 2017-2050, including delivery of 20 minute neighbourhoods;
- dramatically slowing urban growth on the fringe and supporting increased densities across the whole city, including around the NEICs and in outer growth areas;
- major improvements in public transport service levels, for trunk and local movement, to substantially increase the PT mode share (to over 20 per cent across the day); and
- significant improvement in active travel opportunities.

A transport strategy for Melbourne needs to integrate these components. Crucially, benefits will accrue not just in terms of lower congestion costs and GHG emissions but also in higher urban productivity, improved health outcomes, improved social capital and greater social inclusion. Road pricing reform, to make road users accountable for all the societal costs of their travel choices, is probably the single most effective transport policy instrument to lead such change.

The six areas identified as having high population growth rate and low Gross Regional Product per Capita of working age population, Cardinia, Casey, Hume, Melton, Whittlesea and Wyndham, are found in the outer suburbs of Melbourne. Section 4 showed that, in general, the further the distance from Melbourne, the longer distances needed to travel to work, the absence of public transport to make this trip, the further you live away from public transport options, the lower the urban density and job density and the lower the productivity levels. To achieve reduced VKT across Melbourne and improve opportunities in these areas, higher local job creation is required, which will not be easy, and better access must be provided to jobs-rich areas in the inner and middle suburbs. Rail upgrades are important in this regard, as is improved bus access to those rail services.

However, the story doesn't end here. Increasingly research is showing the basic structures or framework that is needed to increase quality of life and wellbeing. Many of these structures or variables were identified in the indicators identified in this report. 'Sufficient' levels of these indicators will improve the social inclusion, wellbeing and health of individuals. This in turn impacts on the ability of individuals to work and be productive. A productive community reduces the need for societal expenses in areas of welfare payments and support, health services and the negative outcomes for society in terms of crimes, anti-social behaviour, substance abuse, family violence and loss of hope and belief in the capacity to change circumstances. This also has considerable implications about the commonly discussed concept of resilience, the ability to recover from an adverse event such as a natural disaster. The lower a person's resources (personal capacity, community and structural options), the less resilient they will be to recover from set-backs. Finally, research by Wilkinson and Pickett (2011) has shown that the greater the inequality present, the greater the adverse impact on all people, both rich and poor. Inequality has the effect of eroding trust and community life, as well as increasing problems in relation to physical and mental health, drug abuse education, crime, obesity, social mobility, violence, teenage pregnancies and child wellbeing.

The main focus of this report has been the overlap between the six high population growth/low productivity LGAs and a number of social structural indicators (see also Appendix 1). Of considerable concern are the poor levels of child development on entering schools, fewer people with higher qualifications, the high levels of youth unemployment, the levels of housing stress, the proportionately lower levels of social capital, particularly relating to trust in their neighbourhood, and higher levels of obesity. Where the threshold for concern is placed determines obviously which LGAs are included or excluded, but these indicators reflect comparative disadvantage relative to other Melbourne LGAs. With the revealed concerns about productivity in these LGAs, there is a strong argument that urgent action needs to be taken across a wide policy front in the outer growth areas, to respond to backlogs and prevent further comparative deterioration and growing inequality.

As Melbourne takes more proactive steps to become a more compact city, inner and middle urban needs will require a greater policy focus. The added population numbers these parts of Melbourne will need to accommodate are likely to compound any existing concerns they may have, unless forward planning measures are put in place to support growth. Sections 4 and 5, together with Appendix 1, reveal that there are a number of concerns in many inner and middle urban LGAs in relation to disadvantage of some of the population. A relatively low SIEFA IRSD index, for example, often reflects many of the disadvantages included in the indicators, with concerns in relation to housing stress, lower education levels and cardio vascular and mental health problems. Interestingly, in these relatively (SEIFA IRSD) disadvantaged areas, there appears to be fewer concerns in relation to social capital and early child development, than noted in the high population growth, low productivity areas identified. The range of social concerns spread through such areas, however, adds to the requirement to improve the provision of infrastructure, transport, place making and so on, in many parts of Melbourne, as well as those with high population growth, if Melbourne is not going to accentuate problems of inequality, with associated negative outcomes for the city as a whole. Greater focus on developing the NEICs should form an important part of this policy direction, because of the economies of scale and scope they offer. Trunk and local transport initiatives and place making should be central in this regard.

An important matter to note is that continued high population growth and the focus on developing a more compact city will necessitate a major program to increase the availability of conservation areas, natural and semi-natural areas, and other urban open space, particularly in inner and middle suburban areas. Our analysis suggests that, if the suggested *standards* or benchmarks for such land use are to be maintained, the cost of additional requisite open space will be $50+ billion to 2031, primarily in inner and middle urban locations, for land acquisition alone, with development costs additional. About 15 per cent of this total is for conservation areas, natural and semi-natural areas and 85 per cent for other open space (e.g. recreational areas, parks and gardens, local play spaces). Alternatively, natural area/open space standards could be allowed to deteriorate, with consequential costs in terms of poorer community health and wellbeing outcomes across a range of dimensions. This would be inconsistent with the policy intent of achieving a more compact city, where publicly accessible natural areas and other open space will become increasingly important. A community discussion about desirable green standards for a growing but more compact city should be a priority.

References

Alston, L., Allender, S., Peterson, K., Jacobs, J., & Nichols, M. (2017), 'Rural inequalities in the Australian burden of ischaemic heart disease: A systematic review', *Heart, Lung and Circulation, 26*(2), 122–133.

Australian Bureau of Statistics (2016a), *Regional Population Growth Australia*, Cat. 3218.0.

Australian Bureau of Statistics (2016b), 'National Health Survey: First results, 2014-15', *ABS cat. no. 4364.0.55.001*, March. http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/4364.0.55.0012014-15?OpenDocument. Viewed 16 May 2018.

Australian Bureau of Statistics (2017), *Australian Demographic Statistics*, *Cat. 3101.0*,

Australian Bureau of Statistics (n.d.), Quickstats, http://www.abs.gov.au/websitedbs/D3310114.nsf/Home/2016%20QuickStats. Viewed 4 May 2018.

Australian Government (n.d.), *Australian Early Development Census 2015*, https://www.aedc.gov.au/. Viewed 1 May 2018.

Australian Institute of Health and Welfare (2016) *Australian Burden of Disease Study: Impact and causes of illness and death in Australian 2011*, Australian Burden of disease Study series no. 3, BOD 4, Canberra.

Australian Institute of Health and Welfare (2017), *Australian Health Expenditure – demographics and diseases: hospital admitted patient expenditure 2004-05 to 2012-13*, Health' Expenditure and Welfare series no. 59, cat. No. HWE 69, Canberra.

Benson, S. (2018), 'Rare allies back a Big Australia, *The Australian*, May 4th p.1

Biddle, T. et al (2006), *The Costs of Infill versus Greenfield Development – A Review of Recent Literature*, Institute of Transport & Logistics Studies, The University of Sydney, NSW, Australia.

Black Dog Institute (undated), Facts and figures about mental health https://www.blackdoginstitute.org.au/docs/default-source/factsheets/facts_figures.pdf?sfvrsn=10.

Bourdieu, P. (1985), 'The forms of capital', in: J. Richardson (Ed.) *Handbook of Theory and Research for the Sociology of Education,* pp. 241–258 (New York: Greenwood).

Buddelmeyer, H, Leung, F. and Scutella, R. (2012), *Educating oneself out of social exclusion*, NCVER, Adelaide.

Bureau of Infrastructure Transport and Regional Economics (2015), Traffic and congestion costs for Australian capital cities, Information Sheet 74, Canberra: Author.

Bureau of Transport and Regional Economics (2007), 'Estimating urban traffic and congestion cost trends for Australian cities'*, Working Paper No. 71*, Canberra: Author.

Commonwealth of Australia, Department of the Prime Minister and Cabinet (2017), *National Cities Performance Framework Report*, Canberra: Commonwealth of Australia.

Constanza, R., R. d'Arge, R. de Groot et al. (2007), 'The value of the world's ecosystem services and natural capital', *Nature*, **387** (6630), 253–260.

Cox, W. and Pavletich, H. (2018), *14th Annual International Housing Affordability Survey*, 22nd January, 2018. http://www.demographia.com/dhi.pdf. Viewed 23 May 2018.

Cruwys T, Haslam SA, Dingle GA, et al. (2014), 'Depression and social identity: An integrative review', *Personality and Social Psychology Review* 18: 215–238.

Department of the Environment and Energy (2017), *National greenhouse gas inventory trend*, http://ageis.climatechange.gov.au/NGGITrend.aspx#. Viewed 22 June 2017.

Department of Environment, Land, Water and Planning (2017), *PlanMelbourne 2017-2050*, Melbourne: Victorian Government.

Department of the Environment, Land, Water and Planning (2016), *Victoria in Future: Population and household projections to 2051*, Melbourne: Author. https://www.planning.vic.gov.au/land-use-and-population-research/victoria-in-future-2016/victoria-in-future-data-tables. Accessed 20th April 2018.

DHHS (n.d.), Victorian population health survey 2011-12, Melbourne; Author.

Department of Transport, Planning and Local Infrastructure (2014), *PlanMelbourne: Metropolitan Planning Strategy*, Melbourne: Government of Victoria

Duranton, G. and Taylor, M. (2011), 'The fundamental law of road congestion: Evidence from US cities', *American Economic Review* **101**(October), 2616-2652.

European Union (2011), *Cities of Tomorrow: Challenges, Visions, Ways Forward*, Brussels: author.

Fisher, P. (2015), 'Concrete jungle? We'll have to do more than plant trees to bring wildlife back to our cities', *The Conversation*, 20 January, accessed 20 January 2015 at https://theconversation.com/concrete-jungle-well-have-to-do-more-than-plant-trees-to-bring-wildlife-back-to- our-cities-51047

Giles-Corti, B., Vernez-Moudon, A, Turrell, G., Dannenbery, A., Badland, H., Foster, S., Lowe, M., Sallis, J., Stevenson, M. & Owen, N. (2016), 'City Planning and population health: A global challenge', *The Lancet*, Vol 388, December 10, pp. 2912-24.

Gill, T. (2011), Children and Nature: A Quasi-systematic Review of *the Empirical Evidence*, London: London Sustainable Development Commission, Greater London Authority.

Holt-Lunstad J, Smith TB, Layton JB (2010), 'Social Relationships and Mortality Risk: A Meta-analytic Review', PLoS Med 7(7): e1000316. doi:10.1371/ journal.pmed.1000316

Heckman, J. (2008), 'Schools, Skills, Synapses', *Economic Inquiry*, 46, 3, pp. 289-324.

Infrastructure Australia (2018a), *Future cities: Planning for our growing population,* Sydney: Author. http://infrastructureaustralia.gov.au/policy-publications/publications/files/future-cities/Future-Cities-Paper-web.pdf. Viewed 21 March 2018.

Infrastructure Australia (2018b), *Summary report. Future cities: Planning for our growing population*, Sydney: Author http://infrastructureaustralia.gov.au/policy-publications/publications/files/future-cities/Future-Cities-Summary-Report-2018.pdf. Viewed 21st March 2018.

Infrastructure Victoria (2016), Victoria's 30-year infrastructure strategy December 2016, Melbourne: Author.

IUCN (International Union for Conversation of Nature) (2016), *The IUCN Red List*, accessed 10 April 2016 at http://support.iucnredlist.org/about.

Kinhill Engineers (April 1995), *Smart planning not sprawl: the costs and benefits of alternative fringe planning*, The Australian Urban and Regional Development Review, Canberra.

KPMG Arup Jacobs (2016), *Preliminary demand modelling and economic appraisal, Infrastructure Victoria, Final Report, 27 September 2016*, Melbourne: Author.

Lamb, S. Jackson, J., Walstab, A. & Huo, S. (2015), Educational opportunity in Australia 2015: Who succeeds and Who Misses Out, Centre for International Research on Education Systems, Victoria University, Melbourne.

Laird, S. and McFarland, L. (2017) Five ways kids can benefit from being outside this summer break, *The Conversation*, January 10, https://theconversation.com/five-ways-kids-can-benefit-from-being-outside-this-summer-break-69129

Levine, J., J. Grengs, Q. Shen and Q. Shen (2012), 'Does accessibility require speed or density?' *Journal of the American Planning Association*, **78** (2), 157-172.

Marselle, M., K. Irvine and S. Warber (2013), 'Walking for well- being: Are group walks in certain types of natural environments better for well-being than group walks in urban environments?', *International Journal of Environmental Research and Public Health*, **10** (11), 5603–5628.

Mayor of London (2002), *Connecting with London's Nature*: *The Mayor's Biodiversity Strategy,* London: Greater London Authority.

Mindframe (undated), Facts and stats about mental illness in Australia, http://www.mindframe-media.info/for-mental-health-and-suicide-prevention/talking-to-media-about-mental-illness/facts-and-stats

OECD (2012), Education Indicators in Focus, June, https://files.eric.ed.gov/fulltext/ED533440.pdf

Property Council of Australia and The Business of Cities (2018a), 2: Benchmarking Australian Cities, https://cdn2.hubspot.net/hubfs/2095495/Great%20Cities/GRACITRO-PCAReport%203-Paper-Two-Benchmarking-Australian-Cities.pdf?__hssc=213300875.2.1527058428085&__hstc=213300875.2f6d968468829b48858c513272707861.1526957935375.1527046517500.1527058428085.3&__hsfp=499537288&hsCtaTracking=a381164f-374d-42fc-9cb9-adf280870242%7Cfc436380-0ea0-4b38-b790-8dd1f71944a4. Viewed 23 May 2018.

Property Council of Australia and The Business of Cities (2018b), Creating Great Australian Cities, https://cdn2.hubspot.net/hubfs/2095495/Great%20Cities/1805%20-%20%20Summary%20Report.pdf?__hssc=213300875.2.1527046517500&__hstc=213300875.2f6d968468829b48858c513272707861.1526957935375.1526957935377.1527046517500.2&__hsfp=499537288&hsCtaTracking=4fcedc3f-4b2f-49b5-81b9-7fe57f530004%7C7ada91a6-68ba-4fbf-b607-34ba97a0b641. Viewed 23 May 2018.

Putnam, R. (1995), 'Tuning in, tuning out: the strange disappearance of social capital in America', *Political Science and Politics,* 28, pp. 667–683.

Rook, G. (2013), 'Regulation of the immune system by biodiversity from the natural environment: An ecosystem service essential to health', *Proceedings of the National Academy of Science*, **110** (46) 18360–18367.

Saeri, A., Cruwys, T., Barlow, F., Stronge, S. and Sibley, C. (2018), 'Social connectedness improves public mental health: Investigating bidirectional relationships in the New Zealand attitudes and values survey', *Australian and New Zealand Journal of Psychiatry,* 52(4) 365–374.

SGS Economics and Planning (January 2012), *Where and how should we grow? Final Report,* Prepared for Rural Councils Victoria

SGS Economics & Planning (2016), *Comparative Costs of Urban Development: A Literature Review: Final Report*, Infrastructure Victoria, July

SGSEP (n.d.), *The current and future state of Victoria: A spatial perspective,* Advice to Infrastructure Victoria, Author.

Stanley, J. and Brain, P. (2016), *Investing in Melbourne's National Employment Clusters. Advice to Infrastructure Victoria, Final Report*. September. http://www.infrastructurevictoria.com.au/sites/default/files/files/Draft%20strategy%20-%20tech%20reports/Professor%20John%20Stanley%20and%20Dr%20Peter%20Brain%20-%20Investing%20in%20Melbourne's%20National%20Employment%20Clusters.PDF. Viewed 23 May 2018.

Stanley, J., Brain, P. and Cunningham, J. (2017), 'Improved public transport services supporting city productivity growth: An Australian case study', *Bus and Coach Industry Policy Paper 9*, Canberra: Bus Industry Confederation.

Stanley, J., Stanley, J. and Hansen, R. (2017), *How great cities happen*, Cheltenham UK: Edward Elgar Publishing.

Stanley, J. and Hensher, D. (2017), 'Getting the prices right', *Road and Transport Research* 26(3), 13-21.

Stanley, J. K., Stanley, J. R. and Hensher, D. (2011), 'Mobility, social exclusion and well-being: Exploring the links', *Transportation Research Part A: Policy and Practice*, 45(8), 789-801.

Stanley, J.K., Stanley, J.R., & Hensher, D. (2012), 'Mobility, social capital and sense of community: What value?' *Urban Studies* 49, 2012 3595 - 3609.

Stanley, J., Ellison, R., Loader, C. and Hensher, D. (2017), 'Reducing Australian greenhouse gas emissions', *Transportation Research Part A*, 109, 76-88.

Stevenson, M., Thompson, J., Hérick de Sá, T., Ewing, R., Mohan, D., McClure, R., Roberts, I., Geetam, T., Giles-Corti, B., Sun, X., Wallace, W., and Woodcock, J. (2016), 'Land use, transport, and population health: Estimating the health benefits of compact cities', *The Lancet*, vol. 388, pp. 2925-2935.

Stopher, P. and Stanley, J. (2014), *Introduction to transport policy: A public policy view*, Cheltenham UK: Edward Elgar Publishing.

Translink (2013), *Regional Transportation Strategy: Strategic framework*. Translink, July.

The Compact (2018), National Compact on Permanent Migration, *The Australian*, May 4th, page 5.

The Economist Intelligence Unit (2017) The Global Liveability Report 2017, https://www.eiu.com/public/topical_report.aspx?campaignid=Liveability17

Trubka, R., Newman, P., & Bilsborough, D. (2009), *Assessing the Costs of Alternative Development Paths in Australian Cities*, Curtin University Sustainability Policy Institute Fremantle, Parsons Brinckerhoff Australia/Curtin University.

Trubka, R., Newman, P. & Bilsborough, D. (2010), *The Cost of Urban Sprawl – Infrastructure and Transportation,* Environment Design Guide.

Urry, J. (2002), Mobility and proximity, *Sociology,* 36(2), pp. 255–274.

Vandenbroek (2017) Underemployment Statistics: A Quick Guide: Research Paper Series 2016-2017, Parliamentary Library, Parliament of Australia.

Veal, A.J. (2013), 'Open space planning standards in Australia: In search of origins', *Australian Planner* **50**(3), 224-32.

Vicroads (2014), *Traffic Monitor 2013-14*, Melbourne: Author.

Victorian Government (2014), *Plan Melbourne: Metropolitan Planning Strategy*, author, May 2014.

Victorian Government (2017), *Plan Melbourne 2017-2050*, author, 11 March 2017.

Victorian Planning Authority (2017), *Metropolitan open space network: Provision and distribution,* Melbourne: Author.

Wilkinson, R. and Pickett, K. (2011) The Spirit Level: Why Greater Equality Makes Societies Stronger, Bloomsbury Press: New York.

Woodland Trust (2015), *Space for people Targeting action for woodland access,* January 2015.

WWF (World Wide Fund for Nature) (2015), *What is an Ecological Footprint*? Accessed 16 March 2016 at http://www.wwf.org.au/our_work/people_and_the_environment/human_footprint/ecological_footprint/