Australian Government

Department of Infrastructure, Transport, Cities and Regional Development

Bureau of Infrastructure, Transport and Regional Economics

Relationship between transport use and income in Australia

At a glance

- Nationally, in 2016, the proportion of households with three or more motor vehicles was highest for the highest household income category (average weekly income of $3000 or more) at 36 per cent, compared to 10 per cent for the lowest household income category ($0-$499 per week).
- In 2016, the average commuting (journey-to-work) distance increased gradually across income categories, rising from 10.6 km (for individuals earning $0-$149 per week) to 20.0 km ($2000-$2999 per week), then dropping to 17.6 km in the highest income category ($3000 and more). Similarly, the average commuting trip duration was lowest (27 minutes) for the lowest income category (annual income of $1-$19 999) and highest (36 minutes) for the highest income individuals (annual income of $150 000 or more).
- The relationship between income and transport mode shares for journey-to-work at the national level showed that:
  - The proportion of employed persons who used the train to travel to work increased with income.
  - The total public transport mode share was at its highest for high income people and was lowest for middle income earners who commuted to work.
  - The pattern for bus users was u-shaped, with low and high income commuters more likely to use the bus than middle income commuters.
  - The private vehicle mode share was highest for those earning $500-$1499 per week, and lowest for very low and high income earners.
- The nature of the relationship between income and the private vehicle and total public transport mode shares for all trips in Greater Sydney is similar to the national pattern for journey-to-work trips. However, while there is a clear tendency for the train mode share to rise with income for national (and Sydney) commuting trips, the relationship is much less evident for all Sydney trips, possibly because the pattern is diluted by the inclusion of other types of trips (e.g. shopping, education) in the Sydney data.
- On average, the estimated weekly personal income for employed persons was $1293 in Australia in 2016, being higher for public transport users ($1503) than for users of private vehicles ($1261), active travel ($1265) or other modes ($1224). There was no difference in estimated weekly income between rail and other public transport users.
- Overall, average weekly personal income was around 17 per cent higher for capital city employed persons ($1352) than those who worked outside the capital cities ($1159). Public transport users tend to have higher average weekly personal income than private vehicle users, with the difference being less pronounced for commuters in capital cities ($184) than in the non-capital major cities ($429).
- Those who used the train to commute to work from regional Australia had particularly high weekly personal incomes (averaging $1611), compared to an average of $1501 for train commuters from the capital cities. However, only 3 per cent of train commuters (or 25 400 persons) live in regional Australia.

- In the five large capital cities, train users tend to have higher incomes than private vehicle users, with the income difference being highest in Melbourne ($231), followed by Perth ($195), Brisbane ($159) and Sydney ($143). In Adelaide, train users have slightly lower incomes ($8) than private vehicle users.
- High income commuters who earn $2000 or more per week have much higher rates of train use (12-13 per cent) than low and middle income commuters (5-9 per cent). This is in part because rail is primarily used by those who commute to a workplace in the CBD, and CBD workers have much higher incomes than those who work in other parts of the five largest capital cities ($604 per week higher, on average). However, while members of the high income group are most likely to benefit from rail investment, people earning between $500 and $1499 per week represent a much larger proportion of rail commuters (49 per cent) than do high income earners (21 per cent).
- A case study of the Geelong-Melbourne corridor shows that rail is increasingly being used to access high income jobs. The rail connectivity benefits are principally being experienced by long-term Geelong residents, but a significant number of former residents of the Melbourne West region are also taking advantage of the rail and road connections and lower housing costs by moving to the Geelong region and commuting to jobs in Melbourne.
- Regression analysis shows that an area's income has no independent effect on the area's public transport mode share. Rather, the observed modest spatial correlation between the two appears to be occurring because income is influenced by public transport accessibility and CBD job share. The CBD job share of an area has a very strong direct influence on the public transport mode share. Additionally, public transport accessibility has a direct influence on the public transport mode share, and also has an influence on the CBD job share.

Introduction

Income appears to influence the type of transport mode used for journeys to work, and the relationship between income and public transport use differs across transport modes (DIT 2013). There is a common perception that low-income people ride public transit to work, while higher income people drive private vehicles (i.e. cars). In other words, the high-income population is mostly car dependent, while lower income people are captive of public transport (Florez 1999). Not surprisingly, higher household incomes increase the amounts of travel that household members make and the modes used change as income increases (Transport for London 2011). In addition, income is expected to increase the number of trips and their average length.

This information sheet presents Australian data, which addresses several key questions relating to the relationship between income and transport use, particularly rail use. To explore the relationship between transport use and income, the study has tackled the following key research questions:

1. What is the nature of the relationship between income and different types of transport use?
2. What is the nature of the relationship between income and public transport use (and how does it differ across the public transport modes, such as Bus, Rail, Tram/Light rail and others)?
3. How does the relationship between public transport use and income vary by location (e.g. by city, by where people live and where people work in a city).

There are numerous other factors that potentially influence public transport use apart from income. For example, public transport accessibility, costs of different modes, skills of workers and their propensity to work in the CBD are likely to influence public transport use. This study investigates some of the factors that influence the spatial relationship between public transport use and income, focusing on public transport accessibility and CBD jobs (see pages 28-31).

Geographically, this study focuses on the five major capital cities, which represent just over 91 per cent of all public transport use for the journey-to-work in Australia. It also has a secondary focus on the non-capital major cities, particularly those within commuting distance of the capital cities.

The findings of this research will help to understand the equity implications of government investment in infrastructure. Since this study has a particular focus on rail, the outcomes will be used to inform urban rail policy and to inform regional development policy for regional cities located within commuting distance of the capital cities.

Data sources

The key data source is the ABS *Census of Population and Housing* data for 2016. Besides ABS Census data, other data sources include:

- NSW State Government Household Travel Survey (or HTS) data is also used for Sydney to explore particular aspects of the relationship between transport use and income. The key value-add of the HTS data for this study is that it is not restricted to journey-to-work trips, but captures trips undertaken for any purpose.
- Melbourne Institute's annual Household, Income and Labour Dynamics in Australia (HILDA) Survey is used to measure average commuting time.
- ABS Household Expenditure Survey (HES) data is used to measure fuel expenditure.

Literature review

This section reviews the literature that is available overseas and in Australia on the relationship between household income and various aspects of transport use (such as types of transport modes, number of trips, average trip length, average trip duration, as well as the number of private vehicles and geographic location).

Overseas studies

A substantial literature is available on the relationship between household income distribution and transport use, in terms of transport mode, number of trips, average trip length, number of vehicles and private vehicle use. Some of the overseas studies reviewed below are related to the current study.

Transport mode

Transport mode use by residents' changes as household income increases (Flórez 1999, South African Department of Transport 2005, Best and Lanzendorf 2005, American Public Transportation Association 2007, Transport for London 2011). In the United Kingdom (UK), Transport for London (2011), using the London Travel Demand Survey data, found that commuters in lower income groups made more bus trips, and higher income groups made more car, rail and Underground trips.

Best and Lanzendorf (2005) found that for households in Germany with a monthly income below €1250, the average car use was 18 per cent; however, the share rose to 71 per cent in households with an income greater than €3250. They noted this strong effect might be confounded with higher car availability and differences in labour force participation. They also found that double income households used the car more often for commuting travel than single income households.

Using data from 150 on-board vehicle passenger surveys conducted in the USA by public transportation agencies from 2000 through 2005, American Public Transportation Association (2007) found that only 20.8 per cent of rail mode trips were made by persons from households with annual incomes less than $25 000, while 43.4 per cent of bus riders were from households with these lower income levels. This study also found that 30.3 per cent of rail mode riders had incomes of $75 000 or more, while only 11.5 per cent of bus rides were taken by persons with these higher household incomes. Further, the income levels of commuters who ride transit to work can vary greatly by location (Versel 2013). In a study on 'Trends and Outlook for Transit Commuting in the Washington Metropolitan Area', this author found that the median earnings for transit commuters living in the District of Columbia, Arlington, Alexandria, and Prince George's were lower than the median income levels for all commuters in those jurisdictions. Conversely, the median earnings of transit commuters living in Fairfax, Prince William and Loudoun were all much higher than the median earnings of all commuters from those counties.

Number of trips and distance

Income affects the number of trips individuals take (i.e trip production or trip generation), as well as the distance travelled in each trip (South African Department of Transport 2005, Memmott 2007, Paulley et al.

2006, Siddique 2010, Transport for London 2011). van Ommeren et al. (1998) also acknowledge that commuting long distances is related to higher incomes and career opportunities for the individual.

Based on the National Household Travel Survey 2003, the South African Department of Transport (2005) found that trips per household per day were highest amongst households in which the average monthly income was more than R6000 (10.9 trips) and lowest for households in which average monthly income was lowest (R500 or less) (7.8 trips).

Using the 2001 National Household Travel Survey in the USA, Memmott (2007) found that higher income households made more trips and travelled more distance than lower income households. Households in the highest income class ($1 000 000 or more annual income) made about 30 per cent more trips, and the average length of those trips was more than 40 per cent longer than trips by those in the lowest income class (less than $25 000).

Transport for London (2011) reported that Londoners with gross annual household incomes under £10 000 made just over 2 trips per day on average, while those with incomes over £75 000 made around 2.8 trips per day. Similarly, using the National Travel Survey 2014 in the UK, the Department of Transport (2016) found that people in the highest quintile household income group travelled more than twice as far as people in the lowest income quintile, which was attributed to differences in car use, relating to patterns of household car availability. However, Guiliano and Narayan (2003) found that in the UK the number of daily trips was not significantly influenced by income, although the distances travelled did increase with income.

Commuting time

A range of studies have identified a positive empirical relationship between wages/incomes and commuting times. For example, McQuaid and Chen (2012) find that UK commuting times tend to rise in association with wages, with workers earning a gross weekly wage of £750 or more commuting an average of 43 minutes to work, compared to 31 minutes for those earning between £500 and £749. In an American study, AASHTO (2013) found that the proportion commuting more than 60 minutes to work was reasonably stable up to a household income of $50 000, and then rose steadily with income. Van Ham and Hooimeijer (2009) conclude that the probability of commuting more than 75 minutes a day increases with higher levels of household income in the Netherlands.

Number of cars and car ownership

Income is a major determinant of the number of vehicles in a household and of car access (ownership of one or more privately-owned vehicles or use of company-owned cars) (South African Department of Transport 2005, Memmott 2007, Zegras and Srinivasan 2007, Department of Transport 2016). As income increases, the money available for transport and hence car use increases (South African Department of Transport 2005).

South African Department of Transport (2005) reported that for households where income exceeds R6000 per month, 82 per cent had access to one or more cars, whereas households that earned less than R3000 per month had minimal access to cars. Similarly, Memmott (2007) found that among households with no vehicles, the vast majority (78 per cent) were in the lowest income category.

Zegras and Srinivasan (2007), who analysed the differences in travel behavior and location characteristics across different income groups in Santiago (Chile) and Chengdu (China), also found high income households[1] had higher car ownership rates as well as higher licensed drivers in both cities.

Using the UK National Travel Survey 2014, the Department of Transport (2016) found that almost half of households (48 per cent) in the lowest income quintile had no access to a car, compared with nearly 10 per cent of those in the highest income quintile.

[1] For Chengdu, the highest recorded income was over US$101 000, while in Santiago, it was over US$633 333 (Zegras and Srinivasan 2007).

Australian studies

Although a substantial literature is available on the relationship between household income distribution and modes of transport use, there are very limited studies conducted in Australia. Some examples include the work done by the Department of Infrastructure and Transport (DIT) (2013), Bureau of Transport Statistics (2012 and 2014), Loader (2012), Wang and Curtis (2015) and BITRE (2016).

Transport mode

Average incomes are related to the type of transport used[2] for journeys to work, and those who use public transport for their journey-to-work tend to have higher average weekly individual incomes than those who use other transport modes (DIT 2013). Based on ABS *Census of Population and Housing 2011* (place of work data), a large proportion (19 per cent) of the highest income bracket (annual income of $104 000 or more) used public transport for the journey-to-work and the mass transit mode share was lowest for those earning between $15 600 and $51 999 per annum (at 11 per cent) (DIT 2013). Nationally in 2011 about one-quarter of those who commuted to work by mass transit earned between $31 200 and $51 999 per annum and a further one-quarter earned between $52 000 and $77 999 per year. The study also found that average incomes were about 10 per cent higher for public transport users than non-users in Sydney, Melbourne, Brisbane and Perth, but Adelaide public transport users had somewhat lower incomes (on average) than users of other transport modes. In addition, the study also found mixed patterns for individual capital cities. For example, in Sydney, Melbourne and Perth, the mass transit mode share was highest in the top income group, while in Adelaide, the top income group had the lowest mass transit mode share and the lowest income group ($0-$15 599) had a comparatively high rate of mass transit use (DIT 2013).

Using the Sydney HTS 2012-13, the NSW Bureau of Transport Statistics (BTS) found that lower income people tended to take public transport or walk more than those with higher incomes and the opposite trend was evident for the use of car in the Sydney Greater Capital City Statistical Area (GCCSA) (BTS 2014). This conclusion appears to contradict that of DIT (2013), but this is most likely due to the BTS study's focus extending beyond journey-to-work trips to examine all trip types. In addition, the relationship between income and mass transit use also differs across transport modes. Based on 2010-11 data from the Sydney HTS, BTS (2012) found that bus use was particularly common among those in the lowest personal income bracket ($25 000 or less), while a relatively high proportion of ferry and taxi users belonged to the highest income bracket (annual income of over $100 000).

Similarly, Loader (2012) found a relationship between income and public transport use for Melbourne people. Based on data from the 2007-08 and 2009-10 *Victorian Integrated Survey of Travel and Activity* (VISTA), Loader (2012) looked at how income (as *equivalised weekly household income per person*) related to public transport use in Melbourne. It found that people on very high incomes of $3000 or more per week were more likely to use public transport than those on $500-1000 per week (although peaking with those on $2250-2500 per week). It also showed that people on higher incomes used public transport less for trips outside the City of Melbourne (particularly the CBD and Southbank/Docklands) and were much more likely to travel to/from the City of Melbourne.

Lagura et al. (2011)[3] found that around 33 per cent of Melbourne Inner residents with annual household income of $25 000 to less than $50 000 per annum use public transport three to seven days a week, the highest among all income levels, whereas the lowest use (20 per cent) was for households with an annual income above $110 000. However, there was not much variation for residents living in Melbourne Outer.

Commuting time

Average commuting trip durations rise strongly and systematically with personal income. BITRE (2016) used the HILDA wave 12 data to illustrate the relationship between commuting times and personal wage and salary income and found the average commuting trip durations of the highest income category ($150 000 or

[2] It is quite likely that income and mode use are both influenced by some other correlated factor (e.g. employment, availability of public transport), rather than one causing the other. The analysis later in this Information Sheet will attempt to control for the most likely correlates, such as public transport access and place of work (e.g. CBD and non-CBD).

[3] Lagura et al. (2011) analysed public transport use and income for two areas of Melbourne (Melbourne 1 and Melbourne 2 as a proxy for inner and outer Melbourne) using ABS collections, including the supplementary survey on *Household Water, Energy Use and Conservation for Victoria* (ABS Cat. No. 4602.2), *Household Expenditure Survey* and *Census*.

more annual income) were 13 minutes longer than the average durations of the lowest income category ($1-$19 999 annual income). Using the same HILDA survey, but wave 2, Flood and Barbato (2005) also found a significant positive association between income and commuting time, even after controlling for days of work, full-time/part-time status, occupation, gender and place of residence.

Car ownership

Wang and Curtis (2015) conducted a study to identify individual external and internal factors, including income of travellers, affecting travel behaviour in Bull Creek in Perth. They found that car ownership increased as income grew.

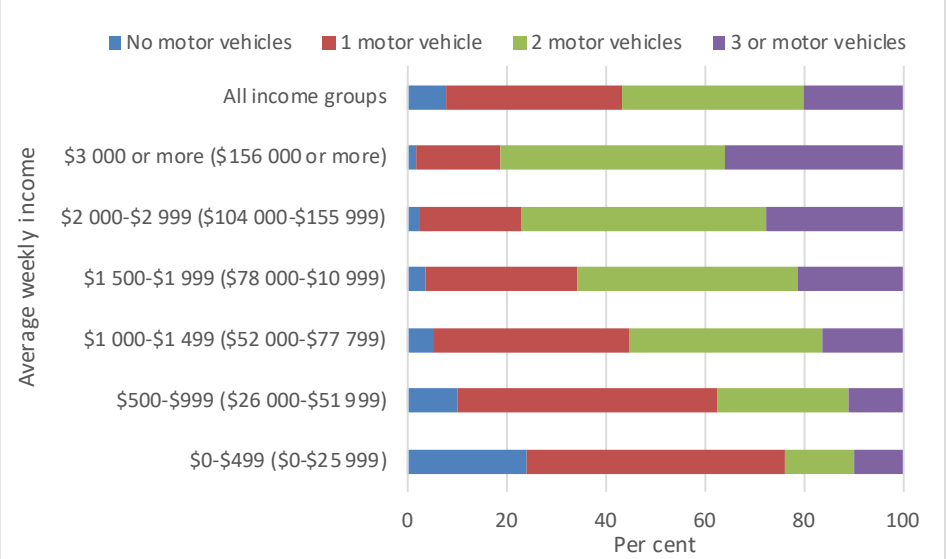
Relationship between income and different aspects of transport use

This section presents results for several transport use measures, such as car ownership and the number of cars, travel distance and travel time. The data were sourced from a range of different data sources. Since the ABS *Census of Population and Housing* only provides information on the journey to work, which represents a small proportion of the total number of trips, in its own right it cannot adequately address this research question. Other broader data sources, particularly the HTS, which consider all types of travel need to be drawn upon (noting that this data source only covers a selected part of Australia). The principal purpose of including the Sydney HTS in this study is that it enables the scope to be broadened out to cover all types of travel, not just journey to work trips. Appendix A provides the comparison of ABS 2016 Census and the NSW 2015-16 HTS, in terms of the proportion of employed residents in Sydney GCCSA by average weekly income and transport modes.

Car ownership and number of cars

Income is a major determinant of the number of motor vehicles (cars only) in a household. Based on ABS 2016 Census data, Figure 1 shows that the number of motor vehicles per dwelling increases with total household income. Overall, nearly 92 per cent of households have at least one motor vehicle. In other words, just over eight per cent of households did not have any motor vehicle. In the lowest household income bracket (less than $26 000 annual income), 24 per cent have no vehicle, while 76 per cent have at least one motor vehicle, and 10 per cent have three or more vehicles. Among households with no vehicles, around 47 per cent are in the lowest income category. Figure 1 also shows that the proportion of households owning three or more motor vehicles was highest for the highest income category (weekly income of $3 000 or more) at 36 per cent. On average, the number of motor vehicles per dwelling was lower in the capital cities (1.92) compared to the rest of Australia (1.98) (data not presented).

Figure 1 Distribution of households by number of motor vehicles for each income category, Australia, 2016



Notes:
1. Total household income in brackets are on annual basis.
2. Motorcycles are not included.
3. Excluding negative income, partial income stated, all incomes not stated, not applicable, not stated and not applicable.
Source: BITRE analysis of ABS *Census of Population and Housing* 2016 (TableBuilder Pro).

Travel distance

Journey-to-work trips

This section provides estimates of average travel distance by commuters for the journey-to-work by average weekly personal income (Table 1) and mode of transport (Table 2), based on the ABS *Census of Population and Housing* 2016.

Average commuting trip distances rise strongly and systematically with personal income. At the national level, the average commuting distance was 16.0 kilometres (km). In terms of average weekly personal income, it increased gradually from 10.6 km ($0-$149 per week) to 20.0 km ($2000-$2999 per week) (Table 1). However, average distance dropped in the highest income category (average weekly income of more than $3000) to 17.6 km.

Table 2 shows the average commuting distance by mode of transport for those who travelled to work. There was a wide variation in distance travelled by mode of transport. Public transport modes usually involve longer distances than private vehicles. The average distance travelled by public transport was 18.7 km, while private vehicle users travelled 16.8 km on average. Among all transport modes, train riders travelled the longest distance. On average, train commuters travelled 22.5 km. Commuters who used other public transport (i.e. bus, tram, ferry and taxi) travelled less distance (12.1 km). Not surprisingly, people who were active travellers (both bicycle riding and walking) travelled the shortest distance (on average, 6.5 km).

Table 1 Average distance travelled for journey-to-work by income, Australia, 2016

Average weekly income	Average distance (km)
$0-$149	10.1
$150-$299	11.6
$300-$399	12.3
$400-$499	12.9
$500-$649	13.6
$650-$799	14.6
$800-$999	15.8
$1000-$1249	17.0
$1250-$1499	17.8
$1500-$1749	18.2
$1750-$1999	19.0
$2000-$2999	20.0
$3000 or more	17.6
Other	16.3
All income groups	16.0

Note: Based on road network distances. Other income includes negative income and not stated.
Source: BITRE analysis of ABS customised data request, based on *Census of Population and Housing* 2016.

Table 2 Average distance travelled for journey-to-work by transport mode, Australia, 2016

Transport mode	Average distance (km)
Train	22.5
Bus	13.1
Tram	7.0
Ferry	15.6
Taxi	9.7
Other public transport	12.1
Total public transport	18.7
Car, as driver	17.0
Car, as passenger	14.0
Motorbike/scooter	14.9
Private vehicle	16.8
Bicycle	7.6
Walking	6.1
Active travel	6.5
Other transport	17.4
All transport modes	16.0

Notes:
1. Other public transport includes bus, tram, ferry and taxi.
2. Total public transport includes train and other public transport modes.
3. Private vehicle includes Car (as driver and passenger) and motorbike/scooter.
4. Active travel includes Bicycle and walking.
5. Other transport includes Truck, other mode and not stated.
6. Based on road network distances.

Source: BITRE analysis of ABS customised data request, based on *Census of Population and Housing* 2016.

All trip types

The preceding section focussed on journey-to-work distances. This section uses the Sydney HTS to consider average distances across all trip types in Sydney. It provides data on the average distances for Sydney GCCSA commuters (all trips), based on Sydney HTS [five years pooled unit record data (2015-16 reference year)].

On average, Sydney residents travelled 10.5 kilometres per trip. However, average distances differ depending on the transport modes. Public transport (i.e. train, bus, taxi and ferry) users travelled longer distances than private vehicle users (20.3 km versus 11.2 km). Train riders travel a longer distance on average (28.0 km), while bus users travelled 9.9 km (Table 3).

Across all transport modes, average distance travelled by Sydney residents (for all trip types) increased with income up to a weekly personal income of $1300-$1599 and then declined. For train riders, average distance peaked in the $1600-$1999 income category.

The results for all Sydney trips are similar to the results for national commuting trips in that average trip distances tend to rise with income (up to a certain point), and are significantly higher for train users than for users of other transport modes.

Table 3 Average distance by weekly personal income and main transport modes, Sydney GCCSA, all trips, 2015-16

Average weekly income	Train	Bus	Total public transport	Private vehicles	All transport modes
			Average distance (km)		
$0-$149	23.1	10.6	16.9	8.2	7.9
$150-$249	26.4	8.1	17.6	7.7	7.5
$250-$399	26.6	6.8	15.3	8.5	7.7
$400-$599	25.7	7.0	17.4	9.6	8.9
$600-$799	25.7	9.3	19.3	11.4	10.6
$800-$999	31.6	10.6	25.4	12.6	12.3
$1000-$1299	29.8	11.4	25.1	13.3	12.7
$1300-$1599	29.8	12.1	25.0	14.5	14.0
$1600-$1999	33.6	13.6	25.2	13.8	13.1
$2000 and more	30.2	13.8	21.9	14.2	12.9
All income groups	28.0	9.9	20.3	11.2	10.5

Notes:
1. 2015-16 Sydney HTS, five years pooled data. Based on linked trips.
2. Data includes weights for weekday.
3. Based on all trips.
4. Total public transport includes train, bus, tram and taxi.
5. Passenger vehicle includes both car (as driver and passenger) and motorbike.
6. All transport modes include total public transport, private vehicle, active travel (walking and cycling) and other modes.
7. All income groups include other income (do not answer, don't know, negative income and refused to answer).

Source: BITRE analysis of NSW *Household Travel Survey* (HTS) (Unit record data).

ABS Household Expenditure Survey data as a proxy for vehicle kilometres travelled

Motor vehicle fuel expenditure can be a useful proxy for vehicle kilometres travelled (VKT). In this section, motor vehicle fuel expenditure data are sourced from the Australian Bureau of Statistics (ABS) *Household Expenditure Survey* (HES) 2015-16 (both published and customised data) by equivalised disposable household income quintiles.

According to HES 2015-16 customised data, Australian households spent an average of $1393 per week on total goods and services in 2015-16, of which $184.39 was on transport as a whole[4] or 13.2 per cent of total goods and services expenditure (Table 4). Both these expenditure measures showed a pattern of increase

[4] BITRE definition of transport expenditure extends beyond the 'Transport' category in the ABS publication to include some additional items, namely holiday fares and petrol and the interest component of loans for vehicles and excludes expenditure derived from non-cash benefits from employer provided vehicles and car parks.

across the equivalised disposable household income quintiles, although the transport share of total expenditure on goods and services only increased with household income up until the fourth quintile.

Australian households, on average, spent $45.36 on motor vehicle fuel (which includes motor vehicle fuel, lubricants and additives (not further defined), petrol, diesel fuel, LPG and other gas fuels, and oils, lubricants and additives) in 2015-16. Motor vehicle fuel expenditure is lowest for the lowest income quintile ($31.17) and rises to reach $54.99 for the fourth income quintile, before declining slightly to $54.13 for the top quintile. This pattern is also evident in the proportion of motor vehicle fuel expenditure to total transport expenditure. A contributor to this drop-off for the top income quintile may be the high incidence of employer-provided vehicles and fuel amongst the top earning households (which are excluded from the household expenditure figures) (refer BITRE 2018). The top income quintile may also be more able to afford newer model vehicles, which tend to be more fuel efficient. This motor vehicle fuel expenditure equates to nearly one-fourth of total transport expenditure.

Household fuel expenditure differences across quintiles may not directly translate into differences in VKT, due to differences in vehicle fuel economy and fuel prices. However, the results of this section (together with those of the previous section), do suggest there is a tendency for VKT to rise with income, at least across the first four income quintiles.

Table 4 Average weekly household expenditure on motor vehicle fuel, total transport and total goods and services by equivalised disposable income quintile, Australia, 2015-16

Expenditure	Equivalised disposable household income quintile					All
	Lowest	Second	Third	Fourth	Highest	households
	Mean weekly household expenditure[a] ($)					
Motor vehicle fuel[b]	31.17	39.72	50.17	54.99	54.13	45.36
Total transport	93.08	133.15	183.82	225.06	305.31	184.39
Total goods and services	769.04	1091.59	1362.69	1601.66	2265.40	1393.34
	Share (per cent)					
Motor vehicle fuel to total transport	33.5	29.8	27.3	24.4	17.7	24.6
Total transport to total goods and services	12.1	12.2	13.5	14.1	13.5	13.2

Notes:
[a] Motor vehicle fuel includes motor vehicle fuel, lubricants and additives (not further defined), petrol, diesel fuel, LPG and other gas fuels, and oils, lubricants and additives.
[b] BITRE definition of transport expenditure extends beyond the 'Transport' category in the ABS publication to include some additional items, namely holiday fares and petrol and the interest component of loans for vehicles and exclude expenditure derived from non-cash benefits from employer provided vehicles and car parks.
Source: BITRE analysis of ABS 2015-16 *Household Expenditure Survey* (customised data).

Travel time

Journey-to-work trips

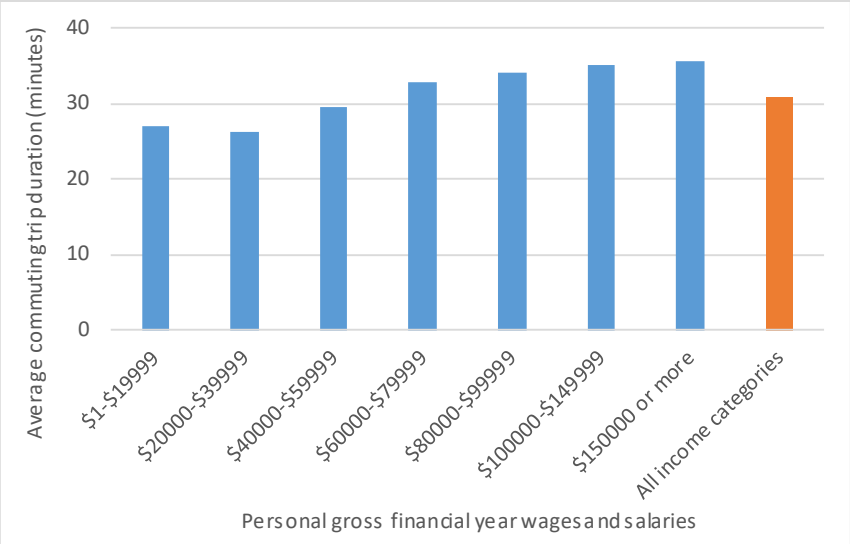
The HILDA (*Household Income and Labour Dynamics in Australia*) survey wave 16 data is used to illustrate the relationship between commuting times (journey-to work) and personal wage and salary income in Figure 2. Nationally, the average commuting trip duration (journey-to-work) was 31 minutes in 2016. Average commuting trip durations rise strongly and systematically with personal income. The average commuting times were very similar for the bottom two income categories, only 0.7 minutes different (26.3 minutes and 27.0 minutes). The average commuting trip durations of the highest income category ($150 000 or more annual income) are 9 minutes longer than the average durations of the lowest income category ($1 to $19 999 annual income) (27 minutes versus 36 minutes). Significance testing reveals that, for both commuting time measures, the $1 to $19 999 and $20 000 to $39 999 income categories are significantly below the 'all income' category benchmark, while all four income categories above $60 000 lie significantly above the benchmark. The positive relationship between wages/incomes and commuting times shown in Figure 2 agree with a range of national and international studies (e.g. Flood and Barbato 2005, Van Ham and Hooimeijer 2009, McQuaid and Chen 2012).

In a previous study, using the same HILDA data, but wave 12, BITRE (2016) found that the difference in commuting time between the same highest and lowest income categories was 13 minutes (23 minutes and 36

minutes). Between wave 12 and wave 16, overall commuting times increased by 2 minutes, from 29 minutes to 31 minutes.

As noted in BITRE (2016), many of the international studies relate commuting time to a household-based measure of income, rather than a personal income measure. BITRE (2016) found that the HILDA household income measure[5] was also positively correlated with commuting time, but the relationship was much weaker (and less systematic) than the relationship between an individual's commuting times and their personal income.

Figure 2 HILDA average commuting trip duration by personal annual gross wages and salary income, Australia, 2016



Notes:
1. Income data relates to income from all jobs in the last financial year and is subject to weighted top coding.
2. The six per cent of commuters with a negative income are not shown in the figure, but are included in 'all income' category.
3. Zero income category is excluded.

Source: BITRE analysis of HILDA survey (Unit record data).

All trip types

The preceding section focussed on journey-to-work travel times. This section uses the Sydney HTS to consider average travel time across all trip types in Sydney. It provides data on the average travel time for Sydney GCCSA residents (all trips), based on Sydney HTS [five years pooled unit record data (2015-16 reference year)].

The average travel time per trip for Sydney residents was 24 minutes, being longer for public transport (i.e. (train, bus, taxi and ferry) users (53 min) and shorter for private vehicle users (22 min) (Table 5). Train users spent more time (63 min) on travelling than bus riders (41 min).

Table 5 also shows that average travel times differ depending on weekly income. Across all transport modes, average travel time by Sydney residents (for all trip types) showed a general pattern of tending to rise with income, but commuting times were relatively stable across the top three income categories. While there is some volatility in average trip times across the income categories for individual modes, there is a general tendency for trip times to be greatest for the top few income categories (earning more than $1000 per week) for public transport users and private vehicle users.

The results for all Sydney trips are similar to the results for national commuting trips, in that average travel times tend to rise with income.

[5] Specifically, the household financial year gross total income (imputed) measure was used. The correlation coefficient of the household income measure with average commuting trip duration was 0.05, compared to a correlation coefficient of 0.11 between the personal income measure and average commuting trip duration.

Table 5 Average travel time by weekly personal income and main transport modes, Sydney GCCSA, all trips, 2015-16

Average weekly income	Train	Bus	Total public transport	Private vehicles	All transport modes
			Average travel time (minutes)		
$0-$149	59.0	37.4	48.5	18.2	21.2
$150-$249	67.2	37.7	52.9	17.4	20.6
$250-$399	62.4	36.4	47.2	18.4	20.2
$400-$599	61.5	34.3	49.2	19.8	20.8
$600-$799	59.8	41.0	53.6	22.3	23.5
$800-$999	64.4	41.8	57.5	24.6	25.7
$1000-$1299	62.3	46.5	58.2	25.4	26.6
$1300-$1599	64.6	45.2	59.5	26.8	28.4
$1600-$1999	68.9	48.4	59.2	25.7	27.3
$2000 and more	63.2	52.1	55.2	26.5	27.9
All income groups	62.8	40.6	53.2	22.3	23.9

Notes:
1. 2015-16 Sydney HTS, five years pooled data. Based on linked trips.
2. Data includes weights for weekday.
3. Based on all trips.
4. Total public transport includes train, bus, tram and taxi.
5. Passenger vehicle includes both car (as driver and passenger) and motorbike.
6. All transport modes include total public transport, private vehicle, active travel (walking and cycling) and other modes.
7. All income groups include other income (do not answer, don't know, negative income and refused to answer).
Source: BITRE analysis of NSW *Household Travel Survey* (HTS) (Unit record data).

Relationship between income and public transport use for the journey-to-work

This section provides data on transport mode shares for various modes (e.g. train, bus, other public transport and private vehicle) for the journey-to-work by personal income categories for Australia. It also provides transport mode shares for the five major capital cities and the rest of Australia. The data are sourced from the ABS *Census of Population and Housing* for 2016 (TableBuilder Pro), and place of usual residence data is used.

Australia

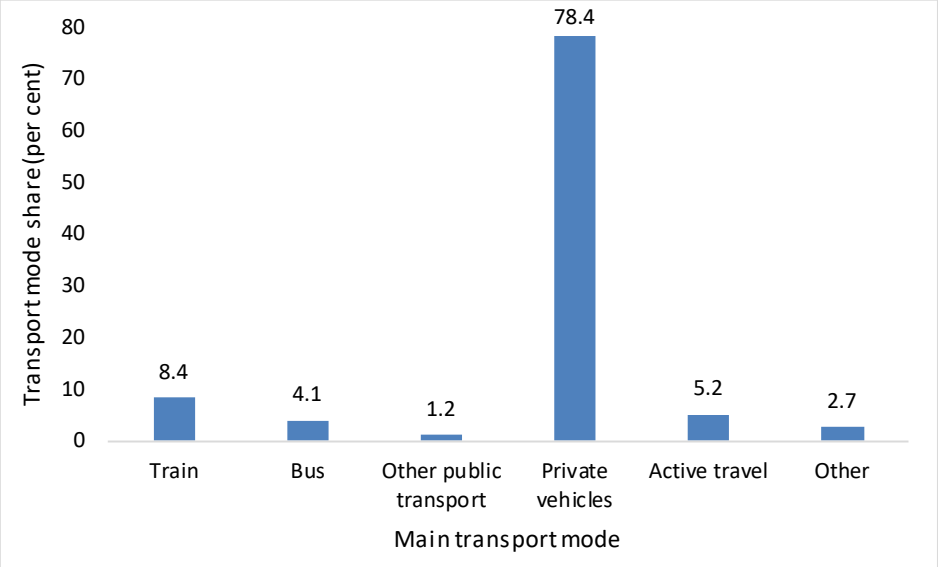
Figure 3 shows the overall transport mode shares for all income groups, while Figure 4 shows the relationship between weekly personal income and transport mode shares for the journey-to-work in Australia in 2016.

Overall, more than three-quarters (78.4 per cent) of employed persons used private vehicles (i.e. car driver, car passenger and motorbike/scooter driver and rider) as the main transport mode[6] of their journey-to-work, while 8.4 per cent of employed people used train as their main transport to work, 4.1 per cent used bus and 1.2 per cent used other public transport (i.e. tram, ferry and taxi). Overall, 13.7 per cent used public transport (Figure 3). Further, 5.2 per cent of employed persons either walked or rode a bicycle (active travel) and 2.7 per cent used other modes (i.e. truck, other and not stated).

[6] It is important to note that many commuters used more than one mode of transport to get to work. In order to assign each person's census response to one key mode of transport for analysis, a category hierarchy has been applied to the Census data used in this information sheet, as: Train (Highest) > Bus > Ferry > Tram/Light rail > Taxi > Vehicle driver > Vehicle passenger > Truck > Motorbike > Bicycle > Other mode (not specified) > Walk only (Lowest). Note that this hierarchy has been based on the *Transfigures* report published by the Ministry of Transport, New South Wales in 2008 and BITRE has used it in several reports in the past.

The hierarchy was created in such a way so that it 'gives priority to public transport over other modes' (ibid, p.14). This means that, for example, if a person used the train, a car and the bus to get to work, their journey to work was classified as a 'train' journey, because train is highest in the hierarchy. Similarly, if a person used the bus and a bicycle, their journey was classed as a 'bus' journey.

Figure 3 Main transport mode shares for the journey-to-work, all income groups, Australia, 2016



Notes:
1. Other public transport includes tram, ferry and taxi.
2. Private vehicles include car as driver and passenger, and motorbike/scooter.
3. Active travel includes Bicycle and Walking.
4. Other transport includes truck, other and not stated.
5. Main transport mode hierarchy is based on the Transfigures report published by the Ministry of Transport, New South Wales in 2008 (see Footnote 6).
6. Excludes people who are not employed, work from home and who did not go to work on census day.

Source: BITRE analysis of ABS *Census of Population and Housing* for 2016 place of usual residence data (TableBuilder Pro).

In terms of the relationship between income and transport mode shares (based on ABS 2016 Census place of usual residence data), the key results for Australia shown in Figure 4 are summarised below:

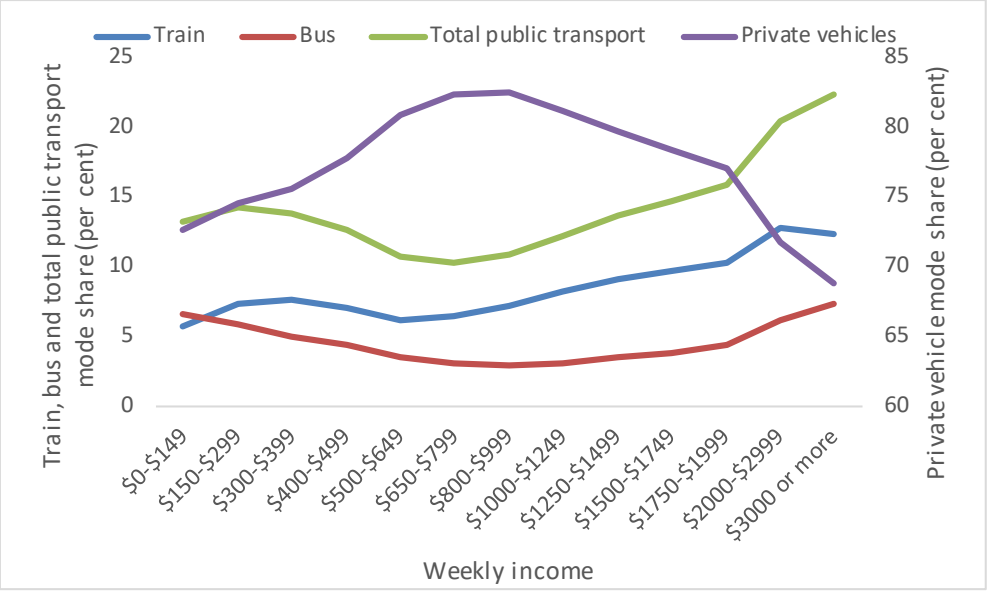
1. In general, the proportion of employed persons who used train to travel to work increased with income. The train mode share was highest for employed persons when weekly personal income was $2000-$2999 (12.7 per cent), closely followed by the highest weekly income category ($3000 or more) (12.2 per cent). The train mode share was 5.7 per cent for the lowest income category ($0-$149).
2. The total public transport mode share was at its highest for high income people and was lowest for middle income earners who commuted to work.
3. The pattern for bus users was u-shaped, with low and high income commuters relatively more likely to use the bus than middle income commuters.
4. The private vehicle mode share was highest for lower middle income individuals with an average weekly income of $500-$1499. The private vehicle mode share was lowest for very low and high income earners.

While this study concentrates on ABS 2016 Census data, these general patterns have also been observed at earlier time points and in different geographic settings. DIT (2013) used 2011 Census data to show that average incomes were related to the type of transport used for journeys to work, with those who used public transport for their journey to work tending to have higher average weekly individual incomes than those who used other transport modes. Similar patterns were also observed in overseas studies. For example, the American Public Transportation Association (2007) found lower rail mode share for low income earners compared to high income earners. In addition, this study also found that low income households were more likely to use bus than those with higher household incomes. In a study in the UK, using the London Travel Demand Survey data, Transport for London (2011) found that commuters in lower income groups made more bus trips, and higher income groups made more car, rail and Underground trips.

A comparison of 2011 and 2016 Census data for Australia reveals that there was a small increase in the overall public transport mode share from 12.8 per cent in 2011 to 13.7 per cent in 2016. This increase was concentrated amongst the high income earners ($2000 or more per week), for whom the mode share

increased from 19.1 to 21.1 per cent. The public transport mode shares were relatively stable for low and middle income households. Thus, the tendency for the public transport mode share to be highest for high income earners appears to be strengthening over time.

Figure 4 Main transport mode shares for the journey-to-work by income category, Australia, 2016



Notes:
1. Total public transport includes train, bus, tram, ferry and taxi.
2. Private vehicles include car as driver and passenger, and motorbike/scooter.
3. Calculation of mode share is based on total transport which include public transport, private vehicles, active travel (walking and cycling) and other transport (truck, other and not stated).
4. Main transport mode hierarchy is based on the Transfigures report published by the Ministry of Transport, New South Wales in 2008 (see Footnote 6).
5. Negative income, not stated and not applicable categories were excluded from total income. Also, Figure 4 excludes people who are not employed, work from home and who did not go to work on census day.

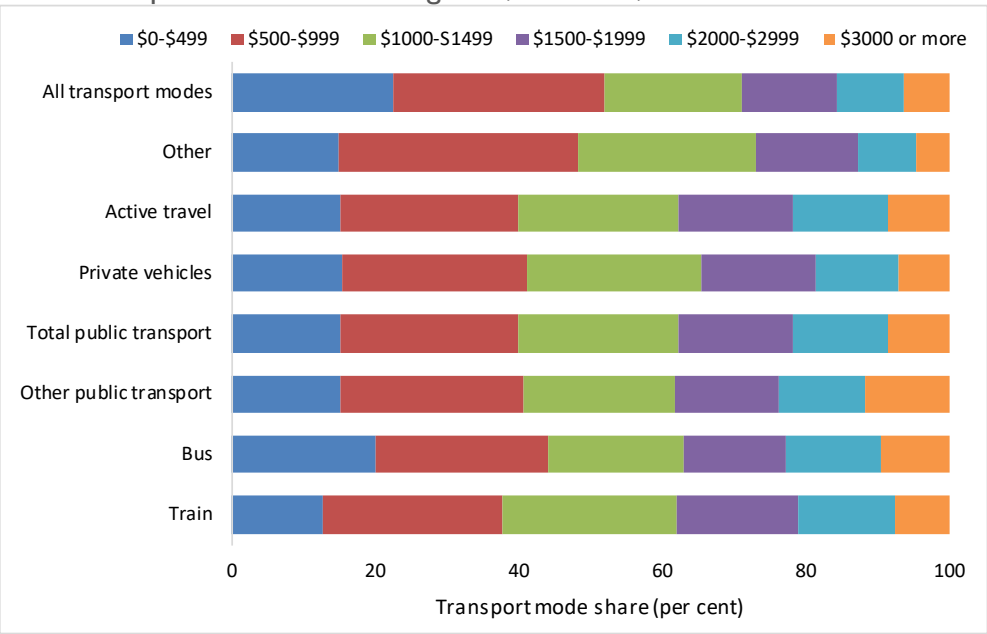
Source: BITRE analysis of ABS *Census of Population and Housing* for 2016 place of usual residence data (TableBuilder Pro).

Figure 5 shows another way of looking at data used in Figures 3 and 4. The proportion of each transport mode was calculated by income categories (with thirteen income categories collapsed into six categories). Although the proportion of journey-to-work commuters for individual public transport modes varied with income, commuters with weekly average income of $500-$999 represented the largest share (24.7 per cent) of total public transport users, while the highest income category (i.e. $3000 or more per week) accounted for only 8.6 per cent of public transport users. Similarly, within the private vehicle users and active travellers, the highest shares were those whose weekly average incomes were between $500 and $1499.

When comparing Figure 5 with Figure 4, the results show the equity implications for public transport investment. The fact that high income individuals have a higher propensity to use the train than low and middle income individuals (see Figure 4), needs to be interpreted alongside the message of Figure 5 that high income train users represent a relatively minor share of all train users, with most train users being in the lower middle income categories (i.e. $500 to $1499 per week).[7] The distributional consequences of policy initiatives targeted at private vehicle users (and specifically, commuters) will be different, given that it is lower middle income individuals (earning between $26 000 and $78 000 per year) who have the highest rates of private vehicle use for the journey to work (see Figure 4).

[7] Those earning between $500 and $1499 per week represent 49 per cent of train commuters, while those earning more than $2000 per week represent 21 per cent of train commuters.

Figure 5 Proportion of journey-to-work commuters by main transport modes, by weekly personal income categories, Australia, 2016



Notes:
1. Private vehicles include car as driver and passenger, and motorbike/scooter.
2. Active Travel includes Bicycle and Walking.
3. Other transport includes truck, other and not stated.
4. Main transport mode hierarchy is based on the Transfigures report published by the Ministry of Transport, New South Wales in 2008 (see Footnote 6).
5. Negative income, not stated and not applicable categories were excluded from total income. Also, Figure 5 excludes people who are not employed, work from home and who did not go to work on census day.
6. Income categories are collapsed into six categories from 13 categories as shown in Figure 4.

Source: BITRE analysis of ABS *Census of Population and Housing* for 2016 place of usual residence data (TableBuilder Pro).

Five major capital cities and rest of Australia

In this section, weekly incomes are categorised into three broad income groups to show the relationship between income and transport modes for the five major capital cites (i.e. Sydney, Melbourne, Brisbane, Adelaide and Perth) and the rest of Australia. The weekly income groups are: low income ($0-$999), medium income ($1000-$1999) and high income ($2000 and more). The results are presented in Table 6.

Generally, those employed people with higher incomes tend to take public transport (i.e. train and other forms of public transport) more than those employed people with lower income. The opposite trend can be seen for the use of private vehicles. However, there are a few exceptions, depending on location. For example, a significantly higher proportion of employed people with higher incomes used other public transport in Sydney, Brisbane and Perth, while there was little variation across income categories in Melbourne and Adelaide.

Other results from Table 6 include:

- Higher proportions of employed people with low and medium incomes used private vehicles in the four largest capital cities. However, in Adelaide, private vehicle use was similar across the low, middle and high income categories.
- In each of the five major capital cities, the proportion using bicycle or walking (i.e. active travel) was highest at the two extremes of the income distribution.
- The other transport (i.e. truck, other and not stated) mode share is at its highest for the lowest income categories in Sydney, Melbourne, Brisbane and Adelaide, but not in Perth. The high proportion of other modes amongst high income earners in Perth may be due to other transport use by fly-in fly-out (FIFO) workers.

Overall, the public transport mode share was just 3.6 per cent for the journey-to-work in the rest of Australia. This involved 111 800 trips by public transport, which is nearly nine per cent of all public transport trips in Australia. Bus was the most common public transport mode, accounting for 71 800 trips or 2.3 per cent of all journey-to-work trips in the rest of Australia. About 62 per cent of the 111 800 trips by public transport in the rest of Australia were undertaken in cities with more than 80 000 people.

For the rest of Australia, the proportion of employed persons who used public transport (both train and other public transport modes, i.e. bus, tram, taxi and ferry) was greatest for the high income category, while the proportions of private vehicle and active transport users were lowest for the high income category.

Table 6 Transport users of various modes for journey-to-work by average weekly personal income, five major capital cities and rest of Australia, 2016

Income category	Transport mode - Share (per cent) of employed persons						
	Train	Other public transport	Total public transport	Private vehicle	Active travel	Other	All modes
Greater Sydney							
Low	16.5	6.9	23.4	67.6	6.1	3.0	100.0
Medium	19.1	6.9	25.9	67.2	4.5	2.4	100.0
High	22.2	12.4	34.6	58.0	5.9	1.5	100.0
All income groups	18.5	7.9	26.3	65.6	5.4	2.6	100.0
Greater Melbourne							
Low	10.6	5.4	16.0	76.3	5.1	2.6	100.0
Medium	14.2	4.4	18.6	75.2	4.5	1.7	100.0
High	19.4	5.7	25.1	66.8	6.6	1.5	100.0
All income groups	13.2	5.0	18.2	74.5	5.0	2.2	100.0
Greater Brisbane							
Low	5.5	6.7	12.2	80.3	4.8	2.6	100.0
Medium	7.5	6.7	14.2	79.6	4.0	2.3	100.0
High	9.0	9.2	18.3	73.4	6.1	2.2	100.0
All income groups	6.7	7.0	13.8	79.0	4.7	2.6	100.0
Greater Adelaide							
Low	2.5	7.9	10.4	83.4	3.9	2.3	100.0
Medium	3.1	7.9	11.0	83.8	3.4	1.9	100.0
High	2.6	7.4	10.0	82.1	5.7	2.1	100.0
All income groups	2.7	7.8	10.6	83.3	3.9	2.3	100.0
Greater Perth							
Low	6.0	4.6	10.7	82.9	3.8	2.6	100.0
Medium	7.4	4.0	11.4	82.8	2.8	3.0	100.0
High	9.0	8.9	17.9	72.4	4.8	4.9	100.0
All income groups	7.1	5.1	12.2	80.9	3.6	3.3	100.0
Rest of Australia							
Low	0.6	2.3	2.9	86.8	6.8	3.5	100.0
Medium	1.0	2.1	3.1	89.0	5.0	3.0	100.0
High	1.8	6.5	8.3	82.7	5.4	3.6	100.0
All income groups	0.9	2.7	3.6	86.9	6.0	3.5	100.0

Notes:

1. Income groups are collapsed into three main categories as: low income ($0-$999), medium income ($1000-$1999) and high income ($2000 and more).
2. Other public transport includes bus, tram, ferry and taxi.
3. Total public transport includes train and other public transport.
4. Total private vehicle includes both driver and passenger, and motorcycle.
5. All modes include total public transport, private vehicles, active travel (bicycle and walking) and other transport modes.
6. Negative income, not stated and not applicable categories are excluded from the analysis.
7. Other transport includes truck, other and not stated.
8. Other income (i.e. negative income, not stated and not applicable) are included in all income.
9. Rest of Australia includes total Australia, excluding Greater Sydney, Greater Melbourne, Greater Brisbane, Greater Adelaide and Greater Perth.
10. Main transport mode hierarchy is based on the Transfigures report published by the Ministry of Transport, New South Wales in 2008 (see Footnote 6).

Source: BITRE analysis of ABS *Census of Population and Housing* 2016 place of usual residence data (TableBuilder Pro).

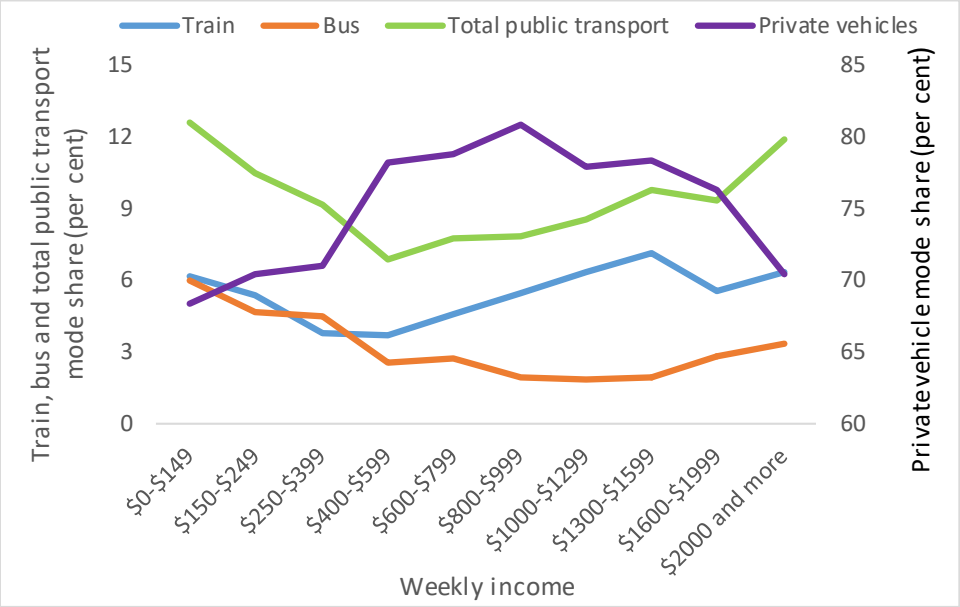
Relationship between income and public transport use, All trips

This section provides data on transport mode shares for various modes (e.g. train, bus, other public transport and private vehicle) for all trips by personal income categories for Greater Sydney. The data are sourced from the Sydney HTS [five years pooled unit record data, 2015-16 reference year].

In terms of the relationship between income and transport mode shares, the key results for Greater Sydney shown in Figure 6 are summarised below:

1. The proportion of people who used train (all trip purposes) was highest for those whose weekly personal income was $1300-$1599 (7.2 per cent), and was also relatively high (at just over 6 per cent) for the top and bottom income categories. The train mode share was lowest for the $250-$399 and $400-$599 income categories (3.8 per cent).
2. The total public transport mode share was at its highest for very low and very high income people, and was lower for middle income earners, showing a U-shaped pattern.
3. The proportion of bus users initially decreased with income, but was relatively stable for incomes over $400 per week.
4. The private vehicle mode share was highest for middle income earners, particularly for those with an average weekly income of $800-$999 (80.8 per cent). The private vehicle mode share was lowest for very low and very high income earners, showing a hump-shaped pattern.

Figure 6 Main transport mode shares for all trips by income category, Greater Sydney, 2016



Notes:
1. 2015-16 Sydney HTS, five years pooled data. Based on linked trips.
2. Data includes weights for weekday.
3. Based on all trips.
4. Total public transport includes train, bus, tram and taxi.
5. Passenger vehicle includes both car (as driver and passenger) and motorbike.
6. All transport modes include total public transport, private vehicle, active travel (walking and cycling) and other modes.
7. All income groups include other income (do not answer, don't know, negative income and refused to answer).
Source: BITRE analysis of NSW *Household Travel Survey* (HTS) (Unit record data).

Comparing Figure 4 (journey to work for Australia) and Figure 6 (all trips for Greater Sydney), the nature of the relationships between average weekly income and mode share are essentially very similar for both total public transport and private vehicles. However, the train and bus mode shares display very different patterns. For national commuting trips, there is a clear pattern of the train mode share rising as income increases, a pattern that is also evident for Sydney commuting trips (see Table 6), whereas for all Sydney trips the relationship is much less evident. The different patterns could reflect the inclusion of other types of trips (e.g. shopping, education) or it could reflect methodological differences between the census and the HTS.

Relationship between income and transport use by location

Generally, transport use and income vary by location (Zegras and Srinivasan 2007). In particular, the income levels of commuters who ride transit to work vary greatly by location (Versel 2013).

The main focus of this section is to identify how personal income influences the use of the different transport modes by journey-to-work commuters at various geographic levels (States/Territories, capital cities, state balances and major cities[8]). It also presents more disaggregated mode use data for the three largest capital cities (Greater Sydney, Greater Melbourne and Greater Brisbane). In addition, the relationships between income and transport mode for commuters by city sector of residence and city sector of work are also presented. Note that data are presented only for employed persons here.

The income distribution of employed, non-employed and total population aged 15 years and more in Australia is presented in Appendix B.

In this section, income and transport use is tackled from two different angles, but both are related. These are:

1. The relationship between average income and the main transport mode used by commuters to get to work.
2. How transport mode shares vary across income categories.

Estimated average weekly personal income and transport mode for commuters

States/Territories, capital cities and state balances

Figure 6 shows estimated average personal weekly income for commuters who used the different transport modes for their journey to work by capital cities (aggregated), state balance and total Australia, while data for individual capital cities, state balances and states/territories is presented in Table 7.

According to ABS Census data for 2016, the estimated average weekly personal income[9] for employed persons was $1293 in Australia (Figure 6 and Table 7). There were income differences across mode use categories. For example, estimated average weekly income was higher for employed public transport users ($1503) than for users of private vehicles ($1261), active travel ($1265) or other modes ($1224). However, there was no difference between train and other public transport (which included bus, tram, ferry and taxi) ($1504 versus $1502). Estimated weekly average income was higher for public transport users compared to private vehicle users or active travellers in both capital cities and state balances.

Figure 6 and Table 7 also show that the patterns of higher incomes for public transport users is repeated for most individual cities and state balances, but not for ACT, Tasmania or Adelaide. However, the observed national pattern is driven by the most populous states of NSW, Victoria, Queensland and WA (and particularly by the four large capital cities). Overall, for capital city employed persons, the average weekly personal income was $1352, around 17 per cent higher than the average weekly income of those who worked outside the capital cities ($1159).

Average weekly personal incomes are also related to the type of transport mode used for journeys to work. In 2016, people in both total capital cities and in total non-capital major cities (rest of states) who used public transport (either train or other public transport) for their journey-to-work tend to have higher average weekly personal income than those who used private vehicles (Figure 6). However, the difference is less pronounced for commuters in capital cities than in the state balances. The difference between public transport and private vehicle commuters for capital cities and state balances were $184 and $429,

[8] Major cities with populations over 80 000 people, which consist of a total of 21 cities including 8 capital cities (i.e. Greater Sydney, Greater Melbourne, Greater Brisbane, Greater Adelaide, Greater Perth, Greater Hobart, Greater Darwin and Canberra) and 13 non-capital major cities (i.e. Albury-Wodonga, Newcastle-Maitland, Wollongong, Ballarat, Bendigo, Geelong, Cairns, Gold Coast-Tweed Heads, Mackay, Sunshine Coast, Toowoomba, Townsville and Launceston) (Commonwealth of Australia 2017, p.7).

[9] BITRE estimated average weekly income based on the categorical income responses in the census. The average value was set as the midpoint of the income range for all categories, apart from the top income category, where the average was set at 1.5 x lower band of top income category (i.e. $4500). Results from the ABS' *Survey of Income and Housing* 2009–10 and 2015-16 show that this rule provides a conservative midpoint for the top income category. BITRE (2014a) provides further information.

respectively. In other words, average incomes were 14 per cent higher for public transport users than users of private vehicles in the capital cities and 37 per cent higher in the state balances.

Figure 7 also reveals that train users who travelled to work in capital cities had lower average weekly personal income than train users in the state balances ($1501 versus $1611, or 7 per cent lower). This pattern is also evident for other public transport users. Note that many of the train users in the rest of Australia would be using the train to travel to a place of work in the nearest capital city. There are relatively few train users in the rest of Australia (25 400) compared to the 734 700 in the capital cities. Private vehicle users and active travellers (walking and cycling) in capital cities have higher average weekly income than in the state balances (14 per cent higher for private vehicle users and 36 per cent higher for active travellers).

Figure 7 Estimated weekly average personal income for users of various transport modes for the journey to work in total capital cities, rest of states and Australia, 2016

Notes:
1. Refer to BITRE (2014a) for information on method for estimating average weekly personal income from census data.
2. Negative income, not stated and not applicable categories were excluded from total income. Also, the table excludes people who are not employed, work from home or who did not go to work on census day.
3. Main transport mode hierarchy is based on the Transfigures report published by the Ministry of Transport, New South Wales in 2008 (see Footnote 6).
4. Other public transport includes bus, tram, ferry and taxi.
5. Total public transport includes train, bus, tram, ferry and taxi.
6. Private vehicles include car as driver and passenger, and motorbike/scooter.
7. Active travel includes bicycle and walking.
8. Other transport includes truck, other and not stated.
9. Australian Capital Territory is the same as Canberra and was included in the Capital cities total.

Source: BITRE analysis of ABS *Census of Population and Housing* for 2016 place of usual residence data (TableBuilder Pro).

For states and territories, the average weekly personal income for all employed persons (all modes) varied substantially, from $1103 (Tasmania) to $1472 (Northern Territory). This primarily reflects differences in the average income of employed persons in the capital cities. For the eight capital cities, the average weekly income of all employed persons was highest in Canberra ($1576) and lowest in Greater Hobart ($1147).

Among the five major states, the average personal income of train users varied between $1188 (South Australia) and $1563 (Western Australia) (Table 7). Among the five major states, average weekly incomes for train users were higher than private vehicle users (both driver and passenger), ranging from 2 per cent higher (South Australia) to 23 per cent higher (Victoria). Similarly, among the five major capital cities, estimated average weekly incomes for train users were between 11 per cent and 18 per cent higher compared to private vehicle users in Sydney, Melbourne, Brisbane and Perth, but Adelaide train users had slightly (0.6 per

cent) lower incomes, on average, than private vehicle users.[10] Average incomes for train users were much higher than private vehicle users in non-capital areas (rest of state) in the five major states, ranging from 22 per cent higher in the rest of South Australia to 59 per cent higher in the rest of Victoria. Among the three largest capital cities, estimated average weekly incomes of other public transport users were higher in Sydney compared to train users, while lower in Melbourne and Brisbane (Table 7).

Table 7 Estimated weekly average personal income for users of various transport modes for the journey to work in various geographic areas, 2016

Geographic areas	Main transport mode						All modes (all employed persons)
	Train	Other Public transport[a]	Total Public transport[b]	Private vehicles[c]	Active travel[d]	Other transport[e]	
	Estimated average weekly personal income ($)						
Greater Sydney	1513	1697	1568	1370	1391	1191	1419
Rest of New South Wales	1536	1079	1281	1160	1016	1057	1152
New South Wales	1513	1652	1556	1289	1279	1139	1334
Greater Melbourne	1504	1287	1444	1273	1373	1128	1306
Rest of Victoria	1723	1003	1436	1059	979	1023	1089
Victoria	1512	1270	1443	1227	1281	1098	1259
Greater Brisbane	1432	1364	1397	1272	1338	1229	1291
Rest of Queensland	1570	1468	1490	1167	1014	1185	1170
Queensland	1444	1391	1414	1218	1166	1203	1232
Greater Adelaide	1185	1142	1153	1194	1255	1129	1190
Rest of South Australia	1289	1610	1565	1053	969	1073	1056
South Australia	1188	1161	1168	1164	1169	1112	1163
Greater Perth	1563	1710	1624	1368	1518	1665	1414
Rest of Western Australia	1775	2638	2615	1346	1153	1709	1428
Western Australia	1563	1918	1734	1363	1395	1687	1417
Greater Hobart	np	983	992	1186	1262	1096	1177
Rest of Tasmania	np	998	1004	1044	978	1027	1039
Tasmania	np	980	990	1107	1134	1063	1103
Greater Darwin	np	2248	2239	1496	1359	1567	1556
Rest of Northern Territory	np	1625	1637	1358	1022	1100	1276
Northern Territory	np	2162	2158	1459	1153	1376	1472
Australian Capital Territory[f]	np	1413	1421	1595	1602	1299	1576
All Capital cities	1501	1493	1498	1317	1388	1261	1352
All Rest of States	1611	1569	1582	1153	1018	1160	1159
Australia	1504	1502	1503	1261	1265	1224	1293

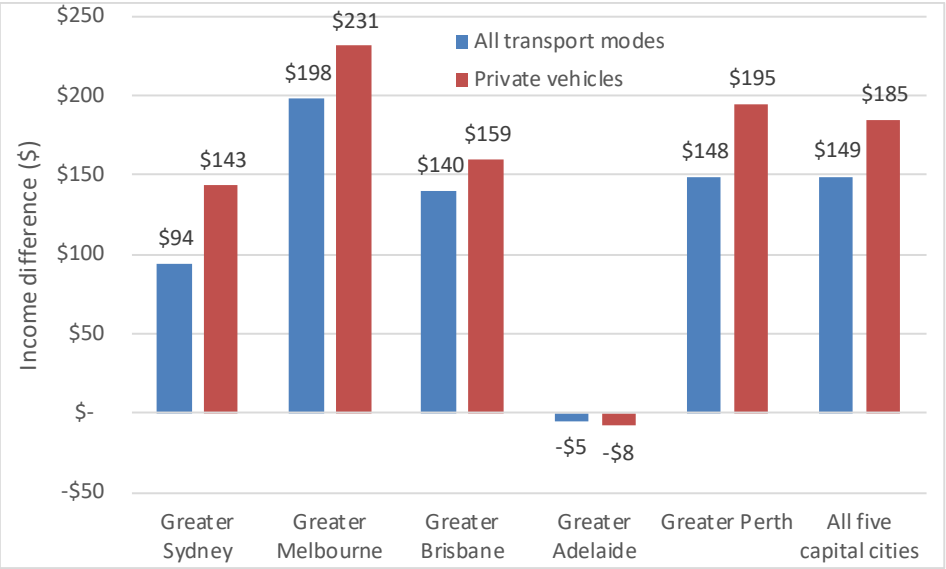
Notes:
1. Refer to BITRE (2014a) for information on method for estimating average weekly personal income from census data.
2. Negative income, not stated and not applicable categories were excluded from total income. Also, the table excludes people who are not employed, work from home or who did not go to work on census day.
3. Main transport mode hierarchy is based on the Transfigures report published by the Ministry of Transport, New South Wales in 2008 (see Footnote 6).
4. np - denotes not published, due to small sample size (<100).

[a] Other Public transport includes Bus, Tram, Ferry and Taxi.
[b] Total Public Transport includes Train and Other Public Transport.
[c] Private vehicles include car as driver and passenger, and motorbike/scooter.
[d] Active Travel includes Bicycle and Walking.
[e] Other transport includes all other modes not mentioned earlier.
[f] Australian Capital Territory is same as Canberra and was included in the Capital cities total.
Source: BITRE analysis of ABS *Census of Population and Housing* for 2016 place of usual residence data (TableBuilder Pro).

Figure 8 shows the total income difference for train users over private vehicle users in the five large capital cities. Train users have higher incomes over private vehicles or all transport modes in four capital cities. Adelaide is the exception. Compared to private vehicles, the highest income difference for train users was in Melbourne ($231), followed by Perth ($195), Brisbane ($159) and Sydney ($143). In Adelaide, train users have slightly lower incomes (a difference of $8) compared to private vehicle users. Similarly, train users have higher incomes over all transport modes in all cities, except in Adelaide.

[10] This may reflect Adelaide's lower CBD income premium (i.e. the average income difference for those who work in the CBD compared to those who work in other parts of the city) (see Table 12). The geographic distribution of Adelaide's rail network also contributes to this result, particularly the lack of coverage in some of Adelaide's more advantaged suburbs, including the eastern suburbs (see Table B1.2).

Figure 8 Total income premium for train users, five large capital cities, 2016



Notes:
1. Refer to BITRE (2014a) for information on method for estimating average weekly personal income from census data.
2. Negative income, not stated and not applicable categories were excluded from total income. Also, the table excludes people who are not employed, work from home or who did not go to work on census day.
3. Main transport mode hierarchy is based on the Transfigures report published by the Ministry of Transport, New South Wales in 2008 (see Footnote 6).
4. All transport modes also include train and other modes (truck, other and not stated).

Source: BITRE analysis of ABS *Census of Population and Housing* for 2016 place of usual residence data (TableBuilder Pro).

Table 8 shows the breakdown of 'Other public transport' into bus, ferry, tram and taxi, private vehicle into car as driver, car as passenger and motorbike/scooter, and active travel as walking and bicycle for Sydney, Melbourne and Brisbane. In Sydney, ferry users had higher income compared to users of other public transport modes (bus, tram and taxi). Bus users had lower personal incomes than the other public transport modes in all three cities. Private vehicle users as driver had much higher personal income than those who used private vehicle as passenger in all three cities. Bicycle riders had significantly higher personal incomes than those who walked to work in all three cities.

Table 8 Estimated weekly average personal income by detailed transport modes for the journey to work in Greater Sydney, Greater Melbourne and Greater Brisbane, 2016

Main transport modes	Greater Sydney	Greater Melbourne	Greater Brisbane
	Estimated average weekly personal income ($)		
Other public transport			
Bus	1609	988	1329
Ferry	2777	1302	1700
Tram	1837	1434	1727
Taxi	2014	1561	1632
Private vehicles			
Private vehicles (Driver)	1397	1301	1299
Private Vehicles (Passenger)	936	811	899
Motorcycle	1766	1584	1480
Active travel			
Walking	1298	1219	1180
Bicycle	1907	1699	1746
All transport modes	1419	1306	1291

Notes:
1. Refer to BITRE (2014a) for information on method for estimating average weekly personal income from census data.
2. Negative income, not stated and not applicable categories were excluded from total income. Also, the table excludes people who are not employed, work from home or who did not go to work on census day.
3. Main transport mode hierarchy is based on the Transfigures report published by the Ministry of Transport, New South Wales in 2008 (see Footnote 6).
4. All transport modes also include train and other modes (truck, other and not stated).

Source: BITRE analysis of ABS *Census of Population and Housing* for 2016 place of usual residence data (TableBuilder Pro).

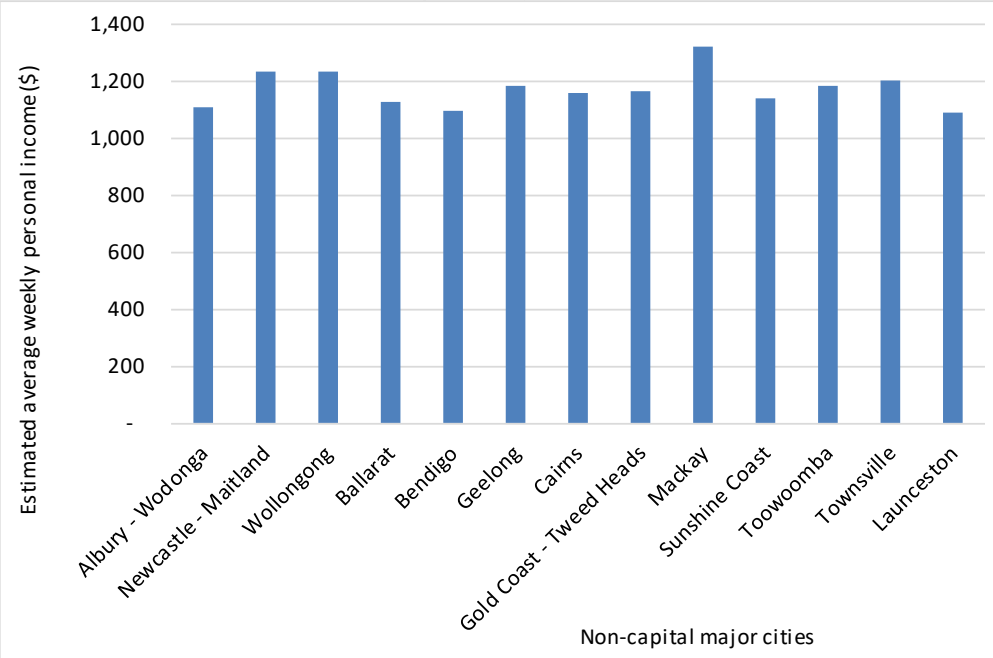
Non-capital major cities

This section provides estimated average weekly income for users of various transport modes for the journey to work in major cities (for details of major cities, see Footnote 7). Note that the results for the eight capital cities are already provided in Table 8. Therefore, the results for non-capital major cities are presented.

Figure 9 shows the estimated average weekly income for users of all transport modes for the journey to work in non-capital major cities, while Table 9 presents estimated average weekly income for users of individual transport modes.

The estimated average weekly income for all transport modes was highest for Mackay commuters ($1317), followed by Newcastle-Maitland ($1233), and lowest for Launceston commuters ($1086) (Figure 9).

Figure 9 Estimated average weekly income for users of all transport modes for the journey to work in all non-capital major cities, 2016



Notes:
1. Only non-capital major cities with populations over 80 000 people of residence are presented. Data for eight capital cities are not included here as they were included in Table 8.
2. Refer to BITRE (2014a) for information on method for estimating average weekly personal income from census data.

Source: BITRE analysis of ABS *Census of Population and Housing* for 2016 place of usual residence data (TableBuilder Pro).

The key results in Table 9 are summarised below:

- Among the non-capital major cities which had a sample size of more than 100 train users, average weekly personal income for train users varied between $1392 (Newcastle-Maitland) and $1862 (Ballarat). Train users in Geelong and Sunshine Coast also had relatively high average weekly personal income ($1791 and $1800, respectively).
- The average weekly personal income of train users was consistently higher than that of all employed persons in each of the non-capital major cities with a substantial number of train users. This most likely reflects the use of train by residents of these smaller cities to access higher-paying jobs in the nearby capital city.
- The average weekly personal income of public transport users was higher than that of all other transport mode users, except for in Albury–Wodonga, Newcastle–Maitland, Cairns and Launceston.

Table 9 Estimated average weekly income for users of various transport modes for the journey to work in all non-capital major cities, 2016

Major cities - Non-Capitals	Main mode of transport						All transport modes
	Train	Other public transport.	Total Public transport	Private vehicles	Active travel	Other transport	
	Estimated average weekly personal income ($)						
Albury - Wodonga	np	886	897	1112	1017	1081	1104
Newcastle - Maitland	1392	1060	1171	1241	1184	1106	1233
Wollongong	1575	899	1376	1226	1066	1122	1229
Ballarat	1862	721	1408	1113	1111	1016	1123
Bendigo	1491	835	1065	1091	1143	1010	1092
Geelong	1791	972	1531	1157	1115	1078	1179
Cairns	np	1105	1116	1159	1087	1351	1159
Gold Coast - Tweed Heads	1540	1000	1219	1165	961	1196	1160
Mackay	np	1903	1896	1306	1122	1284	1317
Sunshine Coast	1800	1242	1382	1134	1030	1260	1141
Toowoomba	np	1188	1225	1187	1074	1126	1181
Townsville	np	1415	1416	1197	1187	1271	1202
Launceston	np	869	889	1092	1111	1030	1086

Notes:
1. Only non-capital major cities with populations over 80 000 people of residence are presented. Data for eight capital cities are not included here as they were included in Table 7.
2. Refer to BITRE (2014a) for information on method for estimating average weekly personal income from census data.
3. Main transport mode hierarchy is based on the Transfigures report published by the Ministry of Transport, New South Wales in 2008 (see Footnote 6).
4. np – Not presented as based on sample of less than 100, which is not considered meaningful.
5. Other public transport includes bus, tram, ferry and taxi.
6. Total public transport includes train, bus, tram, ferry and taxi.
7. Private vehicles include car as driver and passenger, and motorbike/scooter.
8. Active travel includes bicycle and walking.
9. Other transport includes truck, other and not stated.

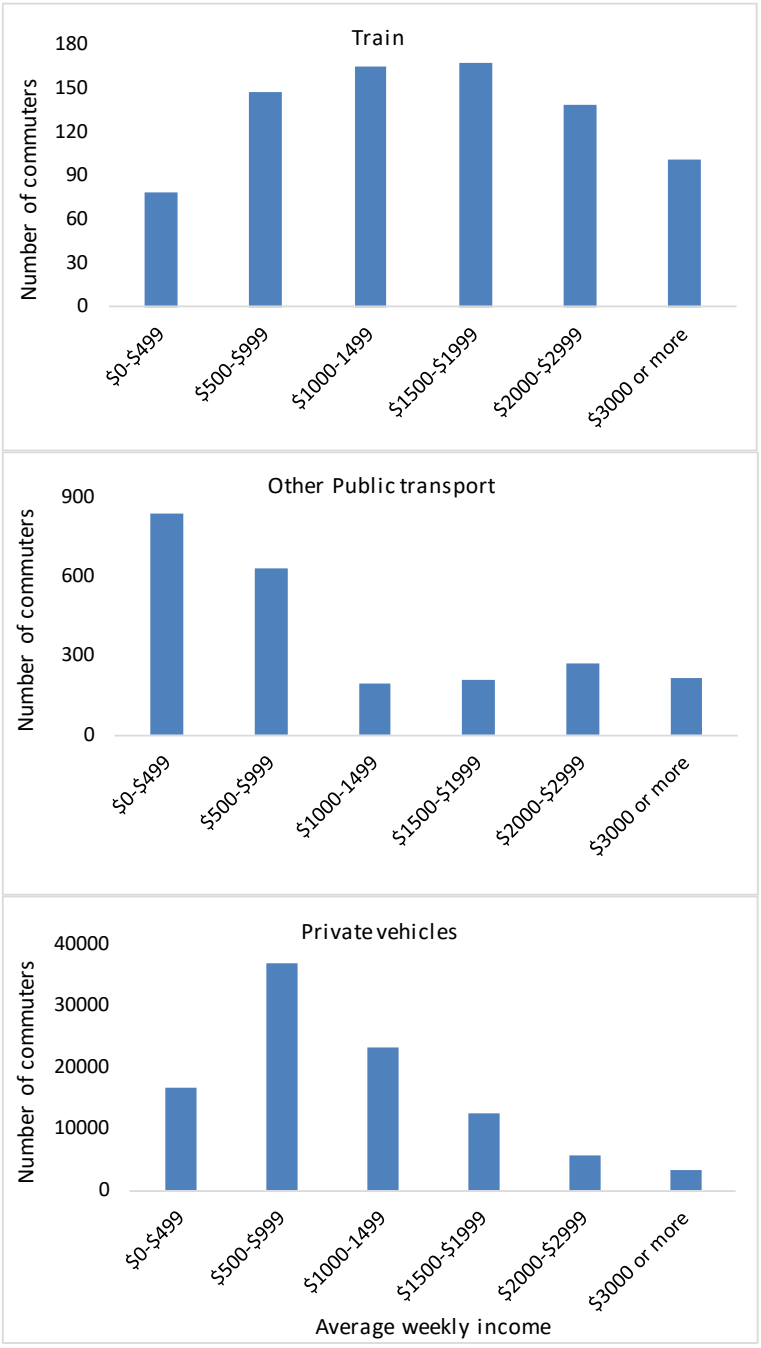
Source: BITRE analysis of ABS *Census of Population and Housing* for 2016 place of usual residence data (TableBuilder Pro).

Table 9 shows that in cities where trains were available, train users had higher average weekly personal income than other public transport and private vehicle users. This is due to the different income distribution of these different types of transport users. For example, the most common train users in Sunshine Coast belong to the middle two income categories (i.e. $1000-$1499 and $1500-$1999) and this represents 42 per cent of all train users (Figure 10). Other public transport users mainly belong to the bottom two income categories ($0-$499 and $500-$999), which represents 62 per cent of all other public transport users, while private vehicle users mainly belong to the bottom second and third income categories ($500-$999 and $1000-$1499), which represent 61 per cent of all private vehicle users. Similar patterns are also evident for the other non-capital major cities.

Table 9 also shows that the estimated average weekly income was high for Mackay employed persons who used public transport for their journey-to work compared to other non-capital major cities. This may be related to use of private (chartered) bus by employed persons who worked in the mining industry. Note that, based on ABS 2016 Census data, mining was the second most important industry for Mackay residents and bus was the main public transport mode.

The issue of the relationship between rail use and income in regional cities is addressed through a case study of the Geelong-Melbourne corridor, which is presented later in this Information Sheet.

Figure 10 Distribution of train, other public transport and private vehicle users in Sunshine Coast, 2016



Notes:
1. Other public transport includes train, bus, ferry, tram and taxi.
2. Total private vehicle includes both driver and passenger, and motorcycle.
3. Main transport mode hierarchy is based on the Transfigures report published by the Ministry of Transport, New South Wales in 2008 (see Footnote 6).

Source: BITRE analysis of ABS *Census of Population and Housing* for 2016 place of usual residence data (TableBuilder Pro).

City Sector of Residence

This section looks at the average weekly personal income of residents who use train, other public transport (combined bus, tram, ferry and taxi) and private vehicles (includes car as driver and passenger as well as motorcyclists) by city sector for the five major cities (Sydney, Melbourne, Brisbane, Adelaide and Perth) for 2016. Note that the definition of Inner, Middle and Outer sectors of these five cities are visually shown in the Maps in Appendix C.

Generally, for the five major capital cities (aggregated), estimated average weekly personal income was higher for train users compared to other public transport modes (combined), private vehicles and all transport modes for residents of the middle and outer sectors, but not the inner sector (Table 10). Overall, inner sector residents have much higher average incomes than middle sector residents, who in turn have higher income than outer sector residents. This pattern is repeated across all five major capital cities.

Table 10 Estimated average weekly personal income for users of various transport modes by sector of residence, five major capital cities, 2016

	Estimated average weekly personal income ($)			
	Inner	Middle	Outer	Total
Greater Sydney				
Train	1747	1425	1472	1513
Other Public Transport	1797	1677	1556	1697
Private vehicles	1872	1388	1254	1370
All transport modes	1791	1401	1286	1419
Greater Melbourne				
Train	1512	1573	1380	1504
Other Public Transport	1528	1219	798	1287
Private vehicles	1819	1388	1126	1273
All transport modes	1649	1404	1139	1306
Greater Brisbane				
Train	1376	1484	1396	1432
Other Public Transport	1491	1322	1295	1364
Private vehicles	1706	1346	1130	1272
All transport modes	1615	1354	1145	1291
Greater Adelaide				
Train	1236	1276	1081	1185
Other Public Transport	1179	1113	1158	1142
Private vehicles	1471	1225	1084	1194
All transport modes	1422	1214	1086	1190
Greater Perth				
Train	1603	1559	1558	1563
Other Public Transport	1852	1514	1809	1710
Private vehicles	1797	1413	1260	1368
All transport modes	1785	1438	1312	1414
All five cities				
Train	1656	1493	1441	1501
Other Public Transport	1656	1379	1417	1493
Private vehicles	1773	1365	1185	1307
All transport modes	1704	1380	1213	1346

Notes:
1. Other public transport includes bus, tram, ferry and taxi.
2. Private vehicles include car (both as driver and passenger) and motorbike/scooter.
3. All transport modes include train, bus, tram, ferry and taxi, private vehicles, active travel (bicycle and walking), other mode and not stated.
4. Total includes Inner, Middle and Outer sectors. Map C.1 in Appendix C shows the definition of Inner, Middle and Outer sectors of all five cities.
5. Refer to BITRE (2014a) for information on method for estimating average weekly personal income from census data.
6. Main transport mode hierarchy is based on the Transfigures report published by the Ministry of Transport, New South Wales in 2008 (see Footnote 6).

Source: BITRE analysis of ABS *Census of Population and Housing* for 2016 place of usual residence data (TableBuilder Pro).

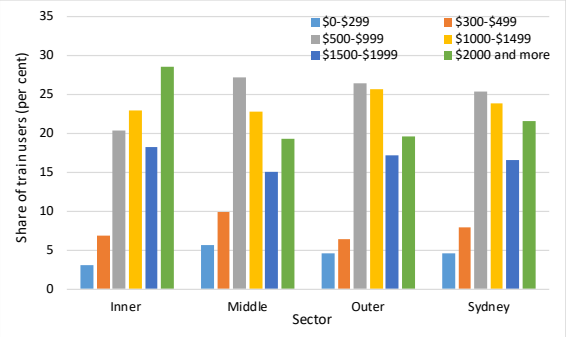
Figure 11 shows the proportion of train users in each average weekly personal income category for each sector of residence in the five major capital cities in 2016.

The top income category accounted for the highest share of train users amongst inner sector residents, while for residents of the middle and outer sectors train users were most likely to have an average weekly personal income of $500-$999 [refer Figure 11 (f)]. In terms of individual capital cities and sectors, the most prominent income categories varied considerably. For example, in the inner sector, the highest income category (weekly income of $2000 or more) was more prominent in Sydney and Perth, while the middle income categories (weekly income of $500-$1499) were more prominent in Melbourne, Brisbane and

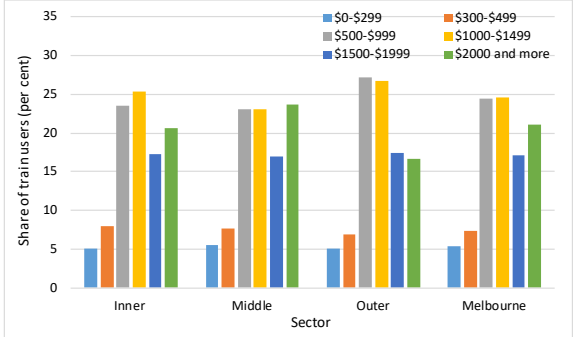
Adelaide. In the middle sector, the top income category was most prominent in Melbourne, while the middle income categories were more prominent in Sydney, Brisbane and Adelaide. In the outer sector, the middle income categories were most prominent in all five cities.

Figure 11 Proportion of train commuters in each income category by sector of residence, five major capital cities, 2016

(a) Sydney



(b) Melbourne

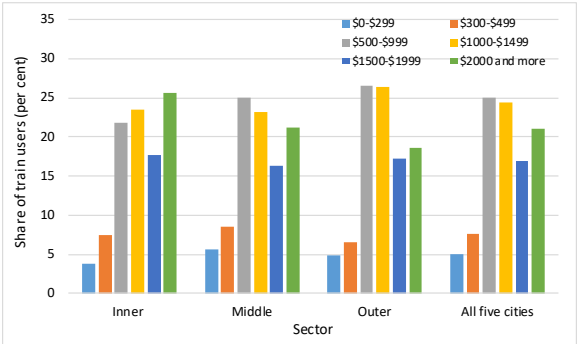


(c) Brisbane

(d) Adelaide

(e) Perth

(f) All five major capital cities



Notes:

1. All transport modes include train, other public transport, private vehicles, active travel (bicycle and walking), other mode and not stated.
2. Refer to BITRE (2014a) for information on method for estimating average weekly personal income from census data.
3. Main transport mode hierarchy is based on the Transfigures report published by the Ministry of Transport, New South Wales in 2008 (see Footnote 6).
4. Definitions of inner, middle and outer sectors provided in Appendix C.

Source: BITRE analysis of ABS *Census of Population and Housing* for 2016 place of residence data (TableBuilder Pro).

City Sector of Work

The earning profile based on where people work is very different from the place of residence profile. The analysis in this section focuses on those who attended work and provided information on their mode of travel for the five major capital cities. The estimated average weekly income by place of work for each city was separated between the Central Business District (CBD)[11] and the rest of the city. The transport modes

[11] CBD is defined as subset of the inner sector for each major capital city using Statistical Area 2 (SA2). The central SA2 of each city forms the starting point of the CBD cluster. Other SA2s are added to form a contiguous cluster around the central SA2, based on the share of key employment industries (e.g. Information Media and Telecommunications; Financial and Insurance Services; Professional, Scientific and Technical

were train, other public transport (i.e. bus, tram, ferry and taxi) and private vehicles (car as driver and passenger, and motorcycle). In addition, data for all transport modes (which includes include train, other public transport modes, private vehicles, active travel (bicycle and walking), other mode and not stated) is also presented.

While the previous sections have shown a connection between income and mode use, this section highlights the very strong dependence of income on place of work (and specifically on working in the CBD of one of the five major capitals). Table 11 shows the average weekly personal income of commuters using the various transport modes for the journey to work to a CBD versus a workplace in the rest of the city in 2016.

Table 11 Estimated average weekly personal income for users of various transport modes by place of work, five major capital cities, 2016

City and transport modes	Place of work		
	CBD	Rest of City	Greater Capital City
	Estimated average weekly personal income ($)		
Sydney			
Train	1741	1285	1526
Other public transport	2162	1152	1707
Private vehicles	2267	1335	1389
All transport modes	1946	1307	1437
Melbourne			
Train	1738	1147	1520
Other public transport	1660	973	1286
Private vehicles	2102	1234	1285
All transport modes	1833	1213	1319
Brisbane			
Train	1616	1170	1457
Other public transport	1567	1008	1322
Private vehicles	2049	1230	1288
All transport modes	1775	1214	1302
Adelaide			
Train	1279	913	1192
Other public transport	1257	764	1118
Private vehicles	1614	1144	1202
All transport modes	1477	1125	1194
Perth			
Train	1789	1098	1572
Other public transport	1875	917	1451
Private vehicles	2026	1294	1364
All transport modes	1946	1277	1390
All five cities			
Train	1721	1221	1515
Other public transport	1815	1034	1461
Private vehicles	2040	1264	1320
All transport modes	1849	1245	1355

Notes:
1. Rest of city includes SA2 in other inner (i.e. non-CBD), middle and outer sectors.
2. Refer to BITRE (2014a) for information on method for estimating average weekly personal income from census data.
3. Main transport mode hierarchy is based on the Transfigures report published by the Ministry of Transport, New South Wales in 2008 (see Footnote 6).
4. Other public transport includes bus, tram, ferry and taxi.
5. Private vehicles include car (both as driver and passenger) and motorcycle.
6. All transport modes include train, bus, tram, ferry, taxi, private vehicles, bicycle and walking, other mode and not stated.

Source: BITRE analysis of ABS *Census of Population and Housing* for 2016 place of usual residence data (TableBuilder Pro).

Services; Administrative and Support Services; and Public Administration and Safety) where selected individual industries have a minimum of 10 per cent of employment.

The SA2s that belong to the Sydney CBD are: Darlinghurst, Potts Point – Woolloomooloo, Pyrmont – Ultimo, Redfern – Chippendale, Surry Hills and Sydney - Haymarket - The Rocks. Melbourne CBD includes Docklands, East Melbourne, Melbourne and Southbank SA2s, Brisbane CBD includes Brisbane City, Fortitude Valley and Spring Hill, Adelaide CBD includes only the Adelaide SA2, and the Perth CBD includes only the Perth City SA2.

Irrespective of transport modes and cities, the average weekly personal income for commuters who travel to work within a CBD was much higher than for those who worked elsewhere in those cities. CBD workers on average earnt $604 more than non-CBD workers across the five major cities. This is much larger than the $195 variation in average incomes across the main transport mode categories.

Overall (i.e. across all transport modes), the difference in average weekly personal income between the CBD and the rest of the city was highest in Perth ($670) and lowest in Adelaide ($352). The differences in average weekly personal income for Sydney and Melbourne were very similar ($639 and $620, respectively), while for Brisbane, the difference was lower ($562). However, these differences varied among transport modes. There was a $456 weekly income premium for Sydney CBD workers who used train as the main mode of transport. Compared to those with a non-CBD workplace, the CBD income premium for train users was $591 for Melbourne, $447 for Brisbane, $365 for Adelaide and $691 for Perth. The CBD income premium was generally higher for other public transport (averaging $781 across the five capital cities) and for private vehicles (averaging $776 across the five capital cities).[12] Given its connection to a person's mode use and income, place of work seems to be an important confounding factor in the relationship between transport use and income.

The following section examines the factors influencing the spatial relationship between public transport use and income using regression analysis.

Factors influencing the spatial relationship between public transport use and income

Spatial differences in public transport access are likely to have an important influence on mode choice. Furthermore, if spatial differences in public transport access are reflected in spatial differences in housing costs, this will also flow through to impact on the characteristics of residents of the area, including incomes. Thus, like place of work, public transport accessibility has the potential to be an important confounding factor in the relationship between income and public transport use. Similarly, CBD job share may also be a mediating factor because it could provide the conditions by which public transport accessibility further influences public transport use.[13] This is because generally in Australian cities, people on higher incomes are more likely work in the CBD and also to live closer to it.

Public transport use is partly influenced by the level of accessibility to public transport for the population (Coleman 2017). Accessibility to jobs by public transport is a key factor explaining the quality of life of individuals (Deboosere et al. 2018). Good accessibility to public transport also promotes walking for active transport (i.e. walking and cycling) (Bull et al. 2015).

Using SA2 data for the five largest cities (i.e. Sydney, Melbourne, Brisbane, Adelaide and Perth), simple Pearson correlations showed some relationships among income, public transport share, public transport accessibility[14,15] and CBD job shares. To explore these relationships further, linear regressions between public transport share by SA2 for these five major capital cities and three independent variables (i.e.. average weekly income, public transport accessibility index and CBD job share) were carried out using the 'R' statistical software package. Note that spatial analysis of individuals is not possible due to data unavailability.

Overall, an area's income has no independent effect on the area's public transport mode share. Although this study is treating income as the 'independent' variable, looking at the regression results suggests that it

[12] This is reflected in the average incomes of train users who work in the CBDs of the five largest capital cities ($1721) being lower than the incomes of private vehicle users who work in the CBDs ($2040) and public transport users who work in the CBDs ($1815).

[13] For a discussion of the role of confounders and mediators in causal relationships, see Bauman et al. (2002).

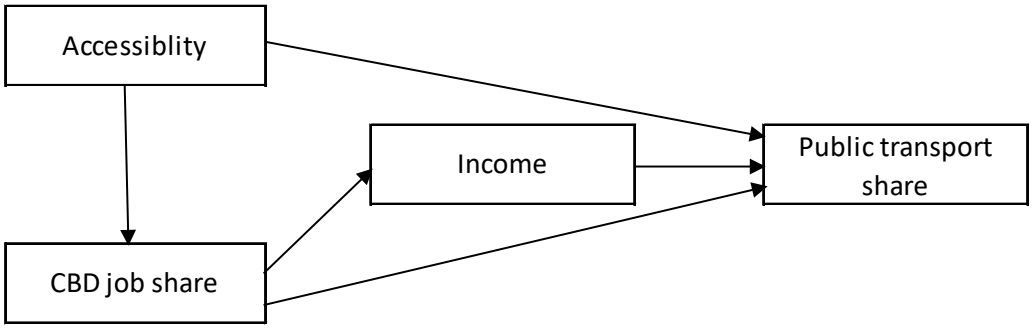
[14] The Metropolitan Accessibility/Remoteness Index of Australia (Metro ARIA), developed by the Hugo Centre for Migration and Population Research, and sponsored by the Australian Urban Research Infrastructure Network (AURIN), provides a nationally consistent and comparable dataset that quantifies geographic accessibility within the metropolitan area. Metro ARIA is the first national metropolitan accessibility index of its kind, covering all Australian capital-city urban centres. The index reflects the ease or difficulty people face in accessing basic services within metropolitan areas, derived from the measurement of road distances that people travel to reach different services (AURIN 2014). This study uses only the Metro ARIA public transport accessibility index.

[15] Ideally, the influence of public transport accessibility on mode use would be mode-specific. However, the Metro ARIA index does not disaggregate by mode.

probably only has a relationship with the public transport mode share in the presence of public transport accessibility and CBD job share. As such, it is likely to best be viewed as a confounding variable.

The proportion of an SA2's residents who work in the CBD has a very strong direct influence on the public transport mode share. It looks like accessibility influences the public transport share independently of other variables, but it also seems to influence CBD job share. CBD job share then influences income. As such, accessibility has an indirect influence on the income of an area. In addition, income has some relationship with the public transport mode share because it is influenced by accessibility and CBD job share. The relationship is diagrammatically shown in Figure 12.

Figure 12 Schematic diagram showing the relations between income, public transport use, accessibility to public transport and CBD job share



Note: This diagram is drawn from data based on the SA2 scale.
Source: BITRE analysis.

Details of the regression results are presented in Box 1.

Box 1: Relationship between public transport share and other variables (average weekly income, public transport accessibility index and CBD employment share)

Table B1.1 presents R-squared values between the public transport share and other variables for 2016, based on SA2 data. The detailed regression results include:

- Income's influence on the public transport mode share is very weak. However, comparing the five major cities, it has a slightly stronger influence in Brisbane and Melbourne.
- The influence of accessibility on the public transport mode share is evident but still not strong in all cities. The relationship is strongest in Brisbane.
- The CBD job share's influence on the public transport mode share is strong everywhere, particularly in Melbourne.
- The combined influence of CBD job share and public transport accessibility is evident in all cites, particularly Melbourne.
- If public transport accessibility is removed from the equation and replaced with income, the relationship changes little.
- If income is retained and CBD job share replaced with accessibility, the relationship weakens considerably.
- The strongest relationship of all is evident when all three independent variables are modelled together. Interestingly, the addition of income does not affect the strength of the model in Sydney, Melbourne or Brisbane.

Table B1.1 Linear regressions (R-squareds) between public transport share and independent variables, 2016

	Sydney	Melbourne	Brisbane	Adelaide	Perth	Five cities
			R-squared			
Individual variables						
Income	0.15	0.25	0.26	0.07	0.02	0.16
Accessibility	0.22	0.20	0.30	0.18	0.20	0.25
CBD job share	0.57	0.80	0.64	0.46	0.63	0.49
Two variables						
Accessibility + CBD job share	0.60	0.81	0.68	0.55	0.65	0.55
Income + CBD job share	0.57	0.80	0.65	0.54	0.67	0.49
Income + Accessibility	0.32	0.40	0.48	0.23	0.20	0.35
All three variables						
Income + Accessibility + CBD job share	0.60	0.81	0.68	0.62	0.68	0.55

Notes:

1. Refer to BITRE (2014a) for information on method for estimating average weekly personal income from census data.
2. Level of accessibility to public transport (based on AURIN's Metro ARIA data) is divided into five indices. These are: Limited accessibility, Low accessibility, Moderate accessibility, High accessibility and Very High accessibility (AURIN 2014). The index reflects the ease or difficulty people face in accessing basic services within metropolitan areas, derived from the measurement of road distances that people travel to reach different services.
3. The regression analyses were done at the SA2 scale rather than the SA1 scale, because the CBD job share variable was only available at the SA2 scale. For this purpose, the 2011 SA1 accessibility classification was converted to a 2016 SA1 classification and then to a 2016 SA2 classification.
4. SA2s which had no data were excluded from the analysis.
5. Based on SA2s, Sydney CBD defined as: Pyrmont – Ultimo, Redfern – Chippendale, Darlinghurst, Potts Point – Woolloomooloo, Surry Hills and Sydney - Haymarket - The Rocks SA2s; Melbourne CBD defined as: Docklands, East Melbourne, Melbourne and Southbank SA2s; Brisbane CBD defined as: Brisbane City, Fortitude Valley and Spring Hill SA2s; Adelaide CBD defined as: Adelaide SA2; and Perth CBD defined as: Perth City SA2.

Source: BITRE analysis of ABS *Census of Population and Housing* 2016 and AURIN (2014).

(Continued on next page)

(Continued from previous page)

Some other relationships emerged which are of interest:

- The CBD employment share had an influence on average weekly income, most strongly in Brisbane and Adelaide (R-squared values of 0.50 and 0.46, respectively).
- Accessibility to public transport showed a very weak relationship with the CBD employment share, while it showed no relationship with the average weekly income of the residents.

Higher income earners are likely to be able to afford to live in areas with better public transport access, Table B1.2 shows the relationship between estimated average weekly incomes for commuters by the level of public transport accessibility in the five largest capital cities. The level of accessibility to public transport generally increases with income. In other words, low income earners tend to have a limited or low level of access to public transport compared to higher income earners. However, in Adelaide, commuters who experienced low access to public transport had a particularly high income.

Table B1.2 Estimated average weekly income of commuters by level of accessibility to public transport, five major capital cities, 2016

Accessibility levels	Sydney	Melbourne	Brisbane	Adelaide	Perth	Five cities
	Estimated average weekly income of employed persons ($)					
Very High	1555	1507	1506	-	1681	1543
High	1375	1305	1295	1191	1436	1330
Moderate	1257	1207	1257	1144	1334	1255
Low	1427	1254	1234	1419	1391	1309
Limited	1335	1336	1256	-	1394	1297
All accessibility levels	1439	1317	1303	1195	1420	1357

Notes:
1. Based on SA2 scale accessibility data. First, 2011 SA1 accessibility classification converted to 2016 SA1 classification and then to 2016 SA2 classification.
2. There were no SA2s in Adelaide with either a Very High Accessibility or Limited Accessibility score.
Source: BITRE analysis of ABS *Census of Population and Housing* 2016 and AURIN (2014).

Table B1.3 shows that public transport use is higher in areas with better access to public transport.

Table B1.3 Public transport mode share of commuters by level of accessibility to public transport, five major capital cities, 2016

Accessibility levels	Sydney	Melbourne	Brisbane	Adelaide	Perth	Five cities
	Public transport mode share (per cent)					
Very High	35.1	33.5	23.0	-	27.1	33.6
High	24.1	18.4	15.1	11.3	12.7	18.1
Moderate	24.1	11.0	11.3	9.5	10.9	11.3
Low	14.1	10.0	10.0	6.2	9.4	10.6
Limited	7.0	12.3	7.1	-	8.5	8.8
All accessibility levels	27.9	19.0	14.3	11.1	12.5	19.7

Notes:
1. Based on SA2 scale accessibility data. First, 2011 SA1 accessibility classification converted to 2016 SA1 classification and then to 2016 SA2 classification.
2. There were no SA2s in Adelaide with either a Very High Accessibility or Limited Accessibility score.
Source: BITRE analysis of ABS *Census of Population and Housing* 2016 and AURIN (2014).

Case Study: Geelong-Melbourne Corridor

The following section provides detailed analysis of one selected commuter corridor (i.e. Geelong–Melbourne) as a case study. It looks at changes in mode use in this corridor, focusing on Geelong residents. Understanding the demographic characteristics of rail users (including their income) can provide insights into the equity implications of public transport subsidies and investments. In recent years, the Victorian Government funded the 'Regional Fast Rail' project on this corridor, which was completed in late 2006. Comparing weekly rail services before and after completion of this upgrade, BITRE (2014b) compiled and analysed data, and found that weekly rail services increased by 13 per cent. In turn, 'the V/Line operations have witnessed strong patronage growth since the completion of the *Regional Fast Rail* upgrades (BITRE 2014b, p.70).

This analysis uses data from the ABS *Census of Population and Housing* (2016 and 2011) to quantify the number of commuters travelling between the origin-destination pair, and to profile those commuters in terms of their educational qualifications, occupation, income and industry of employment. Information is also provided on the transport mode used for the journey to work. It also includes additional information on origins and destinations.

The origin is defined as those with a place of usual residence in the Geelong Statistical Area Level 4 (SA4), which includes surrounding coastal towns such as Torquay and Queenscliff, while the destination is defined as those with a place of work in the Melbourne Greater Capital City Statistical Area (GCCSA).

In 2016, there were nearly 16 600 daily commuters who travelled from the Geelong SA4 to Greater Melbourne. This accounted for 12.4 per cent of Geelong's employed residents. In terms of the transport mode share for the journey to work on this corridor, private vehicles are the dominant transport mode (70 per cent). However, train was also a prominent transport mode, accounting for 26 per cent of all commuters.

Characteristics of commuters in 2016

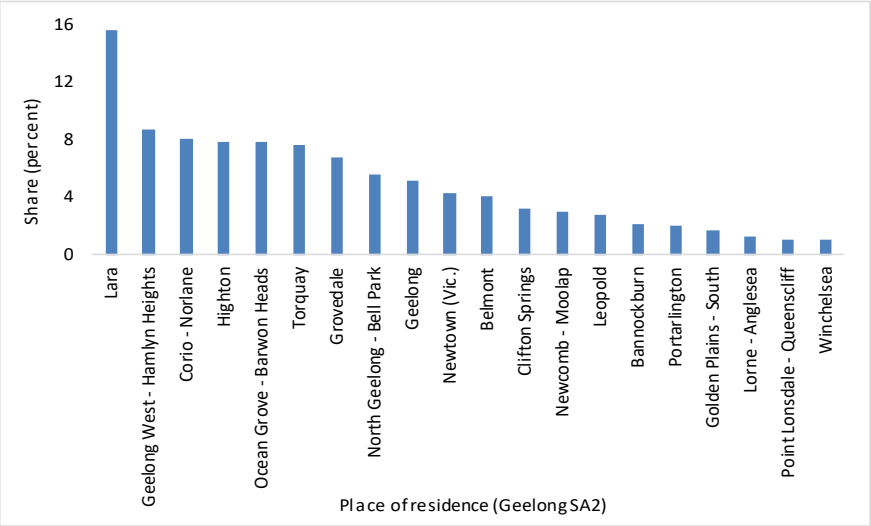
Figure 13 shows the origins of employed persons who commuted from Geelong to Greater Melbourne in 2016, based on place of residence data.

The main SA2s of origin for the Geelong-Melbourne corridor are Lara (which accounts for 15.6 per cent of commuters from Geelong to Melbourne), Geelong West-Hamlyn Heights (8.8 per cent), Corio-Norlane (8.0 per cent), Highton (7.9 per cent), Ocean Grove-Barwon Heads (7.9 per cent), Torquay (7.7 per cent) and Grovedale (6.8 per cent).

There are several factors that influence the extent of commuting from a small area to a nearby capital city. The most obvious factor is distance, with areas that are geographically closer to the capital city having a greater expected number of commuters. The SA2 of Lara directly adjoins the Melbourne GCCSA, while the Corio-Norlane and Geelong West-Hamlyn Heights SA2s also have good accessibility to Melbourne. Around 28 per cent of the employed residents of Lara commute to a place of work in Melbourne, which is more than double the percentage for any other Geelong area. This is affected by the new housing estates in the Lara SA2, which provide an opportunity for people (many of whom could have previously lived in Melbourne) to access relatively affordable housing within a reasonable commuting distance (by car or train) of Melbourne. Changes in population, total employed persons and commuters from Lara SA2 to Greater Melbourne between 2011 and 2016 are explored and the results are provided later (refer Box 2).

It is noteworthy that Ocean Grove-Barwon Heads and Torquay have a significant number of commuters to Melbourne, despite residents having to commute a considerable distance through (or around) Geelong to get to Melbourne. Both areas have a relatively well-educated workforce, with 34 to 38 per cent of employed residents having a bachelor degree or higher qualification (compared to 28 per cent for the Geelong SA4), and as pointed out in BITRE Report 144 (BITRE 2016), those with bachelor degree or higher qualifications are much more likely to engage in lengthy commutes than their less educated counterparts. Ocean Grove-Barwon Heads and Torquay are high amenity coastal towns, and it appears many workers are prepared to trade-off a rather lengthy commute (roughly 100km or 1.5 hours one way) to gain the benefits of living in these locations.

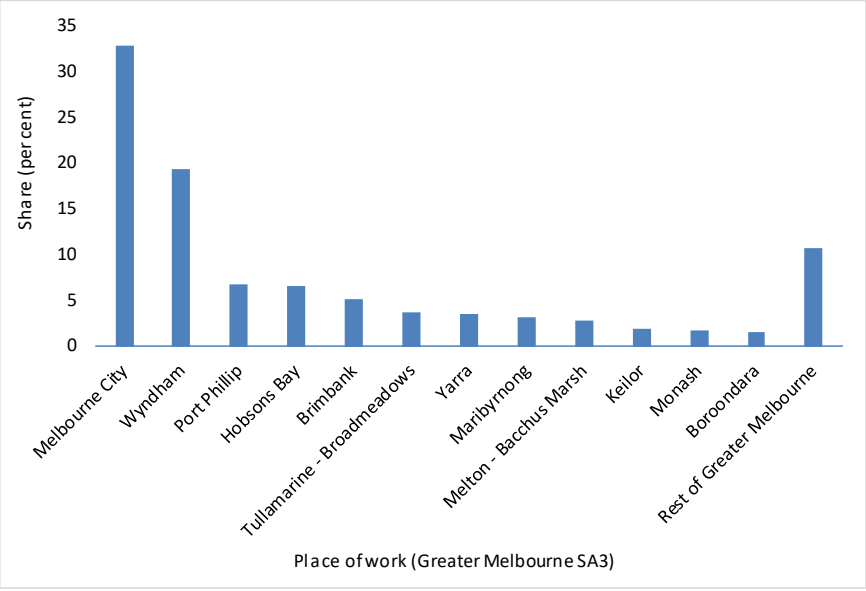
Figure 13 Place of usual residence of those who commuted from Geelong SA4 to Greater Melbourne, 2016



Source: BITRE analysis of ABS *Census of Population and Housing* 2016 data (TableBuilder Pro).

Figure 14 shows the place of work of those who commuted from Geelong to Greater Melbourne in 2016. For the Geelong-Melbourne corridor, the main place of work destinations (at the SA3 scale) are Melbourne City (i.e. Melbourne City SA3) (32.8 per cent), Wyndham (19.4 per cent), Port Phillip (6.8 per cent), Hobsons Bay (6.5 per cent) and Brimbank (5.2 per cent).

Figure 14 Place of work of those who commuted from Geelong to Greater Melbourne, 2016



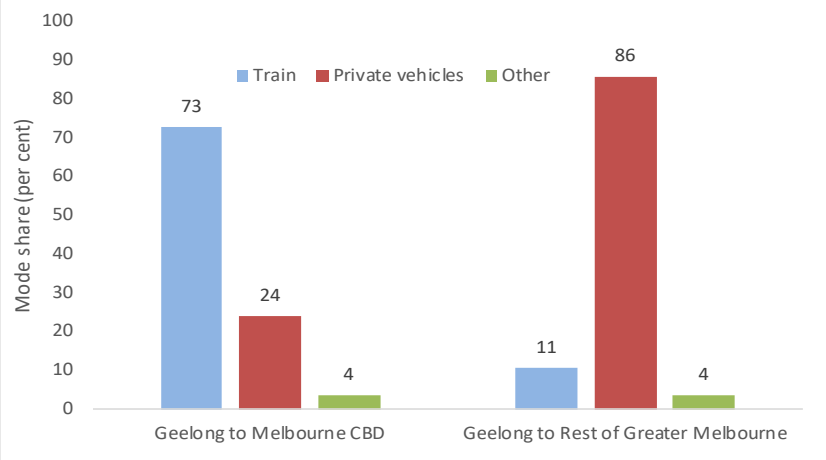
Source: BITRE analysis of ABS *Census of Population and Housing* 2016 data (TableBuilder Pro).

Those who commute from the regional city to the Melbourne CBD[16] have quite different characteristics to those who commute to other areas of Greater Melbourne, in terms of transport mode, and the results are shown in Figure 15.

Nearly three-quarters (73 per cent) of commuters to the Melbourne CBD travel by train, with about 24 per cent travelling by private vehicle. However, for the rest of the Greater Melbourne places of work, private vehicle is the dominant mode, accounting for 86 per cent of commutes.

[16] Melbourne CBD is defined as the combination of four SA2s (i.e. Melbourne, Docklands, Southbank and East Melbourne).

Figure 15 Transport mode share for Geelong to Greater Melbourne corridor, disaggregated by place of work, 2016

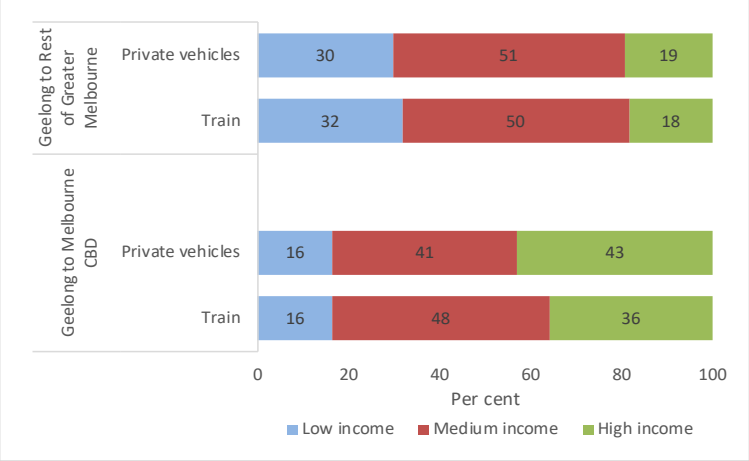


Notes:
1. Melbourne CBD is defined as the combination of four SA2s (i.e. Melbourne, Docklands, Southbank and East Melbourne).
2. 'Private vehicles' includes car and motorcycle, while 'Other' includes bus, tram, ferry, taxi, bicycle, walking and truck.
3. Main transport mode hierarchy is based on the Transfigures report published by the Ministry of Transport, New South Wales in 2008 (see Footnote 6).
4. Excludes those who reported working at home, did not go to work on census day, or did not respond to the transport mode question.

Source: BITRE analysis of ABS *Census of Population and Housing* 2016 data (TableBuilder Pro).

Figure 16 shows the income categories of those who travelled from Geelong to the Melbourne CBD and the rest of Greater Melbourne using train and private vehicles in 2016. Those with high income (average weekly income of $2000 or more) are much more heavily represented amongst CBD commuters (36-43 per cent) than amongst commuters to other places of work within the capital city (18-19 per cent). On the other hand, the opposite pattern is evident for low income earners (average weekly income of $0 to $999). Moreover, the income distribution is not dependent on the transport mode for commuters to the CBD or the rest of Greater Melbourne.

Figure 16 Incomes of those who commute from Geelong to Greater Melbourne, disaggregated by place of work and main transport mode, 2016



Notes:
1. Melbourne CBD is defined as the combination of four SA2s (i.e. Melbourne, Docklands, Southbank and East Melbourne).
2. 'Private vehicles' includes car and motorcycle, while 'Other' includes bus, tram, ferry, taxi, bicycle, walking and truck.
3. Low income represents average weekly income of $0-$999, medium income represents $1000-$1999 per week and high income represents $2000 and more per week.
4. Main transport mode hierarchy is based on the Transfigures report published by the Ministry of Transport, New South Wales in 2008 (see Footnote 6).
5. Excludes those who reported working at home, did not go to work on census day, or did not respond to the transport mode question.

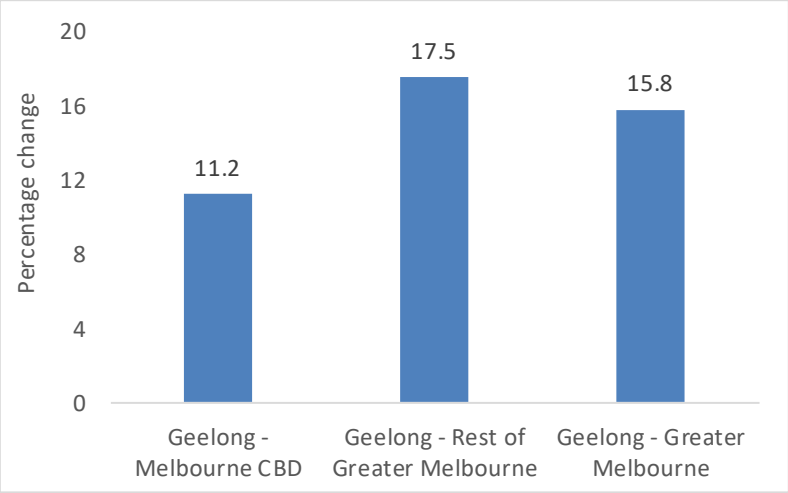
Source: BITRE analysis of ABS *Census of Population and Housing* 2016 data (TableBuilder Pro).

Changes between 2011 and 2016

Based on ABS Census data, there were nearly 114 400 employed people who lived in the Geelong SA4 in 2011 and it increased to just over 125 000 persons by 2016, at an average growth rate of 1.8 per cent per annum. Among these employed residents, 13 100 Geelong employed people travelled to Greater Melbourne in 2011, accounting for 11.5 per cent of all Geelong employed people. In 2016, the number of Geelong employed people who travelled to Greater Melbourne increased by 2 500 persons to 15 200 (or 12.2 per cent of total employed persons). Note that to produce a comparable measure of place of work employment growth between 2011 and 2016, BITRE has excluded all persons who were imputed to an SA2 of work in 2016 from the employment change calculation.[17]

Figure 17 shows the percentage change of Geelong's employed residents who commuted to the Melbourne CBD and the rest of Greater Melbourne between 2011 and 2016. During this period, the number of commuters from Geelong to Melbourne CBD increased by 410 employed people, reflecting five-year growth of 11.2 per cent (or an average annual growth rate of 2.7 per cent). The number of commuters from Geelong to the rest of Greater Melbourne increased by 1666 employed people, reflecting five-year growth of 17.5 per cent (or an average annual growth rate of 4.1 per cent).

Figure 17 Percentage change of Geelong's employed residents commuting to Greater Melbourne, 2011 and 2016



Notes:
1. Melbourne CBD is defined as the combination of four SA2s (i.e. Melbourne, Docklands, Southbank and East Melbourne).
2. To produce a comparable measure of employment growth between 2011 and 2016, BITRE has excluded all persons who were imputed to an SA2 of work in 2016 from the employment change calculation.

Source: BITRE analysis of ABS *Census of Population and Housing* 2016 data (TableBuilder Pro).

The comparison between 2011 and 2016 ABS Census results shows that the train mode share from Geelong to Greater Melbourne increased by only one percentage point during this period, while the private vehicle mode share decreased by two percentage points. This reflects increases of 526 train commuters and 1170 private vehicle commuters from 2011 to 2016. Table 12 shows the proportions of commuters from Geelong to Melbourne CBD and other parts of Greater Melbourne by income categories for target modes (i.e. train and private vehicles) for 2011 and 2016.

The share of high income train users to both the Melbourne CBD and other parts of Greater Melbourne increased (by 12 percentage points and 8 percentage points, respectively), while low income train users decreased by 11 percentage points and 10 percentage points for the Melbourne CBD and the rest of the Greater Melbourne, respectively. The differences in the proportions for private vehicle users are less

[17] This approach was adopted following advice from the ABS on how to generate a comparable measure of change in place of work employment counts, given that while about 8 per cent of workers had a not stated or undefined SA2 of work in 2011, there were no workers in these categories in 2016. ABS imputed an SA2 of work for the 7 per cent of individuals who could not be coded to an SA2 of work in 2016. The effect of this methodological change was to bias the unadjusted change estimates so that they significantly overstate SA2-scale employment change (on a place of work basis).

pronounced. While wage rises would cause a general shift towards the higher income categories, this shift was much more pronounced for rail users.

Overall, the significant increase in commuters on the Geelong to Greater Melbourne corridor was:

- mainly due to increased commuters travelling to non-CBD locations, and
- was associated with a shift away from low income commuters towards high income commuters (particularly amongst train users), suggesting that new commuters on this corridor are using the corridor to access higher-paying job opportunities.

Table 12 Comparison of commuters from Geelong to Melbourne CBD and rest of Greater Melbourne by income categories and target modes, 2011 and 2016

Year	Share (per cent)							
	Train				Private vehicles			
	Low income	Medium income	High income	All incomes	Low income	Medium income	High income	All incomes
Melbourne CBD								
2011	27	49	24	100	19	43	38	100
2016	16	48	36	100	13	41	46	100
Rest of Greater Melbourne								
2011	42	47	11	100	33	52	15	100
2016	32	50	19	100	28	52	20	100

Notes:
1. Melbourne CBD is defined as the combination of four SA2s (i.e. Melbourne, Docklands, Southbank and East Melbourne).
2. To produce a comparable measure of employment growth between 2011 and 2016, BITRE has excluded all persons who were imputed to an SA2 of work in 2016 from the employment change calculation.
3. Main transport mode hierarchy is based on the Transfigures report published by the Ministry of Transport, New South Wales in 2008 (see Footnote 6).
4. Low income represents average weekly income of $0-$999, medium income represents $1000-$1999 per week and high income represents $2000 and more per week.

Source: BITRE analysis of ABS *Census of Population and Housing* 2016 data (TableBuilder Pro).

Box 2: Lara Statistical Area Level 2 – Change in population and commuters to Greater Melbourne, 2011 and 2016

Background

Lara is a residential small town set in rural surrounds between Melbourne and Geelong, 18 km north-east of Geelong CBD across Corio Bay. In recent years, Lara has become a popular place to live for those wishing to work in Melbourne and have ties to Geelong. The local government has undertaken plans for a development on the west of Lara, designed to accommodate a greater population with residential lots and employment opportunities. The town has regular V/Line passenger train services on the Geelong line to Melbourne (and also to Geelong) to cater for the many residents who commute to work each day via Lara's railway station.

Change in Lara SA2 population and commuters to Greater Melbourne, 2011 and 2016

In the 2016 ABS Census, there were 18 088 people living in the Lara SA2, an increase of 2565 people from 2011, which equates to an average annual growth rate of 3.1 per cent (Table B2.1). However, the average annual growth rate of employed persons in Lara between 2011 and 2016 was slower, at 2.4 per cent. The ratio of employed people to total population was slightly higher in 2011 (0.48) than in 2016 (0.46).
The number of employed persons who commuted from the Lara SA2 to Greater Melbourne increased slightly by 149 persons between 2011 and 2016, at an average growth rate of 1.3 per cent. In terms of total employed persons, the proportion of employed persons who commuted from the Lara SA2 to Greater Melbourne was around 30 per cent in both years. Analysis of the characteristics of Lara commuters to Greater Melbourne, based on ABS 2016 Census place of work data, reveals that:

- Nearly two-thirds (65 per cent) of Lara commuters to Greater Melbourne were male;
- 28 per cent were aged between 40 years and 49 years, 26 per cent between 30 years and 39 years, and 22 per cent between 50 years and 59 years;
- Lara residents who commute to Greater Melbourne tend to have a relatively higher proportion of commuters with 'Secondary Education - Years 10 and above' (29 per cent), 'Certificate III & IV Level' (28 per cent) and 'Bachelor degree or higher qualifications' (i.e. Postgraduate Degree, Bachelor Degree, Graduate Diploma and Graduate Certificate) (25 per cent);
- 'Professionals', 'Technicians and Trades Workers' and 'Managers' are the three most common occupations (22 per cent, 17 per cent and 14 per cent of commuters, respectively);
- 'Transport, Postal and Warehousing' is the major industry for Lara commuters (13 per cent), closely followed by 'Manufacturing', 'Construction' and 'Public Administration and Safety' (each accounted for 11 per cent of commuters).

Table B2.1 Total employed persons in Lara SA2

	Number of employed persons			Average annual growth rate (per cent), 2011-2016
	2011	2016	Change (2011-2016)	
Total population in Lara SA2	15523	18088	2565	3.1
Total employed persons in Lara SA2	7397	8335	938	2.4
Commuters from Lara SA2 to a place of work in Greater Melbourne	2164	2313	149	1.3
Ratio of employed people to total population	0.48	0.46		
Share (per cent) of employed persons who commuted from Lara SA2 to a place of work in Greater Melbourne	29.3	27.8		

Note: To produce a comparable measure of place of work employment growth between 2011 and 2016, BITRE has excluded all persons who were imputed to an SA2 of work in 2016 from the employment change calculation.
Source: BITRE analysis of ABS *Census of Population and Housing* place of work data for 2011 and 2016 (TableBuilder Pro).

The high proportion of Lara SA2 residents who commute to Greater Melbourne is likely to reflect generally cheaper house prices in the Lara SA2 compared to Greater Melbourne, and the neighbouring Melbourne West SA4 (see Table B2.2). As of 2016, CoreLogic data (customised request) reveals that there were seven SA2s out of 42 SA2s in the Melbourne West SA4 had a lower median house price than the Lara SA2 (i.e Melton, Rockbank - Mount Cottrell, Melton South, Melton West, Werribee, Bacchus Marsh and Wyndham Vale).

(Continued on next page)

(Continued from previous page)

Analysis of the CoreLogic data reveals that the increase in median house price between 2011 and 2016 was much lower in the Lara SA2 compared to house price increases in either the Melbourne West SA4 or Greater Melbourne as a whole (Table B2.2). This five-year growth of median house prices was only 11 per cent for the Lara SA2 (or an average annual growth rate of 2.1 per cent), while the increases were 23 per cent (or an average annual growth rate of 4.1 per cent) for the Melbourne West SA4 and 41 per cent (or average annual growth rate of 7.2 per cent) for Greater Melbourne.

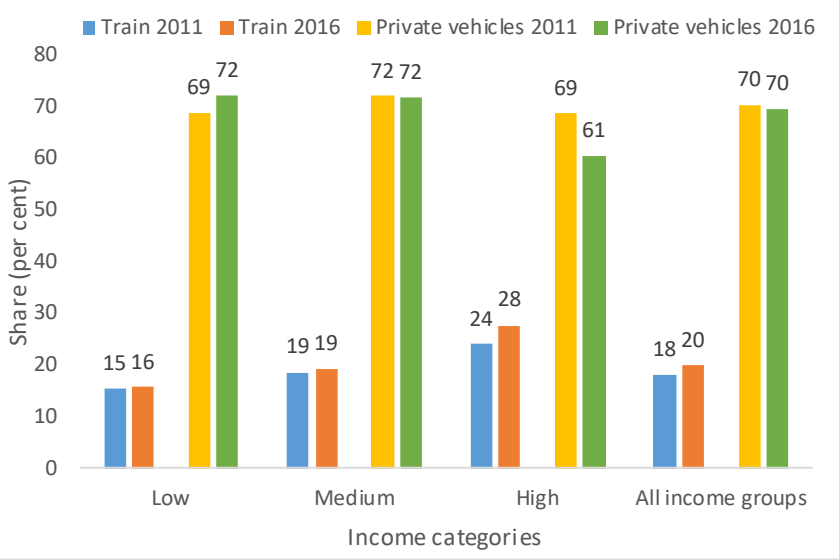
Table B2.2 Comparison of median house price among Lara SA2, Melbourne West SA4 and Greater Melbourne, 2011 and 2016

	House price ($) (Median)		Increase (2011-2016)	
	2011	2016	Amount ($)	Percentage
Lara SA2	350 000	387 500	37 500	11
Melbourne West SA4	394 000	482 750	88 750	23
Greater Melbourne	485 000	685 500	200 500	41

Source: BITRE analysis of CoreLogic customised data request.

Between 2011 and 2016, high income earners tended to increasingly use train as their mode of transportation from Lara SA2 to Greater Melbourne (24 per cent in 2011 and 28 per cent in 2016) (Figure B2.1). The proportion of high income private vehicle users has fallen notably during the same period.

Figure B2.1 Proportion (per cent) of commuters from Lara SA2 to Greater Melbourne by income categories and main transport modes (i.e. train and private vehicles), 2011 and 2016



Notes:
1. To produce a comparable measure of employment growth between 2011 and 2016, BITRE has excluded all persons who were imputed to an SA2 of work in 2016 from the employment change calculation.
2. Low income represents average weekly income of $0-$999, medium income represents $1000-$1999 per week and high income represents $2000 and more per week.

Source: BITRE analysis of ABS *Census of Population and Housing* place of work data for 2011 and 2016 (TableBuilder Pro).

Based on ABS censuses, data reveals that just under half of the commuters from the Lara SA2 to Greater Melbourne had changed address between 2011 and 2016. About half of the movers previously lived elsewhere in Geelong, while a third previously lived in Greater Melbourne (principally in the Melbourne West SA4 that adjoins Lara). The movers were similarly likely to use rail to commute to work as the stayers. The movers and non-movers were equally likely to be rail commuters. With the growth in commuters on the Lara to Melbourne corridor in recent years, rail is increasingly being used to access higher income jobs. The rail connectivity benefits are being experienced principally by long-term Geelong residents, but a significant number of former residents of the Melbourne West SA4 are also taking advantage of these rail connections and lower housing costs by moving to the region and commuting by rail to jobs in Melbourne.

Conclusions

This study explores the relationship between income and transport use in Australia by identifying the nature of the relationship between income and different types of transport use, and how public transport use (especially rail) varies with income in different locations.

The key results show that:

- Several aspects of transport use vary with income. For example, in 2016, the proportion of households owning three or more vehicles rose from 10 per cent for the lowest income category ($0-$499 per week) to reach 36 per cent for the highest income category ($3 000 or more per week). Commuting distance increased gradually with income, being highest for commuters whose weekly income was $2000-$2999, but then dropped for the highest income category ($3000 and more). The average commuting trip duration was highest for the highest income earners (annual income of $150 000 or more) and lowest for the lowest income category (annual income of $1-$19 999).
- Nationally, average weekly personal income was higher for public transport commuters ($1503) than for private vehicle commuters ($1261) or active travel commuters ($1265). However, there was no difference in average income between rail and other public transport users.
- The proportion of employed people who used train to commute to work increased with income. The pattern for bus commuters was u-shaped, with low income and high income earners more likely to use the bus than middle income commuters. The private vehicle mode share was highest for those earning $500-$1499 per week, and lowest for the very low and high income commuters.
- The nature of the relationship between income and the private vehicle and total public transport mode shares for all trips in Greater Sydney is similar to the national pattern for journey-to-work trips (see Figures 4 and 6). However, while there is a clear tendency for the train mode share to rise with income for national (and Sydney) commuting trips, the relationship is much less evident for all Sydney trips, possibly because the pattern is diluted by the inclusion of other types of trips (e.g. shopping, education) in the Sydney data.
- The total income difference for train users over private vehicle users in the five large capital cities was highest in Melbourne ($231), followed by Perth ($195), Brisbane ($159) and Sydney ($143). In Adelaide, train users have slightly lower incomes ($8) compared to private vehicle users.
- Irrespective of transport modes and cities, the average weekly personal income for commuters who travel to work within CBDs was higher than for those who had a place of work in the rest of the city.
- This study has shown a notable correlation between income and transport mode for individuals. While there is also some spatial correlation between an area's income and its public transport mode share, regression analysis shows that an area's income has no independent effect on the area's public transport mode share, with the observed modest spatial correlation occurring because income is influenced by the area's public transport accessibility and CBD job share. The CBD job share has a very strong direct influence on the public transport mode share. Public transport accessibility has a direct influence on the public transport mode share, and also influences the CBD job share.
- In each of the non-capital major cities with a significant number of train users, the average weekly personal income of train users was consistently higher than that of all employed residents. This most likely reflects the use of train by residents of these smaller cities to access higher-paying jobs in the nearby capital city.

The findings of this research are broadly consistent with overseas studies and with previous Australian research for earlier time points. However, the tendency for the public transport mode share to be highest for high income earners in Australia appears to be strengthening over time.

This analysis also provides some insight into the equity implications of new rail infrastructure. Low and middle income earners ($500 to $1499 per week) represent a major share of the employed population and also contribute the largest proportion of train users and of public transport users more broadly, at 49 and 47 per cent respectively. However, higher income individuals who earn $2000 or more per week have much higher rates of train use than low and middle income individuals, and are therefore most likely to benefit from public investment in rail infrastructure and ongoing subsidies. This is in part because rail is primarily used by workers who have a workplace in the CBD, and CBD workers have much higher incomes than those who work in other parts of the major capital cities. Rail connections open up access to the high-paying CBD jobs to people who live in the suburbs and in regional cities within a reasonable commuting distance of the

CBD, as can be seen by the relatively high incomes for rail users who live in regional Australia (and in the generally higher incomes of rail users versus other modes in the middle and outer suburbs of the five major cities).

Acknowledgement

The author is grateful to Dr Gary Dolman and Dr David Marshall for helpful comments. In addition, special thanks to David for providing critical and valuable advice on regression analysis and preparing maps.

Appendix A

Comparison of ABS *Census of Population and Housing* and Sydney *Household Travel Survey (HTS)*

The ABS *Census of Population and Housing* (hereafter, simply 'the Census') provides a measure of the number of commuting trips undertaken by employed persons aged 15 years and over, whilst the Sydney HTS does not provide a meaningful measure of employed persons. It measures travel activity, e.g. trips. In addition, there are a number of methodological and scope differences that cause estimates produced from these two collections to differ.

The Census is conducted on Census night every five years, while the HTS is conducted every day of the year. The Census counts all people in Australia on Census night, including overseas visitors, but excluding foreign diplomats and their families as well as Australian residents who are overseas on Census night. HTS excludes overseas visitors and those in non-private dwellings, thus the HTS population estimates are slightly lower than those reported in the ABS Census.

The HTS collects information on personal travel behaviour and each year approximately 5000 households are selected to participate. Data is collected on all trips made over a 24-hour period. Surveys are conducted using face-to-face interviews and each member of the household is included. In addition, annual estimates from the HTS are produced using three years of pooled data. For example, 2015-16 estimates are based on 2013-14, 2014-15 and 2015-16 pooled data and are weighted to the 2015-16 population. All estimates are weighted to the ABS' Estimated Resident Population, corresponding to the year of collection.

An attempt has been made to compare two data sources (ABS 2016 Census and NSW 2015-16 HTS) for Sydney Greater Capital City Statistical Area (GCCSA). Table A.1 compares the proportion of commuting trips by employed residents in Sydney GCCSA by average weekly income and transport modes used. Despite the differences in data collection methodologies, estimates are broadly comparable, although some variations are evident. For example, the Census captured lower proportions of private vehicle users for individual income groups compared to the corresponding HTS income groups and the reverse trend was evident for total public transport.

Table A.1 Comparison of proportion of commuting trips by Sydney GCCSA residents by average weekly income and transport modes, the ABS 2016 Census and NSW 2015-16 HTS

Average weekly income ($)	Train	Bus	Other public transport	Total public transport	Private vehicles	Active travel	Other	All modes
				Share (per cent)				
ABS 2016 Census of Population and Housing								
$0-$149	13.3	9.5	0.4	23.2	62.1	10.5	4.1	100.0
$150-$399	17.8	8.0	0.5	26.3	62.5	8.1	3.1	100.0
$400-$799	16.4	6.2	0.6	23.1	68.2	5.8	2.9	100.0
$800-$999	16.6	5.3	0.5	22.4	70.4	4.5	2.7	100.0
$1000-$1999	19.1	6.2	0.7	25.9	67.2	4.5	2.4	100.0
$2000 or more	22.2	10.0	2.5	34.6	58.0	5.9	1.5	100.0
All income groups	18.5	6.9	0.9	26.4	65.7	5.4	2.5	100.0
NSW 2015-16 Household Travel Survey (HTS)								
$0-$149	12.7	6.4	0.8	19.8	69.3	9.8	1.1	100.0
$150-$399	13.0	8.8	0.0	21.8	68.0	9.7	0.5	100.0
$400-$799	13.1	4.9	0.3	18.3	74.6	7.0	0.0	100.0
$800-$999	13.7	3.6	0.6	17.9	77.0	5.1	0.1	100.0
$1000-$1999	16.2	5.1	0.8	22.0	69.8	8.2	0.0	100.0
$2000 or more	13.7	8.1	3.6	25.5	62.3	12.2	0.0	100.0
All income groups	14.4	5.7	1.1	21.2	70.3	8.4	0.1	100.0

Notes:
1. NSW 2015-16 Sydney HTS, five years pooled data, commuting linked trips.
2. Data includes weights for an average weekday.
3. 'Other public transport' includes ferry and taxi; 'Total public transport' includes train, bus, ferry and taxi; 'Passenger vehicle' includes both car (as driver and passenger) and motorbike; and 'Active travel' includes walking and cycling.
4. Income ranges were collapsed to match and compare ABS Census and NSW HTS income ranges.
5. Excluded Do not answer, Don't know, Negative income and Refused to answer for HTS.

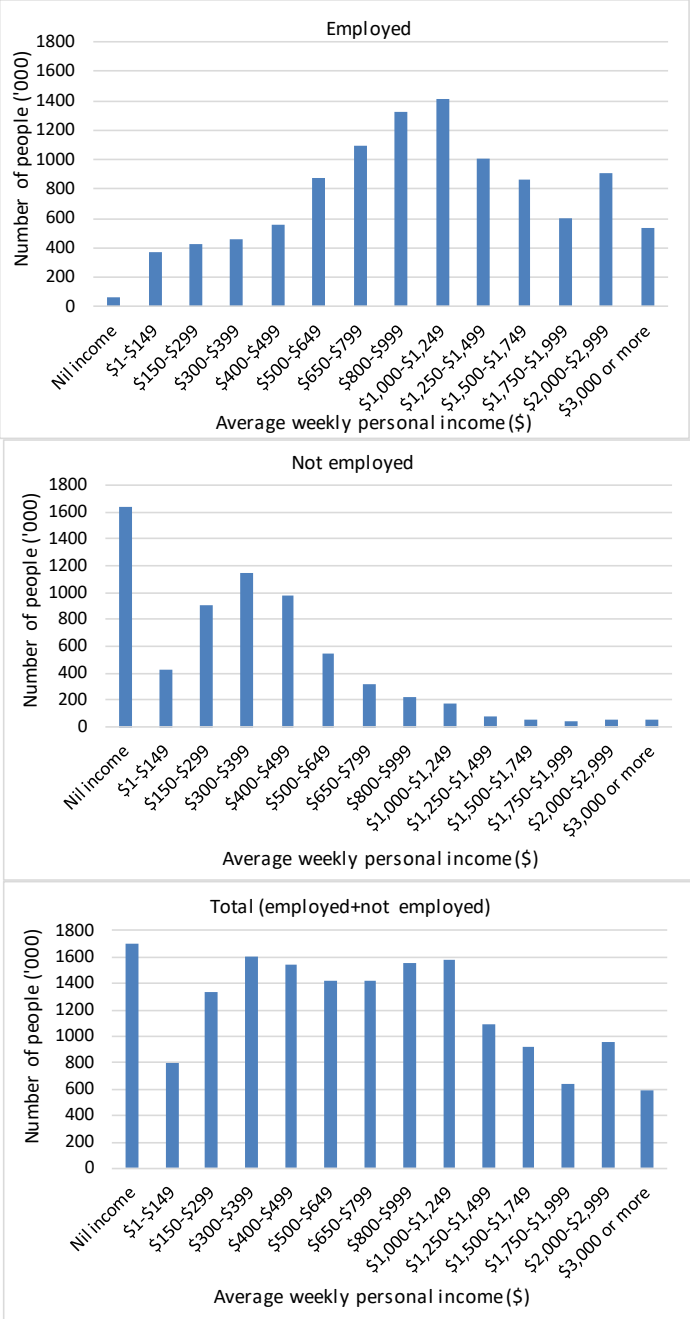
Source: BITRE analysis of ABS 2016 *Census of Population and Housing* (TableBuilder Pro) and NSW HTS (unit record data).

Appendix B

Comparison of employed persons and general population

The distribution of employed, non-employed and the total population aged 15 years and more in Australia (including other territories) show different patterns (Figure B.1). For example, the income distribution of employed persons is skewed to the left (i.e. negatively skewed), while the distribution of non-employed persons is skewed to the right (i.e. positively skewed). The distribution of total persons is bi-modal (excluding zero income).

Figure B.1 Distribution of employed, non-employed and total persons, total Australia, 2016

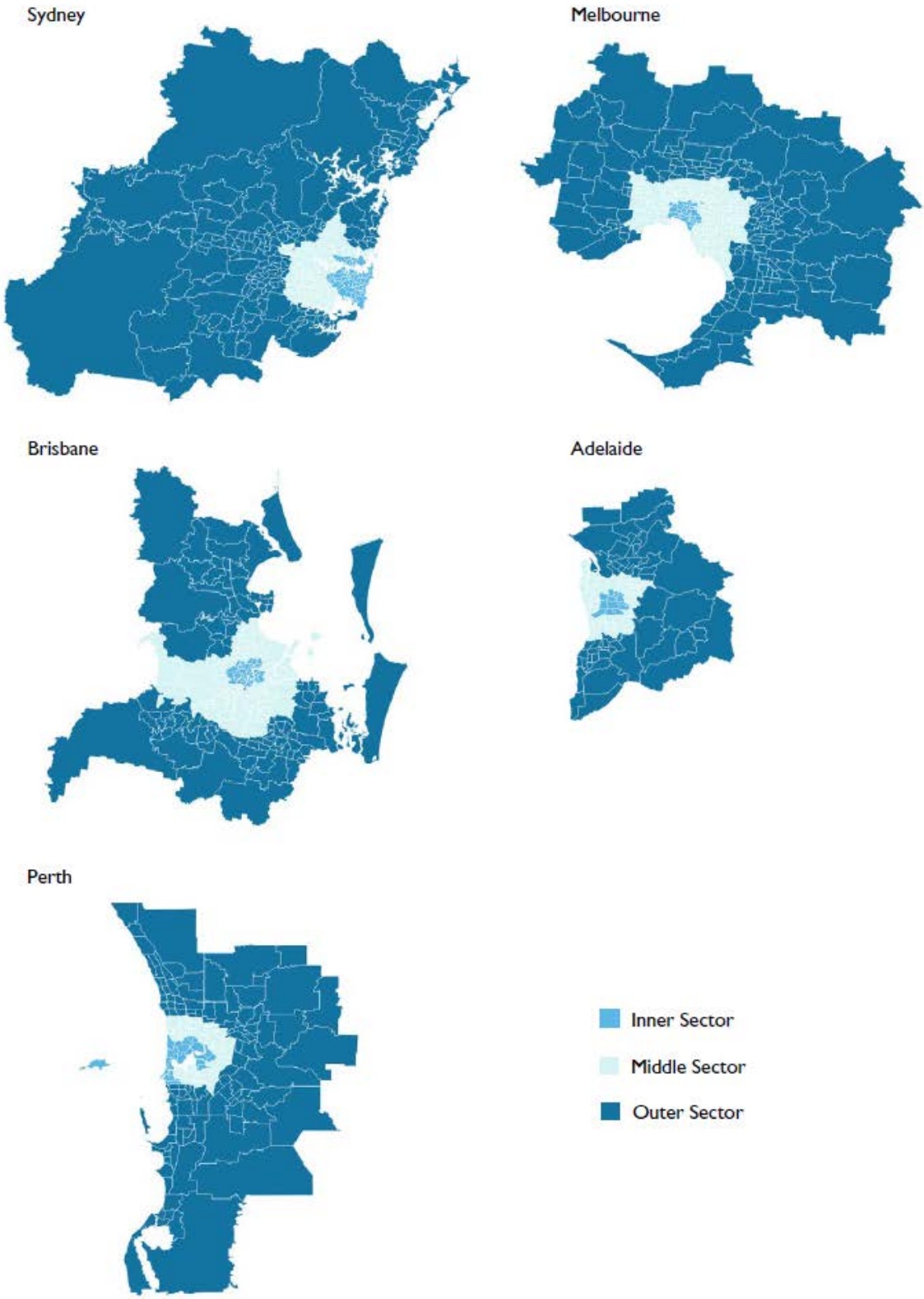


Notes:
1. Persons 15 years and more for total Australia (including other territories).
2. Employed persons include worked full-time, worked part-time and away from work.
3. Not-employed persons include looking for full-time work, looking for part-time work, not in the labour force.
4. Excluded negative income, not stated and not applicable.

Source: BITRE analysis of ABS *Census of Population and Housing* for 2016 place of usual residence data (TableBuilder Pro).

Appendix C

Map C.1 Inner, Middle and Outer sectors of Sydney, Melbourne, Brisbane, Adelaide and Perth



Note: All five city maps are presented at a common scale. Each city has been disaggregated into Inner, Middle and Outer sectors, based on ABS 2016 Statistical Area 2 (SA2) boundaries. Sydney, Melbourne, Adelaide and Perth reflect GCCSA boundaries, while Brisbane reflects a narrower definition (capturing 3 per cent less population than the GCCSA), based on BITRE's sectoral classification. The inner, middle and outer sectors for Sydney, Melbourne, Brisbane, Adelaide and Perth have been developed by BITRE.

Source: BITRE analysis of ABS 2016 SA2 boundaries.

Abbreviations and Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ABS	Australian Bureau of Statistics
ACT	Australian Capital Territory
AURIN	Australian Urban Research Infrastructure Network
BITRE	Bureau of Infrastructure, Transport and Regional Economics
CBD	Central Business District
DIT	Department of Infrastructure and Transport
FIFO	Fly-in-fly-out
GCCSA	Greater Capital City Statistical Area
HES	Household Expenditure Survey
HILDA	Household, Income and Labour Dynamics in Australia
HTS	Household Travel Survey
km	Kilometre
Metro ARIA	Metropolitan Accessibility/Remoteness Index of Australia
np	not presented
NSW	New South Wales
SA2	Statistical Area 2
SA3	Statistical Area 3
SA4	Statistical Area 4
UK	United Kingdom
US$	United States dollar
VKT	Vehicle kilometres travel

References

American Association of State Highway and Transportation Officials (AASHTO) 2013, *Commuting departure time and trip time, Commuting in America 2013*, The national report on commuting patterns and trends, Brief 11, AASHTO, October.

American Public Transportation Association 2007, *A profile of public transportation passenger demographics and travel characteristics reported in on-board surveys*, Report published by American Public Transportation Association, Washington, May 2007, 52 pages.

AURIN (Australian Urban Research Infrastructure Network) 2014, SA1 Metro ARIA 2014 for Australian capital city urban centres, Hugo Centre for Migration and Population Research, University of Adelaide, Adelaide.

Baumann A E, Sallis J F, Dzewaltowski D A and Owen N 2002, Toward a better understanding of the influences on physical activity: The role of determinants, correlates, causal variable, mediators, moderators, and confounders, *American Journal of Preventive Medicine*, Volume 23, Number 2S, pp. 5-14.

Best H and Lanzendorf M 2005, Division of labour and gender differences in metropolitan car use: An empirical study in Cologne, Germany, *Journal of Transport Geography*, 13(2), 109-121.

Bull F, Hooper P, Foster S & Giles-Corti B 2015, *Living liveable: the impact of a liveable neighbourhoods policy on the health and wellbeing of residents*, University of Western Australia, Perth.

Bureau of Infrastructure, Transport and Regional Economics 2018, *Spending by Australian households on owning and operating vehicles in 2015–16*, Information Sheet 95, BITRE, Canberra.

Bureau of Infrastructure, Transport and Regional Economics 2016, *Lengthy commutes in Australia*, Report 144, BITRE, Canberra.

Bureau of Infrastructure, Transport and Regional Economics 2014a, *Major transport employment hubs, Information Sheet 58*, BITRE, Canberra.

Bureau of Infrastructure, Transport and Regional Economics 2014b, *Improving regional passenger rail services*, Report 137, BITRE, Canberra.

Bureau of Transport Statistics 2012, *Household Travel Survey summary report: Sydney 2010-11*, NSW Bureau of Transport Statistics, Sydney.

Bureau of Transport Statistics 2014, *Household Travel Survey summary report: Sydney 2012-13*, NSW Bureau of Transport Statistics, Sydney.

Coleman S 2017, *Australia state of the environment 2016: built environment*, independent report to the Australian Government Minister for the Environment and Energy, Australian Government Department of the Environment and Energy, Canberra.

Commonwealth of Australia 2017, Department of the Prime Minister and Cabinet, *National Cities Performance Framework Interim Report*, Smart Cities Plan, 64 pages, Canberra.

Deboosere R, Boisjoly G and El-Geneidy A 2018, *Understanding the relationship between changes in accessibility to jobs, income and unemployment in Toronto, Canada*, Paper presented at the 97th Annual Meeting of the Transportation Research Board, Washington D.C., USA.

Department of Infrastructure and Transport 2013, *State of Australian Cities 2013*, Report, Major Cities Unit, DIT, Canberra.

Department of Transport 2016, *Road Use Statistics Great Britain 2016*, Statistical Release, 7 April 2016, 41 pages.

Flood M and Barbato C 2005, *Off to work—Commuting in Australia*, Discussion Paper Number 78, The Australia Institute, April.

Florez J 1999, *Attracting higher income class to public transport in socially clustered cities: The case of Caracas*, European Transport Conference, Proceedings of Seminar B: Transport Planning, Policy and Practice, Published by PTRC, Cambridge.

Guiliano L and Narayan D 2003, Another Look at Travel Patterns and Urban Form: The US and Great Britain, *Urban Studies*, 40 (11), pp. 2295-2312.

Lagura E, Norman P, Richmond M and Walting R 2011, *The public transport usage of two Melbournes*, Paper presented at the Australasian Transport Research Forum, 28-30 September 2011, Adelaide, South Australia.

Loader C 2012, *What sorts of people use public transport*? (Part 2), Charting Transport, Released 21 September 2012 (https://chartingtransport.com/page/5/), Assessed 10 July 2017.

McQuaid R and Chen T 2012, Commuting times - The role of gender, children and part-time work, *Research in Transportation Economics*, 34(1), pp. 66-73.

Memmott J 2007, *Trends in personal income and passenger vehicle miles*, Special Report, Bureau of Transport Statistics, U.S. Department of Transportation, October 2007, 4 pages.

Ministry of Transport (former Transport Data Centre) 2008, 2006 employment and commuting, *Transfigures*, April 2008, NSW Ministry of Transport, Sydney.

Paulley N, Balcombe R, Mackett R, Titheridge H, Preston J M, Wardman M R, Shires J D, White P 2006, The demand for public transport: The effects of fares, quality of service, income and car ownership. *Transport Policy*, 13(4), 295-306.

Siddique A B 2010, Public transit for the lower and middle-income people in Khulna City of Bangladesh: Balancing efficiency and equity, *Geospatial World*, November 29, 2010. <https://www.geospatialworld.net/article/public-transit-for-the-lower-and-middle-income-people-in-khulna-city-of-bangladesh-balancing-efficiency-and-equity/>, Assessed 6 August 2017.

South African Department of Transport 2005, *Key results of the national household travel survey*, The first South African National Household Travel Survey 2003, Report, August 2005, Pretoria, South Africa.

Transport for London 2011, *Travel in London*, Supplementary Report: London Travel Demand Survey (LTDS), London, UK, 72 pages.

Van Ham M and Hooimeijer P 2009, Regional differences in spatial flexibility: long commutes and job-related migration intentions in the Netherlands, *Applied Spatial Analysis*, 2, pp. 129–46.

van Ommeren J, van den Berg G J and Corter C 1998, Estimating the marginal willingness to pay for commuting, Research Memorandum 1998-46, Applied Labour Economics Research Team, Vrije University, Amsterdam, The Netherlands, 25 pages.

Versel D E 2013, *Trends and Outlook for Transit Commuting in the Washington Metropolitan Area*, Working Paper 2013-11, Center for Regional Analysis, George Mason University, Virginia, Washington, DC.

Wang S and Curtis C 2015, *The Function of Individual Factors on Travel Behaviour: Comparative Studies on Perth and Shanghai*, State of Australian Cities Conference, 9-11 December 2015, Gold Coast, Queensland.

Zegras P C and Srinivasan S 2007, Household income, travel behavior, location and accessibility: Sketches from two different developing contexts, *Transport Research Record*, Vol. 2038, pp. 128-138.

ISSN 1440-9593

ISBN: 978-1-925531-55-8

July 2019 / INFRA: 3289

This publication should be attributed in the following way; Bureau of Infrastructure, Transport and Regional Economics (BITRE), *Relationship between transport use and income in Australia*, Information Sheet 102, BITRE, Canberra.

Prepared by Afzal Hossain under the guidance of Leanne Johnson.

For further information on this publication please contact bitre@infrastructure.gov.au.

Use of the Coat of Arms

Contact us

Department of Infrastructure, Transport, Cities and Regional Development
Bureau of Infrastructure, Transport and Regional Economics (BITRE)
GPO Box 501, Canberra ACT 2601, Australia

Phone: (international) +61 2 6274 7210
Fax: (international) +61 2 6274 6855
Email: bitre@infrastructure.gov.au
Website: www.bitre.gov.au