Cycling Down Under: A Comparative Analysis of Bicycling Trends and Policies in Sydney and Melbourne

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Abstract

The purpose of this paper is to document and explain differences in cycling between Australia's two largest cities. Our comparative case study analysis is based on a wide range of statistical datasets, secondary reports, and interviews with a panel of 22 bicycling policy and planning experts. The main finding is that cycling levels in Melbourne are roughly twice as high as in Sydney and have been growing three times as fast in recent years. The difference is due to Melbourne's more favorable topography, climate, and road network as well as more supportive public policies. In particular, Melbourne has more and better integrated cycling infrastructure as well as more extensive cycling programs, advocacy, and promotional events. Melbourne also benefits from safer cycling than Sydney, which suffers from a lack of traffic-protected cycling facilities and aggressive motorist behavior toward cyclists on the road. While cycling has been increasing in Australia, it remains at very low levels relative to northern Europe, where both land use and transport policies are far more supportive of bicycling while discouraging car use through numerous restrictions and financial disincentives.

Keywords: Bicycling, Active travel, Urban transport, Australia, Policy, Sustainability

1. Introduction

Bicycling accounts for about one percent of daily trips in Australia (Australian Bicycling Council, 2004; Bauman et al., 2008). That is roughly the same as in the UK, the USA, and Canada, but it is much lower than bicycle mode shares in northern Europe, which range from a

high of 27% in the Netherlands to 16% in Denmark and around ten percent in Finland, Germany, Sweden, and Belgium (Pucher and Buehler, 2008).

Similar to many countries, Australia has been seeking to increase cycling to improve the overall sustainability of urban transport (Austroads, 2005; House of Representatives Standing Committee on Environment and Heritage, 2005). Although the Australian Government officially endorses the goal of increased cycling, it has played a limited role in actively supporting cycling programs. Various federal departments have financed TravelSmart programs (social marketing campaigns aimed at reducing car use), occasionally sponsored research on cycling, promoted cycling tourism, and helped fund AustCycle, a new cycling training program (AustCycle, 2009; TravelSmart Australia, 2009).

State and local governments in Australia have primary responsibility for urban transport. Consequently, they have taken the lead role in planning, financing, and implementing the programs and facilities needed to increase cycling. Although cycling promotion efforts vary widely, most states and cities have been devoting more funding, staff, and public space to cycling facilities and programs in recent years (Bauman et al, 2008; City of Sydney, 2007; Lehman et al, 2009; Victorian Department of Transport, 2009a). Numerous Non-Governmental Organizations (NGOs) have also been working to promote cycling and to prod governments at every level, including the federal government, to do more to facilitate cycling (Bicycle Federation of Australia, 2009; Cycling Promotion Fund, 2009a and 2009b).

The results of these efforts have been encouraging, though unevenly distributed geographically. The number of bicycle-only work commuters in Australia grew by 15% between 2001 and 2006 (Australian Bureau of Statistics, 2009). Including bicycle trips combined with other modes, there was a 22% increase in Australians who used a bicycle for at least part of their trip to work. Most of that increase, however, was due to population growth and overall increases in travel demand. The bicycle share of work trips hardly grew at all from 2001 to 2006: from 1.15% to 1.20%.

Aggregate national statistics such as these hide considerable variation between urban and rural areas and among individual cities. Perhaps most striking is the contrast between Australia's two largest cities, Sydney and Melbourne. The bicycle share of trips is about twice as high in Melbourne as in Sydney, and cycling has been growing about three times faster in Melbourne in

recent years. The differences between the two cities in their cycling rates are interesting because they are similar in many other ways.

Sydney and Melbourne have long been Australia's largest cities. Both are located in the southeastern corner of Australia and benefit from a temperate climate. Both are surrounded by vast areas of car-dependent suburban sprawl. Moreover, the two cities have similar per-capita incomes, widespread car ownership, and virtually identical economic and political systems. Precisely because of their proximity and their role as Australia's dominant cities, Sydney and Melbourne have been economic, political, sporting, and cultural rivals for over a century. An analysis of the factors underlying the differences in cycling in these cities may reveal the relative importance of policies in promoting cycling, and thus provide lessons for other cities.

This paper first presents a detailed examination of cycling in Sydney and Melbourne, documenting overall trends in cycling as well as differences in cycling rates by trip purpose, location, gender, and age. The paper then explores a range of possible causes for the difference in cycling levels, including topography, climate, population density, car ownership, roadway traffic, cycling infrastructure, traffic safety, and cycling promotional and training programs. The analysis relies mainly on aggregate data for each of these factors. Statistical information was complemented by published reports and consultation with a panel of 22 bicycling policy and planning experts in Australia to provide a qualitative, contextual assessment of differences in cycling levels and policies in the two cities. Information was obtained from the experts through written questionnaires, follow-up emails, personal and phone interviews, and feedback on various drafts of this paper. The experts also facilitated access to relevant documents and datasets and helped the authors evaluate their accuracy.

The panel included six university professors (three in public health and three in transport), eight city and state government transport planners (five of whom are specifically bike planners), three transport planning consultants, and five representatives of bicycling organizations. To facilitate their cooperation, we offered these experts anonymity, since many of the issues addressed in this paper are controversial, and opinions expressed sometimes differed from organizational policies.

2. Overall differences in cycling levels

There are several different sources of information on cycling in Sydney and Melbourne, but the most comparable is the journey to work component of the Australian Census, which is conducted every five years in August (Australian Bureau of Statistics, 2009b). As shown in Figure 1, the bicycle-only share of work trips in Sydney rose from 0.4% in 1976 to 0.6% in 1981, but has remained virtually constant for the 25-year period from 1981 to 2006 (Mees et al. 2007). The bicycle-only share of work trips in Melbourne has been consistently higher than Sydney's and has risen from about 1.0% in 1976 to 1.3% in 2006. These percentages reflect trips made entirely by bicycle. If bicycle trips made to access other travel modes are included (e.g., cycling to a station and then catching the train), the bicycle share rises to 1.5% for Melbourne and 0.8% in Sydney in 2006. Between the last two Australian censuses, Melbourne pulled far ahead of Sydney. From 2001 to 2006, the number of people commuting to work by bicycle in Melbourne rose about two and a half times faster than in Sydney (48.2% vs. 17.2% increase) (Bauman et al., 2008).

Figure 1

While these bicycle mode shares may seem low, the absolute numbers of daily work trips by bicycle in 2006 are noteworthy: 18,909 in Melbourne and 10,887 in Sydney. The highest rates of cycling are in the inner areas of both cities (Figure 2 and Figure 3), with the bicycle mode share of work trips in central Melbourne more than twice as high as in central Sydney: 4.8% vs. 2.2%. If those bike trips were made instead by car or public transport, they would add to the already serious congestion problems on central city roads, where most cycling is concentrated, or squeeze more passengers on already over-crowded trains, buses and trams. Victoria's roadway authority estimates that 12,000 bicycle commuters are the equivalent of 10,000 cars, 86 trams or 15 trains (VicRoads, 2008). Thus, cycling is more important for daily travel to Sydney's and Melbourne's main city centers than indicated by the low average mode shares for their entire metropolitan areas.

Figure 2

Figure 3

The higher bicycle mode share in Melbourne is confirmed by the Environmental Issues Survey conducted every 3 or 4 years by the Australian Bureau of Statistics (Australian Bureau of Statistics 2007). It reports the main form of transport used for journeys to work or study. These data are aggregated at the state level, but they reflect the situation for Sydney (New South Wales) and Melbourne (Victoria) as well, since each of these capital cities accounts for about three-fourths of its state's population (Australian Bureau of Statistics, 2009a). While the bicycle share of work and school trips was only slightly higher in Victoria than in New South Wales in 2000 (0.9% vs. 0.7%), by 2006 it was more than twice as high (2.1% vs. 0.8%). Thus, the bicycle share of work and school trips in Victoria more than doubled over the same period that the bicycle share in New South Wales barely increased at all (Australian Bureau of Statistics, 2007).

A third source of survey information is the annual nationwide Exercise, Recreation, and Sport Survey (ERASS) of physical activity, which reports on whether respondents have cycled in the past 12 months. It indicates consistently higher percentages of cycling participation in Victoria than in New South Wales, around 12% vs. 9% over the period 2001 to 2008 (Australian Sports Commission, 2009).

Corresponding to its lower level of cycling, Sydney also has a lower rate of bicycle ownership than Melbourne: 0.29 vs. 0.37 bicycles per capita in 2004, the most recent year for which data are available (Australian Bicycle Council, 2004). As shown in Table 1, Sydney has the lowest rate of bicycle ownership of any major city in Australia as well as the lowest proportion of people who cycle every day. This is the fourth dataset confirming that cycling rates are about twice as high in Melbourne as in Sydney (2.1% vs. 1.0% daily cyclists).

Table 1

Data on the use of key cycling routes into the central business districts of Sydney and Melbourne also show higher and more rapidly increasing levels of commuter cycling in Melbourne. In 2008, 7,896 cyclists used the key cycling routes into the Melbourne CBD (an

increase of 76% from 2005), while in Sydney 3,330 cyclists used the key cycling routes into the Sydney CBD (an increase of 38% from 2005) (Australian Bicycle Council 2010).

Sydney and Melbourne each has its own metropolitan area travel survey, but the overall bicycle mode shares they report are not directly comparable due to different trip definitions and the sampling of different age groups. Nevertheless, as noted later, they reveal some interesting differences between cycling in the two cities in terms of trip purpose, day of the week, age, and gender.

In summary, Melbourne has roughly twice as high a bicycle mode share of trips as Sydney. While the bicycle share in Melbourne has grown considerably in recent years, Sydney's cycling growth has been much slower. We now proceed to a disaggregation of these overall differences by trip purpose, day of travel, gender, and age**.**

3. Disaggregate variations in cycling rates

Aggregate comparisons of cycling levels in Sydney and Melbourne conceal much important spatial variation within each metropolitan area as well as differences in cycling rates by day of the week, gender, and age.

3.1. Spatial variations within each metropolitan area

As shown in Figure 2 and Figure 3, cycling rates are much higher in the center of Melbourne and Sydney than in the outer suburbs. The spatial pattern in Melbourne is especially pronounced, with a striking decline in bicycle share of work trips with increased distance from the core: from about 4% in the center to less than 0.5% in most of the outer suburbs. The highest cycling rates in Sydney are also in and around the center (1.2%-2.1%), but some of the far northern and northwestern suburbs have rates of cycling higher than the inner suburbs immediately to the south and west of the city. Nevertheless, in both metropolitan areas there is generally much more cycling in the city center and inner suburbs than in the outer suburbs. That pattern is confirmed by three studies which show that most of the increase in cycling in recent years has been concentrated in and around the center (Telfer and Rissel, 2003; VicRoads, 2003; Lehman et al, 2009). From 2001 to 2006, for example, the average annual increase in bicycle trips to work was three times as high in inner Melbourne as in the outer suburbs (11.7% vs. 3.7%).

It seems likely that the higher cycling rates in the city center are at least partly due to higher density, more mixture of land uses, and shorter trip distances in older areas of the city. For the work trip, in particular, living in or near the city center puts many jobs within easy cycling distance. In comparison, both jobs and residences in the outer suburbs tend to be much farther from each other, as well as from shopping, entertainment, and educational opportunities. As discussed later, bicycle use in the city center is facilitated by more extensive cycling facilities than in the suburbs. Compared to car travel, cycling is most attractive in the city center, where traffic congestion is worst, and where the relative speed of cycling, compared to driving, is the highest. Moreover, parking is less available and more expensive in the city center than in the suburbs, yet another incentive to cycle. In their analysis of Sydney cycling, Telfer and Rissel (2003) emphasize the availability of quiet back-street routes and off-road cycle paths in inner suburbs such as Marrickville, Newtown, and Waverley. Similarly, the local street network in central Melbourne and its inner suburbs is far more bicycle-friendly than in the car-dependent outer suburbs.

Combined with less car-dependent lifestyle preferences and well-organized advocacy by bicycle user groups, all these factors enhance the attractiveness of cycling in the inner suburbs. The gentrification and population growth of the inner areas of both Melbourne and Sydney might help explain why almost all the growth in cycling has been in these core areas. In both cities, young singles and couples as well as older 'empty nesters' have increasingly chosen to live in the inner city. It is also where several universities in both cities are located, and thus where many students live.

3.2. Differences in trip purpose and day of travel

The only available information on bicycle travel for the whole range of trip purposes comes from household travel surveys conducted for each of the two metropolitan areas. The Sydney Household Travel Survey (SHTS) has run continuously from 1999 to the present. The Victorian Activity and Transport Survey (VATS) for Melbourne was conducted from 1993-1999 and is currently being updated. Cycling statistics derived from these surveys are subject to high standard errors because of the small numbers of cycling trips captured. Moreover, 1999 is the only year for which both cities conducted surveys. In spite of some differences in methodology, the two surveys permit some approximate comparisons of cycling in the two metropolitan regions.

According to the SHTS, the bicycle share of all trips in Sydney in 2001 was higher on weekends than on weekdays (0.8% vs. 0.6%), a difference that had grown even wider by 2005 (1.1% vs. 0.7%) (Transport Data Centre, 2007). In contrast to Sydney, the bicycle share of trips in Melbourne in 1999 was lower on weekends than on weekdays, although not by much (1.1% vs. 1.2%) (VicRoads, 2004).

Survey data about trip purpose are broken down by weekend and weekday for Sydney, while for Melbourne they are only provided for an average day across the year, limiting the direct comparison to an average day (Table 2). Both the SHTS and VATS surveys are conducted every day of the year with the 'average day' constituting the average of travel conducted over all 365 days including weekdays, weekends, and holidays. Social-recreational trips account for 53% of bicycle trips on an average day in Sydney, compared to only 27% in Melbourne. On weekends, the share of social recreational trips rises to 70% of bicycle trips in Sydney (RTA, 2003). On an average day in Melbourne 39% of all bicycle trips are for commuting to work and education, compared to only 27% in Sydney. The large proportion of "other" trip purposes reported in the Melbourne survey distorts these differences, however, overstating the gap between the two cities in the percentage of social-recreational trips and understating the gap in work and education trips.

Table 2

In short, cycling in Sydney tends to be mainly for recreational purposes and is mostly on the weekend. In contrast, cycling in Melbourne tends to be more utilitarian and spread evenly over the week.

3.3. Differences by gender and age group

As in most countries with low levels of cycling, young men make up a disproportionate share of Australian cyclists. For Australia as a whole, only 21% of commuting cyclists are women, even lower than the 25% share in the USA and 30% share in Canada. By comparison, women account for 45% of cyclists in Denmark, 49% in Germany, and 55% in the Netherlands (Pucher and Buehler, 2008). Thus, evidence suggests that the higher the overall bicycle share of trips in a country, the higher the percentage of bicycle trips that are made by women. As shown by the work trip data from the 2006 Australian Census, that generalization appears to hold for

individual cities as well. In Sydney, with its much lower level of cycling, only 17% of bicycle work trips are by women, compared to 25% in Melbourne. The bicycle mode share of work trips for women in Sydney is only about a third as high as in Melbourne (0.27% vs. 0.76%).

The statistical relationship between gender and bicycle mode share appears to hold as well for different parts of the same city. As shown in Figure 4, the proportion of work bicycle trips by women rises sharply as the overall bicycle share of work trips increases from one locality to another within the Melbourne metropolitan area. Women account for 37% of all commuter cyclists in the inner suburb of Yarra (911 females, 1532 males), which has the city's highest rate of cycling (7.5% of work trips). In contrast, women account for only 6% of commuter cyclists in the outer suburb of Whittlesea (9 females, 143 males), where the total bicycle share of work trips is only 0.3%.

Figure 4

The VATS and SHTS surveys find considerable spatial variation in the age of cyclists in both cities. In the outer suburbs of both Melbourne and Sydney, the majority of bicycle trips are by cyclists under the age of 20, mainly for recreation (on weekends) or education (on weekdays). By comparison, most cyclists in the city center and inner suburbs are between the ages of 20 and 50. Bicycle trips in the inner areas are more likely to be for work, shopping, and other utilitarian purposes, especially on weekdays.

4. Underlying structural factors affecting cycling in Sydney and Melbourne

Although Sydney and Melbourne are similar in many ways, there are several differences that might help explain why there is about twice as much cycling in Melbourne and why it has been increasing so much faster than in Sydney. We examine these factors in two sections. The first section considers a range of basic, underlying factors inherent to each city's location, size, and overall structure. The second section examines factors related specifically to transport policies and programs in each city.

4.1. Topography and climate

Perhaps the most obvious explanatory factors that come to mind are topography and climate. In general, Melbourne is flatter than Sydney, whose coastal suburbs to the north and

south, in particular, are characterized by hilly terrain (Lehman et al, 2009). Recent topographic analysis of popular cycling routes into the CBD finds that the absolute rise in grade as well as the vertical profile is substantially higher for Sydney than Melbourne (Lehman et al., 2009). The authors note that such analysis needs to be conducted for other cycling routes to ascertain whether the perceptions hold true for other routes and locations within the cities. Hilly terrain discourages cycling in Sydney not only due to the effort required in hill climbing but also because it forces cyclists to share the best ridge-top routes with busy motor vehicle traffic, thus increasing the risk of conflicts and crashes. Perhaps the most significant obstacles to cycling in Sydney are the many natural barriers created by the large central harbor, many bays and inlets, and rivers—which cause large gaps in transport routes, require diversions to a limited number of crossing points, and increase travel distances. Melbourne's topography is more continuous and thus offers more direct and faster travel between origins and destinations. For example, the two main business districts of Sydney (CBD and North Sydney) are separated by the harbour with only one crossing for cyclists, the famous Harbour Bridge (Lehman et al, 2009). This greatly impedes north-south travel. In Melbourne, by comparison, the Yarra River has about 20 crossings, making its CBD more easily accessible from all directions.

Melbourne's climate is probably better for cycling, although it is often maligned for being less sunny and cooler than Sydney's. In the summer months, average maximum temperatures are similar in the two cities; during the winter months, temperatures in Melbourne are only about 4 degrees C. cooler than in Sydney, but rarely fall below freezing (Bureau of Meteorology, 2009a). Cordon counts in both Melbourne and Sydney indicate a slight decline in commuter cycling during the winter months, while recreational cycling on winter weekends falls sharply (Lehman et al., 2009; VicRoads, 2009a). As in cities throughout the world, therefore, winter cycling is less than cycling in other seasons of the year, but the difference appears to be less pronounced in Sydney and Melbourne due to their relatively mild winters. The peak cycling season in both cities is the autumn, followed by the summer and spring (about 15% less than in the autumn) and the winter (20% less) (Lehman et al., 2009; VicRoads, 2009a).

While Melbourne is cloudier than Sydney, its average annual rainfall is only about half as much, with the biggest difference during the months January to June (see Figure 5). Moreover, rainfall in Sydney often comes as torrential downpours, whereas Melbourne is more likely to get drizzle or light rain (Bureau of Meteorology, 2009b). In this respect, Melbourne's climate is

closer to the maritime climates of the Netherlands, northern Germany, and Denmark, where cycling rates are much higher.

Figure 5

While topography and climate appear to favor cycling in Melbourne, these factors have not changed much over the past ten years. Thus, they do not explain why rates of cycling have increased so much faster in Melbourne than in Sydney. Nevertheless, such factors may provide a more supportive environment in Melbourne for policy and program interventions aimed at increasing cycling.

4.2. Population density and urban form

Table 3 summarizes a few key demographic and socioeconomic statistics for the two cities. According to the 2006 ABS Census, the Sydney Statistical Division (Figure 3) had 339 inhabitants/km^2, compared to 467 inhabitants/km^2 in the Melbourne Statistical Division (Figure 2). Those density figures must be qualified however, as they are based on total metropolitan regions that include undeveloped areas such as parks, nature preserves, and water features. If undeveloped land is excluded, the Sydney metropolitan region is about a third denser than metropolitan Melbourne. Sydney had 2,040 inhabitants/km^2 of developed area in 2000, compared to1,570 inhabitants/km^2 in Melbourne (Kenworthy and Laube, 2001). The Sydney metropolitan area also had a somewhat stronger core, with 12.8% of its jobs in the CBD, compared to 9.4% in Melbourne (Kenworthy and Laube, 2001). Higher population density and a strong CBD are usually associated with more public transport use and walking (Newman and Kenworthy, 1999). That might help explain why the public transport share of work trips in Sydney is so much higher than in Melbourne (20.2% vs. 13.9%). The walk share of trips is also higher in Sydney (4.9% vs. 3.6%).

Strong growth in both population and jobs in the Melbourne CBD may be contributing to the increase in cycling in Melbourne in recent years, although the impact of these changes is difficult to quantify. Census data for 1996, 2001 and 2006 show that the growth in cycling to work has been greater than the growth in walking to work (Bartley Consulting Pty Ltd, 2008). That suggests that demographic and employment changes alone do not account for the especially rapid growth in cycling, as one would expect similar increases in walking. Key cycle route usage data indicate increasing use of inner Melbourne cycling infrastructure over time,

suggesting that demographic changes are interacting with infrastructure provision to contribute to increases in commuter cycling in Melbourne (Australian Bicycle Council, 2010).

Table 3

Other potentially important aspects of urban form include the degree of mixture of land uses (e.g. residential, commercial, and services) and the design of the street network (grid pattern, cul-de-sacs, and connectivity of street system). There is no comparable statistical information available along these dimensions, but the consensus among the experts consulted in both cities is that the street network is more conducive to cycling in Melbourne than in Sydney. Melbourne generally has wider streets with less traffic, thus providing more space for cycling, whether in special bicycle lanes or wide curbside lanes. Moreover, most of the road network in inner Melbourne is laid out in a grid pattern that facilitates the connectivity of local streets used by cyclists (Davison, 2004). Many of Sydney's streets are winding and narrow, have limited connectivity, and carry high levels of traffic, all of which disadvantage cycling (Lehman et al, 2009).

Several experts also noted that the Melbourne CBD is far more accessible for cyclists than the Sydney CBD. Local streets in many of Melbourne's inner suburbs provide direct access to the CBD. By comparison, many local streets in Sydney's inner suburbs are cut off from the CBD by motorways or major arterials as well as the expansive harbour and other natural barriers. That difference in cycling accessibility to the CBD might help explain why the bicycle share of work trips in Yarra (just to the north of central Melbourne) (7.5% bicycle-only) is three times higher than in Marrickville (just to the west of central Sydney) (2.5 %), although the two localities are very similar in their topography, proximity to the center, demographics, and development patterns (Lehman et al., 2009; Australian Bureau of Statistics 2009a).

Urban form also affects cycling levels in different parts of the same metropolitan area (Figures 2 and 3). In general, the core areas of each of the two cities tend to have higher density, more mixed use development, and more connectivity in their street networks (Newman and Kenworthy, 1999). Further out in the suburbs, density is much lower, residential areas tend to be segregated from commercial uses, and there is less connectivity in the street network. The

segregation of land uses and lack of street connectivity both tend to lengthen trip distances, thus deterring cycling as well as walking in the suburbs.

4.3. Trip distance

The distribution of trips by distance crucially affects the potential for growth in cycling. The Australian Census provides no publicly available information on this important dimension of travel behavior. A study by Kenworthy and Laube (2001) found that the average work trip length in 1995 for all modes combined was 16.9km in Sydney vs. 15.6km in Melbourne. That suggests that trips tend to be about ten percent longer in Sydney than in Melbourne, which might be due to the overall larger land area of the Sydney metropolitan area (12,145 sq. km vs. 7,700 sq. km).

The only comprehensive data on trip distances for all trip purposes are from the Sydney HTS and Melbourne VATS metropolitan travel surveys, but they use incomparable definitions of trip distance. The Sydney survey reports linked trips, from origin to final destination, while the Melbourne survey reports unlinked trips, with each link in the trip chain reported as a separate trip. That leads to longer reported trips in Sydney than in Melbourne.

A more comparable source of information on trip distance is the March 2006 ABS Environmental Issues Survey, which reports on trips to work and school (Australian Bureau of Statistics, 2006). ABS uses the same trip definitions and survey methodology for all Australian cities. It finds longer trip distances in Sydney than in Melbourne. For example, it reports that 19.4% of all work and education trips in Sydney are 30 km or longer, compared to 12.8% in Melbourne. Conversely, 32.9% of work and education trips in Sydney were 10km or shorter, compared to 36.0% in Melbourne. The two cities have almost the same percentage of trips 5km or shorter: 15.5% in Melbourne vs. 15.1% in Sydney. In short, average trip distances are indeed shorter in Melbourne than in Sydney, and thus more bikeable, but the difference does not appear to be large except over very long distances, which few people cycle.

The concentration of most bicycle trips in the inner areas of both Melbourne and Sydney reflects the impact of trip distance on cycling. Average work trip distances in the urban cores are much shorter than in the outer suburbs (Victorian Department of Transport 2009b). Clearly, the proximity of residences and jobs in central city areas generates shorter trips than in the low-density suburbs, where many households are not within cycling distance of workplaces.

4.4. Socioeconomic and demographic differences

Sydney and Melbourne are roughly comparable in their socioeconomic and demographic structures. Median income per capita in 2006 was slightly higher in Sydney than in Melbourne ($29,936 vs. $25,012) as was median income per household ($60,008 vs. $56,108). In spite of higher incomes, Sydneysiders actually have fewer cars per capita than Melburnians (515 vs. 594 per 1,000 residents), and they drive fewer kilometers per capita per year than Melburnians (10,506 vs. 11,918 km) (Kenworthy and Laube, 2001). The somewhat lesser degree of car-dependence in Sydney might be due to its higher modal shares of public transport (21.2% vs. 13.9% in Melbourne) and walking (4.9% vs. 3.6% in Melbourne) (Mees, 2000; Mees et al., 2007).

The age structures in the two cities are almost identical, with median ages of 35 in Sydney and 36 in Melbourne. In both cities, 33% of the population is younger than 25 years, 44% is aged 25-54, 10% is aged 55-64, and 13% is aged 65 and older. Similarly, there are no significant differences in gender distribution in the two cities, with men accounting for 49.3% of the population in Sydney and 49.0% in Melbourne. Thus, age and gender distributions do not play an important role in explaining overall cycling differences between the two cities. As noted earlier, however, both the elderly and women are more likely to cycle in Melbourne than in Sydney.

5. Trends in cycling safety

Concern about the danger of road cycling is a serious deterrent to getting more people to cycle—especially for children, the elderly, and women, but also for anyone who is risk averse (Bauman et al, 2008). A recent survey of 1,150 Sydney residents living within 10 km of the CBD suggests that perceived traffic danger is the primary reason why non-regular cyclists do not cycle more often (City of Sydney, 2006). Thus, improving cycling safety is an important approach to encouraging more cycling among a broader cross-section of society. Of course, reducing cyclist injuries and fatalities is an appropriate public health goal in itself, but the potential impact of improved safety on people's willingness to cycle is yet more reason to pursue this goal.

Serious cyclist injuries per capita are similar in Sydney and Melbourne, with the Sydney rate slightly higher than the Melbourne rate from 2001 to 2004, and slightly lower in 2005 and

2006 (see Figure 6). The injury rate has been increasing in both cities over most of this period. These statistics only include serious injuries requiring hospital admission and stay for at least one night. They do not include less serious injuries treated as out-patients in emergency rooms or by general practitioners and obviously do not include minor injuries treated at home or not at all.

Figure 6

Per-capita injury rates are misleading, however, because they do not control for exposure. Ideally, one would calculate injury rates relative to the number of bicycle trips or bicycle km traveled or hours of bicycle travel. Lack of good exposure data precludes such calculations. The only comparable exposure data for the two cities is from the Census Journey to Work (ABS, 2009a). As noted earlier, the bicycle mode share of work trips in 2006 was almost twice as high in Melbourne as in Sydney (1.3% vs. 0.7%). On a per-capita basis, there were roughly twice as many bicycle trips to work per 1,000 inhabitants in metropolitan Melbourne as in metropolitan Sydney (5.7 vs. 2.9). With twice as many bicycle work trips per capita but roughly the same number of serious cyclist injuries per capita, Melbourne appears to have much safer cycling than Sydney.

The Census data indicate that the growth in bicycle work trips from 2001 to 2006 was much faster in Melbourne than in Sydney (42.6% vs. 9.0%). Increased cycling exposure probably explains why serious injuries per capita rose faster in Melbourne than in Sydney from 2001 to 2006 (27.5% vs. 11.5%). It is noteworthy that the increase in serious injuries in Melbourne was less than the increase in bicycle work trips (27.5% vs. 42.6%), indicating that injuries per bicycle trip in Melbourne may be falling and that cycling may be getting safer. By comparison, serious injuries rose faster in Sydney than the number of bicycle work trips (11.5% vs. 9.0%), suggesting that the injury rate per bicycle trip rose slightly from 2001 to 2006. Overall, the available statistics suggest that cycling is safer in Melbourne than in Sydney and getting safer over time.

However, there are problems comparing injury rates per capita with bicycle trips to work. Cyclist injury statistics are for all kinds of bicycle trips and not just the journey to work. Moreover, the injury statistics include all ages, while the Census work trip data only include persons at least 15 years old. Nevertheless, all three of the other surveys of cycling levels

discussed earlier in this paper (Environmental Issues Survey, ERASS, and Australian Bicycle Council) find higher cycling rates in Melbourne for other trip purposes and other age groups as well. Thus, all the available evidence points toward lower injury rates per bicycle trip in Melbourne.

This empirical evidence is consistent with media coverage, surveys and expert opinions suggesting that cycling is generally perceived as being safer in Melbourne than in Sydney (Australian Bicycle Council, 2004; City of Melbourne, 2008; City of Sydney, 2006 and 2007b; Lehman et al., 2009). Safer cycling in Melbourne might help explain why cycling levels there have been consistently higher than in Sydney, and why cycling continues to grow at a faster rate in Melbourne. Conversely, the higher cycling levels in Melbourne might themselves encourage safer cycling.

The principle of "safety in numbers," documented in many countries around the world, indicates that cycling becomes safer as levels of cycling increase (Elvik, 2009; Jacobsen, 2003; Robinson, 2005). The hypothesized mechanism behind the principle is that large numbers of cyclists are more visible—a key factor in avoiding traffic crashes—and generate more respect and consideration by motorists, especially the legal requirement to share the road with cyclists. Moreover, if an increase in the number of bicycles on roads is accompanied by a reduction in the number of cars, the potential for serious injury from collision decreases (Elvik, 2009). In most cases, rising cycling levels are also accompanied by expansion in cycling infrastructure, so that it is not entirely clear what causes increased safety with higher cycling rates.

6. History and culture of cycling

The cycling experts we consulted emphasized the longer history of cycling in Melbourne. Australia's first bicycles were imported to Melbourne in the 1890s, generating a spurt of cycling, with numerous bicycling clubs, competitions, and related events (Bicycle Victoria, 2009; Dunstan, 1999). Cycling came later to Sydney and never reached the levels in Melbourne. Comparable statistics on cycling are only available since the 1976 Australian Census. As shown earlier in Figure 1, the bicycle share of work trips has been consistently higher in Melbourne than in Sydney (Mees et al., 2007).

In this respect, Melbourne has had a better foundation for increasing cycling in recent years. Moreover, its topography, climate, and street layout have been more conducive to

cycling. Such factors do not necessarily determine the fate of cycling, however. Many large cities around the world have succeeded in greatly increasing cycling levels in spite of hilly and discontinuous topography (e.g., San Francisco and Seattle), cold or rainy climates (e.g., Minneapolis, Ottawa, Portland, and Vancouver), and lack of a utilitarian cycling culture (e.g., Bogota, Barcelona, and Paris) (Pucher et al., 2010). Those cities implemented a coordinated package of self-reinforcing policies and programs to encourage more bicycling and make it safer. Such success stories show that policies can play a crucial role in determining cycling levels, and they might also help explain some of the differences between Melbourne and Sydney.

7. Differences in cycling policies and programs

To what extent have government policies and programs been more favorable to cycling in Melbourne than in Sydney? This section examines the available evidence, grouped according to the categories of infrastructure (bicycle paths, lanes, and intersection modifications), route signage and mapping, traffic calming, roadway congestion and motorist behavior, bicycle parking, integration with public transport, training programs, and marketing and promotional programs. In some instances, data do not exist at all or are only partially available or incomparable for quantifying differences between Sydney and Melbourne in their cycling policies. Thus, we also relied in this section on our panel of cycling experts in the two cities to provide qualitative assessments of the differences where quantitative measures are not available or where they are misleading.

7.1. Existing and planned provision of cycling infrastructure

Probably the most visible commitment of a city to cycling is a comprehensive system of separate bicycle paths and lanes, providing a reserved right of way to cyclists and sending a clear signal that bicycles belong. It is difficult to compare the extent of the cycling networks in Melbourne and Sydney, let alone the quality, connectivity, and practical usefulness of cycling infrastructure. Neither metropolitan area has consistent time-series statistics on cycling facilities. Because local councils, state road authorities, and park authorities all provide various kinds of cycling infrastructure, there are no consolidated statistics for each metropolitan area.

Most of the cycling experts interviewed for this paper suggested that Melbourne's cycling facilities are generally more extensive and better integrated than those in Sydney, especially in

the central city and inner suburbs. Yet the available statistics do not facilitate a direct comparison.

The (NSW) Roads and Traffic Authority (RTA) routinely reports on the progressive construction of cycling facilities on a statewide basis for NSW and indicates a 137% increase in the length of its overall bikeway network between 1997 and 2007: from 1,685km to 3,986km (RTA, personal communications, 2009b). Of the 2007 total, 2,586km are on-road bicycle routes, and 1,400km are off-road paths. However, only 2% of the on-road facilities are fully separate bicycle lanes; the other 98% are simply shared car lanes or roadway shoulders. Almost all the off-road paths are mixed-use, recreational facilities shared with pedestrians. With few exceptions, cycling facilities in NSW do not provide an exclusive right of way for cyclists. This can result in the occurrence or at least the perceived risk of inconvenient, stressful, and potentially dangerous conflicts between cyclists and motor vehicles or pedestrians.

The increase in cycling facilities reported by the RTA in recent years does not all relate to improvements put in place primarily to meet the needs of daily cycling commuters. Some of the increase in Sydney's route network has been on routes along waterways or through parks, and some of these routes have seen faster growth in weekend than weekday usage. Other completed facilities, built when the opportunity has arisen in the course of major road projects, have been located in outer areas where there has existed, at least initially, relatively low demand for cycling facilities compared to inner Sydney (RTA, 2007). Only about a fourth of the off-road cycling facilities funded by the RTA since 2000 have served routes leading to commercial and employment centers. The balance of completed works includes mostly on-road markings and signage improvements to local on-road routes on quiet streets, and local shared paths. In the case of Sydney CBD, the City of Sydney council reports 161km of cycling routes in 2009, but only 8km of those are lanes or paths exclusively for cyclists (City of Sydney, personal communication, 2009b).

There are some new, well-used "flagship" cycling facilities in Sydney, such as the pathways along the Cooks River, Anzac Bridge, Anzac Parade, and M7 Westlink. But these have evolved in a project-driven way, as stand-alone facilities, rather than as incremental improvements to a coherent network. Although there are plans for further improvement (see Figure 7), metropolitan Sydney is still far from having a fully integrated bikeway network (RTA, 2009a). Many of the existing facilities are poorly designed, not well maintained, unconnected, or

more useful for recreation than for daily trips to work and school. The design and construction of facilities are not generally coordinated among the 38 local governments of metropolitan Sydney, causing discontinuities in bicycle routes. With the exception of major new regional cycleways, directional and distance signage for cyclists is generally nonexistent, incomplete, or inconsistent from one local government area to another. Our experts emphasized that there are some good bicycle routes on quiet back streets, but that it takes considerable experience to navigate these routes since signage is poor and bicycle route maps can be misleading.

Cycling facilities in metropolitan Melbourne suffer from many of the same problems as those in Sydney, but to a lesser extent. In particular, the central city and inner suburbs have more and better connected bicycle lanes and paths with better signage than in Sydney. As of 2009, approximately 1,200km of on-road and off-road bicycle routes have been established, representing 35% of the proposed 3,485 km of the Principal Bicycle Network (Victorian Department of Transport, 2009a). To a greater degree than Sydney, Melbourne has been introducing intersection modifications such as advance stop lines (bike boxes), special turning lanes, and advance green traffic signals for cyclists. Moreover, there are detailed bicycle route maps for various parts of the region and web-based on-line interactive bicycle maps (VicRoads 2009b). A bicycle trip planner is currently under development in Melbourne.

As indicated by a 2008 survey of cyclists, however, even the City of Melbourne (Australia's busiest commuter cycling destination) is hardly a cycling paradise (City of Melbourne, 2009). When questioned about conditions in central Melbourne, cyclists complained about discontinuities in the cycleway network, poor signage, insufficient separation from motor vehicles, inconsistent facility design, poor lighting, some narrow and uneven cycling facilities, and insufficient bicycle parking. On a scale of 1 to 10 (with 10 being best) cyclists, on average, gave central Melbourne a rating of 6 on each of four evaluation criteria: overall cycle friendliness, cycle path design, cycle path maintenance, and overall provisions for cyclists. Cycling safety and cycleway connectivity were both rated at 5. The survey is part of the Melbourne Bicycle Account, started in 2007 and patterned after the Copenhagen Bicycle Account. It provides annual feedback from cyclists to the City administration, helping to detect and prioritize problems and gauge progress in dealing with them. The Bicycle Account also reports statistics on trends in cycling infrastructure, safety, cycling levels, and cyclist behavior over time. That such a bicyclist survey even exists is a sign of the City of Melbourne's greater

attention to cyclist concerns, perhaps in response to much stronger cycling advocacy in Victoria (see section 7.4). By comparison, there is no such Bicycle Account in Sydney.

Both Sydney and Melbourne, and their respective states of NSW and Victoria, are currently expanding and improving cycling infrastructure and have ambitious plans for the coming years. In 1999, the RTA set a goal of building a regional cycleway network that would comprise (including existing facilities) 420km of off-road cycleways and 214km of bike lanes in metropolitan Sydney by 2010. Figure 7 illustrates the current status of this "Sydney Metropolitan Strategic Cycle Network." It shows regional links that existed before 1999; regional links built between then and today; and uncompleted regional links, including both those outlined in 1999 and subsequently proposed projects. The regional network shown in this map is currently under review as part of work to prepare a new NSW BikePlan. Local council routes (existing or proposed) are not shown.

The City of Sydney (2007) recently adopted a Cycle Strategy and Action Plan that aims to improve cycling conditions in the central area by constructing 200 km of cycleways by 2012, including 55 km of traffic-separated cycle tracks—on-road bike lanes protected from motor vehicle traffic by physical barriers. In 2008 the City of Sydney began installing the highest-priority 35km of this network of on-road separated bike lanes. Currently, the City of Sydney is leading the Inner Sydney Regional Bike Plan project, working with 14 neighboring local government areas to develop a regional bicycle network (City of Sydney, personal communication, 2009b). Thus, there is the prospect of considerable improvement in cycling conditions in Sydney and its inner suburbs in the coming years.

As indicated in Figure 8, metropolitan Melbourne already has a denser network of cycling facilities than metropolitan Sydney, when local routes are included, especially in the center and inner suburbs. Melbourne's bikeway network has been expanding rapidly, roughly doubling in length between 2000 and 2008. The concentration of new facilities near the center is due to an explicit policy by the Victorian Department of Transport and VicRoads of giving priority to cycling infrastructure improvements within a 10km radius of the center of Melbourne (Victorian Department of Transport, 2009a). That is where roadway congestion is worst, and where a modal shift away from the car to the bicycle is most needed as well as most feasible, given the shorter trip distances, mixed land use, and higher density near the center.

Figure 7

Figure 8

7.2. Traffic calming, speed limits, and roadway cycling conditions

Local neighborhood streets with reduced speeds and low volumes of motor vehicle traffic can provide ideal cycling routes. To promote more and safer walking and cycling, most cities in the Netherlands, Denmark and Germany traffic calm their local residential streets through a variety of infrastructure measures as well as speed limits of 30km/hr (Pucher and Buehler, 2008). In addition, cities in all three countries are increasingly implementing home zones, residential streets with speed limits of 7-10km/hr, where motorists must share the full width of the roadway with pedestrians, cyclists, and playing children. The bicycle-friendly residential streets of northern Europe are a long way from the car-dominated streets of Sydney and Melbourne.

In both the Sydney and Melbourne metropolitan areas, the general speed limit on local, non-arterial roads is 50km/hr, with a reduced speed limit of 40km/hr in school zones and on selected neighborhood streets identified as having high pedestrian activity (City of Sydney, 2007; RTA, 1999; VicRoads, 2010; Garrard, 2008). There are a few isolated instances of 10km/hr shared zones on very short sections of streets. Available studies indicate that motorists regularly exceed posted speed limits on local roads in both cities (Australian Associated Motor Insurers 2009). In general, the limited traffic calming that exists in Sydney and Melbourne is concentrated in central and inner suburban neighborhoods and takes the form of speed humps, artificial dead-ends or mid-street blockages, and street narrowing in combination with posted speed reductions. There are no statistics available on kilometers of traffic-calmed or reduced-speed roads in the Sydney and Melbourne metropolitan areas. Our panel of experts did not suggest any significant differences between the two cities but several noted a somewhat higher incidence of traffic calming and reduced speeds in central city and inner suburban neighborhoods compared to the outer suburbs. In combination with shorter trip distances near the center, lower speed limits for motor vehicles and the slowing effects of traffic congestion in inner city might contribute to the higher cycling rates there.

Many of the surveyed experts indicated that roadways in Melbourne—except for the problematic tram tracks—are generally more conducive to cycling because they are wider and

less congested than roads in Sydney. Most experts also suggested that motorists in Melbourne are perceived as less aggressive in their driving vis-à-vis cyclists. The media have reported several sensational incidents of road rage motorist attacks on cyclists in Sydney (Bibby, 2009; Braithwaite, 2006; Daily Telegraph, 2009; Frew, 2008; Harvey 2008; Welch and Emerson, 2008). Although there are no scientific studies of the extent and nature of such incidents, the media reports have fueled the general impression that many motorists in Sydney are not willing to share the roadway, and that some motorists deliberately endanger cyclists. The media coverage of motorist aggression led a former NSW Roads Minister to suggest that cyclists in Sydney not ride at all during peak hours to avoid motorist road rage (Daily Telegraph, 2008).

A survey of non-regular cyclists living near the Sydney CBD showed that 75% would cycle more regularly if there were increased driver awareness of bicycle safety and sharing the road (City of Sydney, 2006). A 2005 survey of motorists throughout Australia found that road rage was more common in NSW than in any other Australian state or territory (Hensher and Greaves, 2005). But available studies find high levels of aggressive, dangerous motorist behavior toward cyclists in both Sydney and Melbourne (Bauman et al, 2008; Garrard et al, 2006). Moreover, a 2004 survey of 1,880 adult Australians indicated that 46% of women and 36% of men walked and cycled less due to hostile motorist behavior (Australian Associated Motor Insurers, 2004).

Overall, there is insufficient evidence to draw any firm conclusions on this aspect of policies affecting cycling in the two cities, although the general impression from our experts is that the roadway environment is probably safer, more convenient, and more accommodating for cyclists in Melbourne than in Sydney. At noted at the outset, however, it is much worse than in most European cities due to their restricted traffic and much lower speeds on residential streets.

7.3. Bicycle parking and integration with public transport

End of trip facilities such as bicycle parking, lockers, and showers are important for cyclists, and their availability significantly influences cycling levels (Pucher et al, 2010). The City of Melbourne (2009) and City of Sydney (2009a) both report increases in bicycle parking in recent years. Since 2007, for example, the City of Sydney has installed a thousand bicycle parking hoops on sidewalks and 400 parking rings on street light poles. That is not much different than the 1,200 bicycle hoops installed by the City of Melbourne over the same period. Neither metropolitan area has comprehensive statistics on bicycle parking spaces. About 1,400

bike lockers are available for use at 140 rail stations, bus interchanges and ferry wharves in Sydney (NSW Government, 2008)—although at a cost, unlike generally free commuter car parking spaces. There are also a presently unknown number of racks at these locations. Melbourne's Connex metropolitan train network provides 959 bike lockers, 2,781 hoops/racks, 18 secure cages (26 bicycles each) (with an additional 10 secure cages to be installed shortly) at Melbourne metropolitan train stations (Connex Melbourne, personal communication). Bicycles are allowed on rail vehicles at all times in Melbourne without extra charge, although peak hour travel is discouraged. In Sydney, however, cyclists must purchase an extra ticket (children's ticket) for their bicycles if taking them on trains during weekday peak hours. Thus, it appears that Melbourne's rail system is more amenable to bike-and-ride, at least in terms of permitting free access for bicycles on rail vehicles at all times. Buses do not come equipped with bicycle racks in either the Sydney or Melbourne metro areas. That contrasts sharply with Canada and the United States, where over three-fourths of city buses have bicycle racks (Pucher and Buehler, 2009).

In addition to public bicycle parking, both NSW and Victoria have state planning guidelines to encourage commercial buildings to offer bicycle parking, but they are only recommendations, and there is considerable variation among local governments in their actual implementation. Victorian planning provisions require new commercial buildings to provide facilities such as showers and bike racks for people cycling to work (Victorian Department of Transport, 2009a). Our experts suggested that the City of Melbourne and its inner suburbs generally have done more to encourage private provision of bicycle parking than the City of Sydney and its inner suburbs, but there is movement in both cities toward local codes that require or at least encourage bicycle parking, showers, and change facilities (City of Sydney, 2007 and 2009a; Victorian Department of Transport, 2009a). The 2008 Bicycle Account in Melbourne found that 75% of cyclists reported adequate bicycle parking at their workplace, 82% had access to showers, and 50% had access to lockers. There is no similar survey in Sydney for comparison.

Overall, there does not appear to be a significant difference in the quantity of bicycle parking in the two cities, but the statistics are too incomplete to know for sure, and they do not reflect the quality of facilities at any rate. It is noteworthy that the central cities of Toronto, Canada; Chicago, Illinois; San Francisco, California; and Minneapolis, Minnesota each have

over 15,000 public bicycle parking spaces, with roughly a thousand new bicycle racks added each year (Pucher, 2008; Pucher and Buehler, 2009; Alliance for Biking and Walking, 2010). That is about ten times as much bicycle parking as in either the City of Sydney or the City of Melbourne. In addition, Toronto has 1,800 bicycle parking spaces at subway and suburban rail stations and a new full service bicycle station located at Union Station, its main public transport hub in the CBD. Chicago has 6,420 bike parking spaces at its rail stations as well as a full service bike station at a CDB train terminal. San Francisco has 6,813 bike parking spaces at its rail stations and five full-service bike stations at train stations. Similar to hundreds of such bicycle stations in Europe and Japan, the bike stations in Toronto, Chicago, and San Francisco offer secure parking, bicycle repairs, bicycle rentals, trip planning, and other services. Neither Sydney nor Melbourne has such an advanced, full-service bicycle parking facility at any of its public transport stations, although two such bike stations have recently opened in Brisbane.

The preceding discussion suggests that cycling and public transport are complementary. Over short distances, however, they may be competitors, since cycling can be faster as well as cheaper than public transport, especially in congested central cities and inner suburbs. Several of our experts emphasized that public transport services in Sydney are generally more extensive and faster than in Melbourne (Mees 2000; Mees et al, 2007; Mees 2009). In 2006, public transport's mode share was 50% higher in Sydney than in Melbourne (21.2% vs. 13.9%). Melbourne's tram system, in particular, is often criticized for its high fares, undependable service, crowded vehicles, long wait times, and slow rides in congested traffic. For many Melburnians, cycling has become a faster and cheaper alternative to public transport, especially in the central city and inner suburbs. The better public transport services in Sydney might help explain the lower rates of cycling there.

7.4. Bicycling programs, promotion, and advocacy

Melbourne has stronger bicycling advocacy than Sydney and offers a wider range of cycling events and programs, attracting much more public participation. The key player in Melbourne is Bicycle Victoria, which has four times as many members as its counterpart in Sydney, Bicycle New South Wales (40,000 vs. 10,000) (Bauman et al, 2008). Bicycle Victoria also has more permanent staff (50 vs. 10) and mobilizes more volunteers (500 for large cycling events vs. 100). Many of the experts we interviewed felt that Bicycle Victoria has been a major

force behind pro-bicycle policies in Melbourne, more effective than Bicycle NSW at raising public awareness of cycling and lobbying for improved cycling infrastructure.

Both Bicycle Victoria and Bicycle NSW organize large group rides, some of which are conducted in cooperation with dozens of local bicycle user groups (BUGs). However, a comparison of similar rides conducted in 2007 finds that the turnout is usually larger in Melbourne: 3,700 for the Great Victorian Bicycle Ride vs. 1,000 for the NSW Big Ride; 14,000 for Portfolio Partners Ride in Melbourne vs. 11,000 for Portfolio Partners Ride in Sydney (Bauman et al, 2008). The biggest difference, however, is in bicycle commuting events. Ride-to-Work Day in Victoria attracted 60,000 participants in October 2008 compared to only 10,000 in New South Wales (Bauman et al, 2008). These differences reflect greater cycling participation in Melbourne in general, as well as a larger and more experienced cycling advocacy organization in Victoria (Bicycle Victoria). Ride-to-Work Day has been conducted in Victoria (including Melbourne) since 1993, and has recently expanded nationally. New South Wales (including Sydney) commenced the program two years ago, based on Bicycle Victoria's Ride-to-Work Day model and using Bicycle Victoria's on-line registration system.

TravelSmart is an individualized marketing program that informs individual households, workplaces and schools/universities about site-specific ways to bicycle, walk, take public transport and carpool instead of driving alone. While the Sydney metropolitan area only has two participating communities (the outer suburbs of Woy Woy and Ermington, which were in fact only pilot schemes), there have been 23 TravelSmart projects across Victoria, mostly in the Melbourne metropolitan area. They have led to sustainable travel plans in over 80 schools and 35 workplaces and reached over 400,000 Victorians. Since cycling is one of the transport modes promoted by TravelSmart, this is yet another program area that has encouraged cycling in Melbourne more than in Sydney (Bauman et al, 2008; TravelSmart Australia, 2009 summaries).

Both Victoria and NSW have bicycling education and Ride to School programs for children, but they are far more extensive in Victoria. In 2006, for example, 30% of Victorian primary school offered cycling training courses, sometimes combined with TravelSmart programs, Ride to School days and Bicycling School Buses. Less than 10% of schools in NSW offer similar bicycle education programs (Bauman et al, 2008).

7.5. Overall policy summary

Melbourne comes out ahead of Sydney on most of the categories of transport policy examined above. Quantifiable measures generally suggest a more cycling friendly environment in Melbourne than in Sydney, and cycling experts we interviewed in the two cities suggested that most relevant policies were more favorable to cycling in Melbourne. The actual extent of the differences between the two cities is not clear, since much of the data were incomplete or incomparable. Nevertheless, the bottom line is that bicycling infrastructure provision, programs and related policies have contributed to the higher and faster growing cycling rates in Melbourne.

8. Conclusions and policy recommendations

Cycling levels in Melbourne are roughly twice as high as in Sydney and have been growing three times as fast in recent years. There is large variation within each metropolitan area, however, with much higher rates of cycling in the central city and inner suburbs than in the outer suburbs. Cycling in Sydney is mainly for recreation on the weekends, while cycling in Melbourne tends to be for a wider range of purposes, including weekday trips to work or school. Women account for a low percentage of bicycle trips in both cities, but cycling is somewhat less male dominated in Melbourne than in Sydney (75% vs. 83% of bicycle trips to work by men).

The lack of an extensive, disaggregate database precludes any sort of advanced multivariate analysis of cycling determinants in the two cities. Nevertheless, almost all the underlying environmental and structural factors we examined favor cycling in Melbourne over Sydney: flatter and more contiguous topography, less rainfall, wider roads with less traffic, and greater connectivity of the road network. Melbourne's CBD, in particular, is far more accessible by bicycle from residential neighborhoods in the central city and inner suburbs. Sydney's CBD has far fewer access routes, and bicycle trips can be circuitous and arduous due to the extensive harbour and hilly terrain. In addition, Melbourne's roads are generally wider than in Sydney and thus more amenable to cycling. In both cities, however, cycling provision in outer suburban areas generally remains poor, and presents a challenge in terms of achieving the more uniformly distributed increases in cycling required to substantially raise bicycle mode shares for the greater metropolitan areas of both cities.

It is difficult to measure differences in policy, since quantitative measures do not exist or are incomparable between the two cities. The bulk of evidence, however, suggests more favorable policies toward cycling in Melbourne than in Sydney. In particular, Melbourne has more and better integrated cycling infrastructure, which has been strategically focused on the commuting routes into the CBD. By comparison, many of Sydney's cycling facilities have been ad hoc, uncoordinated, and often located along motorways in the suburbs with limited usefulness for daily commuting. In addition to better infrastructure provision, Melbourne also benefits from much more extensive cycling programs, advocacy, and promotional events. Finally, Melbourne benefits from safer cycling than in Sydney, which suffers from a lack of traffic-separated cycling facilities and more aggressive motorist behavior toward cyclists on the road (City of Sydney, 2006).

Looking forward, both central cities and a few of their inner suburbs are headed in the right direction, with planned expansion and improvement of their bikeway networks. The City of Sydney, for example, is currently investing $76 million over four years to expand its cycling infrastructure, including 55km of cycle tracks, which provide more separation of cyclists from motor vehicles. That is especially important in the Sydney metropolitan area, where there are serious concerns about conflicts between cyclists and motor vehicles (City of Sydney, 2007). In both Melbourne and Sydney, more traffic separation would increase the safety and comfort of cycling, which are crucial to encouraging more women, children, and seniors to cycle.

Of course, bicycling facilities cost money. As part of its overall strategy to reduce Greenhouse Gas emissions, improve population health, reduce traffic congestion and improve livability, Australia's federal government should help finance cycling infrastructure with a large, long-term funding commitment. As in the USA, however, that federal funding should be stipulated on careful coordination of routes, facility design, and signage among the many different local governments within each metropolitan area. The current fragmentation of cycling infrastructure and programs is a major deterrent to progress in improving cycling conditions on a regionwide basis.

Another obvious area for improvement is the integration of cycling with public transport. Many studies throughout Europe and North America find that bike-and-ride is an economical and environmentally sustainable way to expand the catchment area of rail stations (Martens, 2007; Pucher and Buehler, 2008; Pucher and Buehler, 2009; TRB, 2005). Yet there is a lack of

modern, secure parking facilities at public transport stations in metropolitan Sydney and Melbourne, and there are almost no provisions for dedicated bicycle storage on rail vehicles. Moreover, the total lack of bicycle racks on buses is puzzling given that over three-fourths of all buses in Canada and the USA have such racks. In short, bike-and-ride has been greatly neglected in both the Sydney and Melbourne metropolitan areas.

Bicycle parking, in general, could be greatly improved. Cyclists obviously need somewhere to park their bicycles when they reach their destination. The supply of bicycle parking is insufficient in both Sydney and Melbourne. Equally important, there is almost no secure, sheltered bicycle parking, let alone full-service bicycle stations, such as those in most northern European cities as well as an increasing number of North American cities. Melbourne and Sydney lag far behind the rest of the developed world in this respect.

Perhaps the most important deterrent to cycling is the excessive speed permitted on Australian roads. Australia has among the highest speed zones for most road types in the industrialized world (Fildes et al., 2005). If all residential neighborhoods in Sydney and Melbourne were traffic calmed to 30km/hr, as in northern Europe, cycling would become much safer and more pleasant than it is now, and it would greatly enhance the overall bicycle route network. In combination with a coordinated policy of lower speeds, there must be much stricter enforcement of the legal right of cyclists to ride on roads, and increased penalties for motorists injuring or endangering cyclists.

As shown by a recent international review, substantial increases in bicycling require an integrated package of many different, complementary interventions, including infrastructure provision and pro-bicycle programs, as well as supportive land use planning and restrictions on car use (Pucher et al, 2010). Clearly, both Sydney and Melbourne lag far behind European cities and have a long way to go on virtually every dimension of the necessary policy package before cycling can attain truly significant levels.

In terms of policy ‘carrots’, bicycling infrastructure in Western Europe is much more extensive and much better integrated than in Australia, similar to the situation in the USA and Canada (Pucher and Buehler, 2006 and 2008). Cycling facilities in Europe are also much better integrated with public transport. In addition, cycling education is either inadequate or completely lacking in most Australian cities. In Germany, the Netherlands, and Denmark all school children benefit from mandatory training in safe cycling by the third or fourth grade.

Indeed, they must pass a police-administered test to show that they can cycle safely, since most children cycle or walk to school. A few Australian states have supported cycling and walking safety programs in their schools, but none have made it mandatory, and the programs are not nearly as intensive as in Europe.

The policy 'sticks' used extensively in Europe to curb car use are almost entirely lacking in Australia (just as in the USA and Canada) (Pucher and Buehler, 2006 and 2008). For example, petrol prices in Western Europe are about twice as high as in Australia, with the price differential almost entirely due to taxation. Motor vehicle taxes and registration fees are also much higher in Europe than in Australia. Driver licensing is both more stringent and more expensive in Europe. Moreover, European cities have far less car parking—and more expensive car parking—than Australian cities. In sharp contrast to Australia, many European cities have comprehensively traffic-calmed residential neighborhoods and have made large parts of their city centers entirely car-free. Europe has much stricter land use policies, leading to higher urban densities and more mixed-use development than Australia. The result is average trip distances that are shorter and more bikeable in Europe than in Australia.

Such land-use and transport polices are crucial for explaining the very different levels of cycling in Australia and Western Europe. Similar to the USA and Canada, the biggest obstacle to increasing cycling in Australia is the political reluctance to using any of the really effective policy 'sticks' that deter car use in Europe (Pucher and Buehler, 2006 and 2008). For example, it seems unlikely that politicians anywhere in Australia would be willing to raise petrol taxes to European levels. Similarly, car-free city centers and comprehensive traffic calming of all residential neighborhoods do not have enough public or political support for widespread implementation in Australian cities. Perhaps most ominous, low-density, car-dependent suburban sprawl continues to spread out around every Australian city, just as in the USA and Canada. Central cities in Melbourne, Sydney, and elsewhere in Australia have succeeded at raising cycling levels somewhat, but their suburban counterparts have done little, and longer trip distances on the suburban fringe make cycling less practical, except for local recreational trips.

Although the bike share of work trips in Melbourne is twice as high as in Sydney (1.3% vs. 0.7%), it is still a very small share indeed. Cycling remains a marginal mode of travel in both cities. In recent years, Melbourne and Sydney have begun implementing more bike paths and lanes, better bike parking, cycling education and promotional programs. The actual extent of

such measures, however, remains insignificant compared to massive investments in roadway infrastructure over the same period. Indeed, most transport, housing, and land use policies in Australia promote more car use and car-dependent sprawl. After a decade of modest 'carrot' policies to encourage bicycling, the bike share of travel remains extremely low. Given political constraints that prevent adoption of car-restrictive policy 'sticks', it seems likely that cycling will remain a marginal mode in Australia, just as it is in other car-dependent countries such as the USA and Canada, limited mostly to recreational activities and not for practical transport.

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Table 1: Bicycle ownership and use in Australia's major cities (2004)

	Bicycles/Person	**Rank**	**% who cycle every day**	**Rank**
Sydney	0.29	7	1.0%	6
Melbourne	0.37	6	2.1%	4
Brisbane	0.45	4	3.0%	3
Perth	0.59	3	4.0%	1
Adelaide	0.42	5	1.7%	5
Hobart	0.61	2	Not Provided	----
Canberra	0.65	1	3.1%	2

Source: Australian Bicycle Council (2004)

Table 2: Bicycle trip purpose comparison in 1999 (average day)

	Melbourne	**Sydney**
Commuting	24%	19%
Social/recreation	27%	53%
Education	15%	8%
Shopping	10%	9%
Drop-off	5%	1%
Other	18%	10%

Note: The surveys are conducted every day of the year – the 'average day' is the average of travel conducted over all 365 days (weekdays, weekends, holidays)
Source: Melbourne (VicRoads, 2004), Sydney (RTA, 2003)

Table 3: Selected characteristics of Sydney and Melbourne (2006)

	Sydney Statistical Division	**Melbourne Statistical Division**
Population	4,119,190	3,592,590
Total land area (population density)	12,145 km^2 (339 persons/ km^2)	7,700 km^2 (467 persons/ km^2)
Urbanized Area (population density)	1,687 km^2 (2,040 persons/ km^2)	1,705 km^2 (1,570 persons/ km^2)
% Males	49.3%	49.0%
Average Household Size	2.7	2.6
Cars/capita	0.515	0.594
Median per capita income	$29,936	$25,012
Median Household Income	$60,008	$56,108
Median Age	35	36

Source: Australian Bureau of Statistics (2009a)

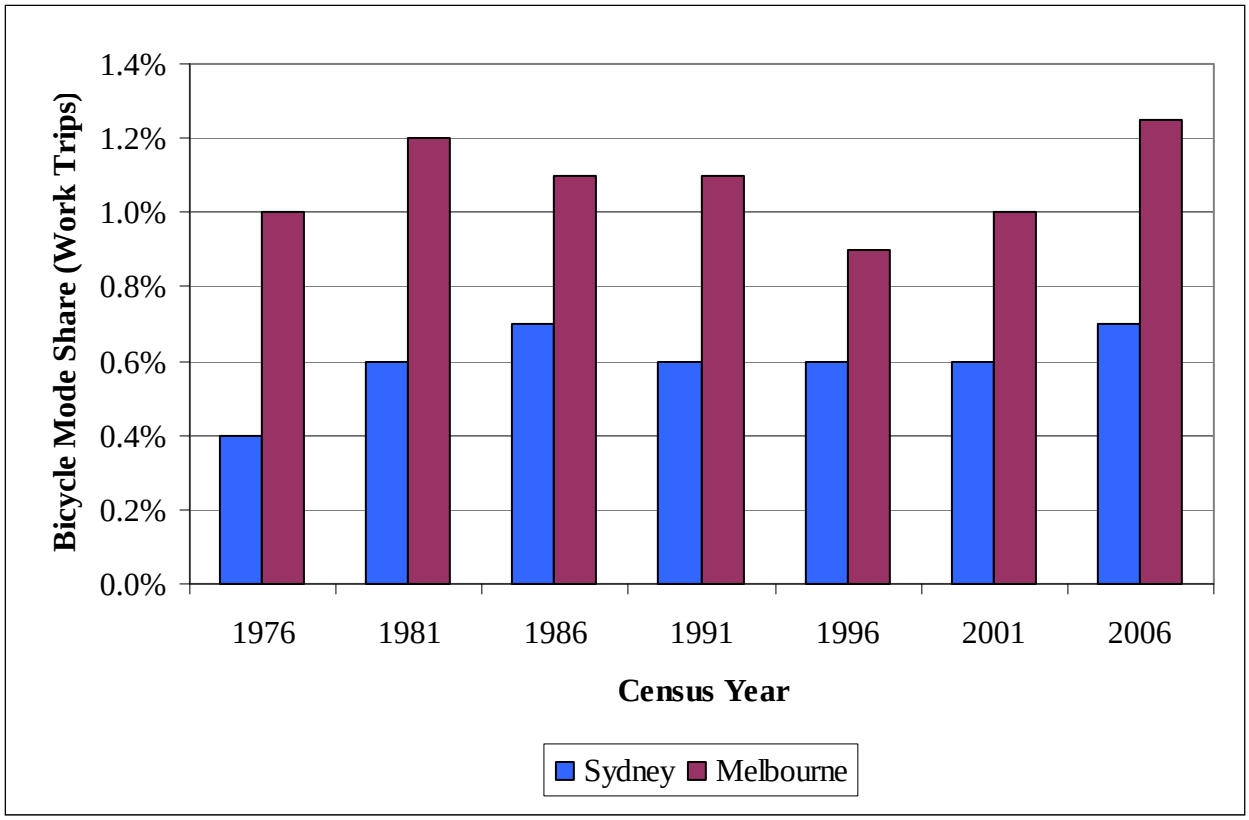


Figure 1: Bicycle mode share for work trips in Sydney and Melbourne metropolitan areas, 1976-2006
Source: Adapted from Mees et al. (2007)

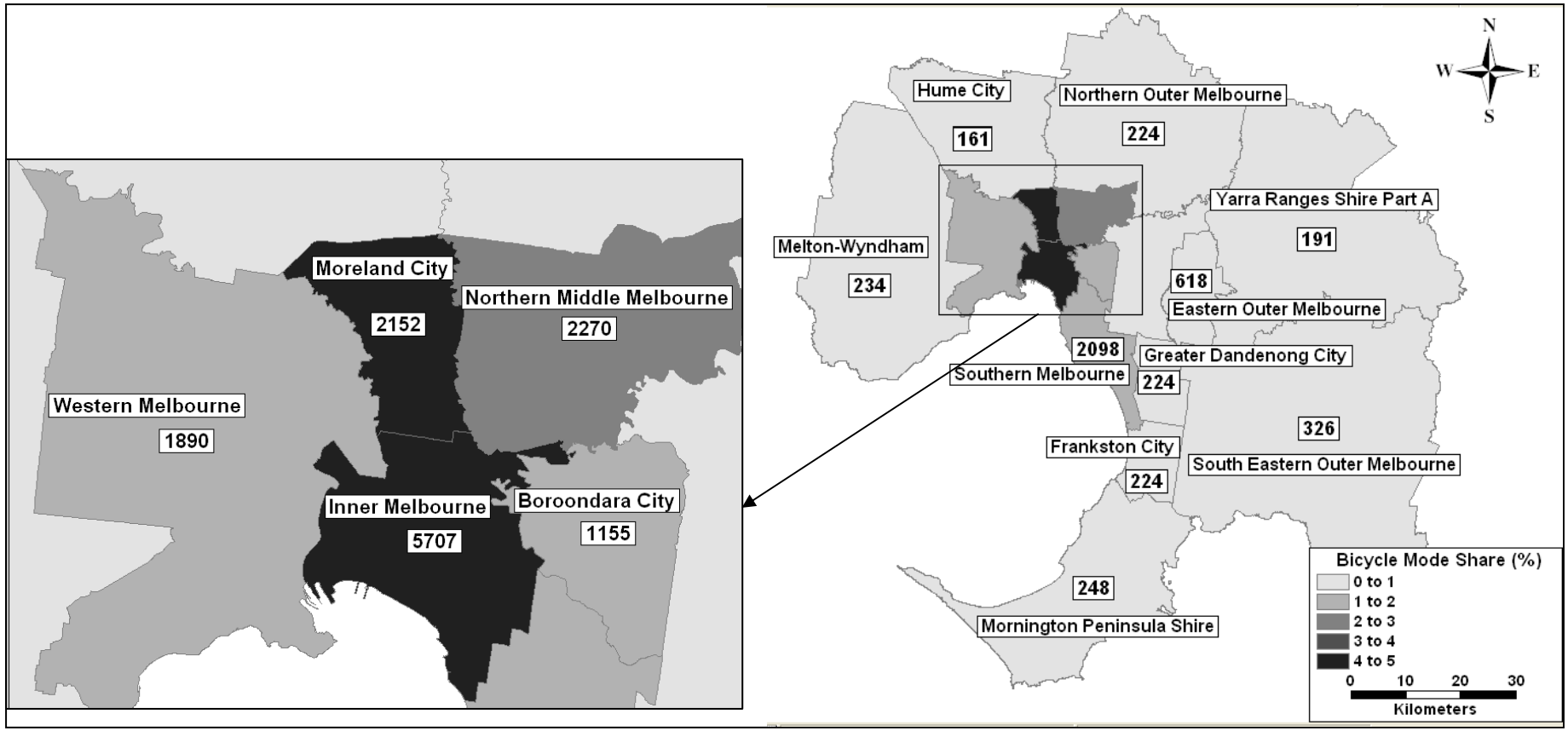
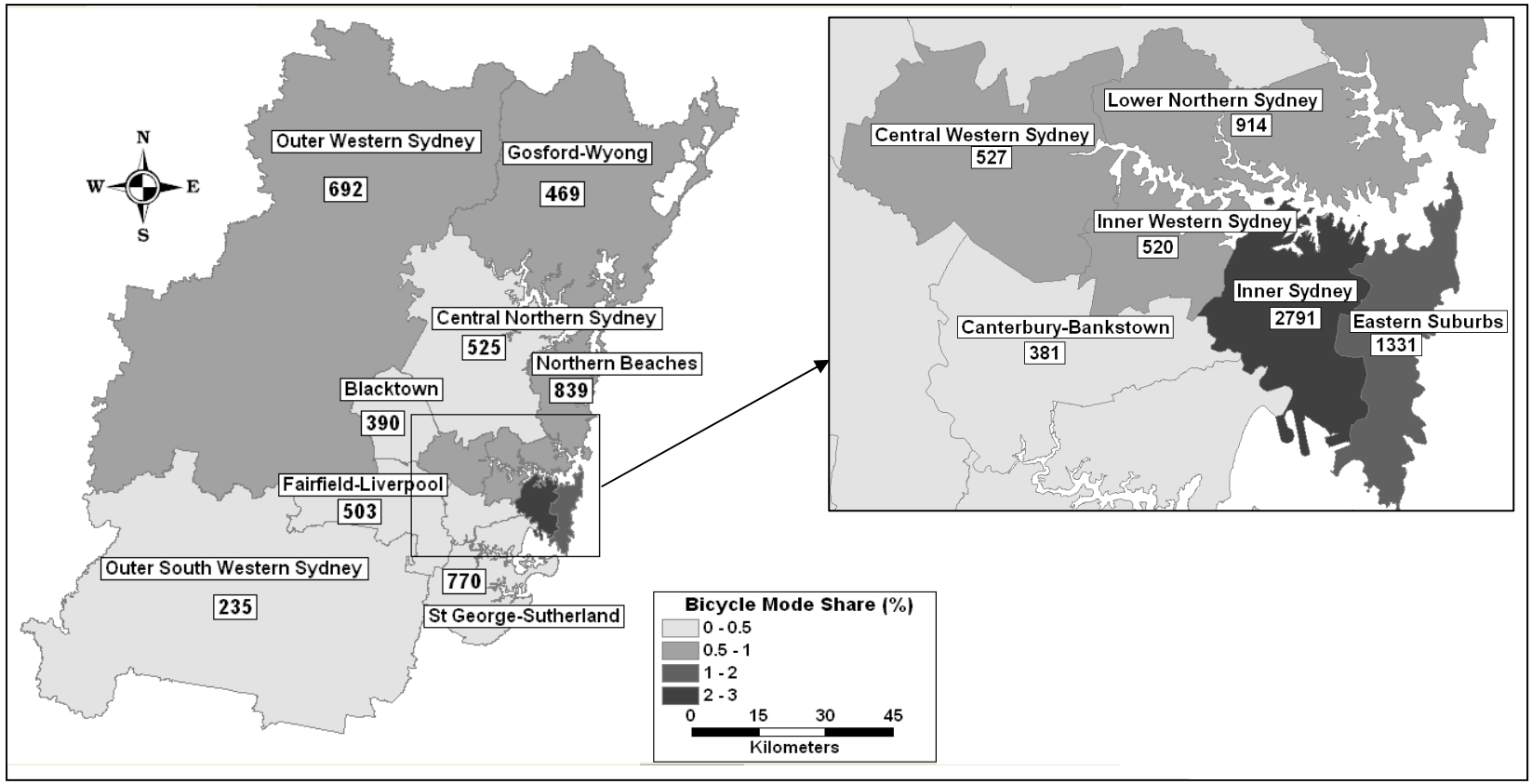


Figure 2: Bicycle-only mode shares for trips to work in Melbourne in 2006

Note: Numbers on map indicate total weekday bicycle trips to work that start at places of residence in each district.
Source: Developed by the authors using data from the Australian Bureau of Statistics (ABS) 2006 Census of Population and Housing – Method of Travel to Work (ABS, 2009b)



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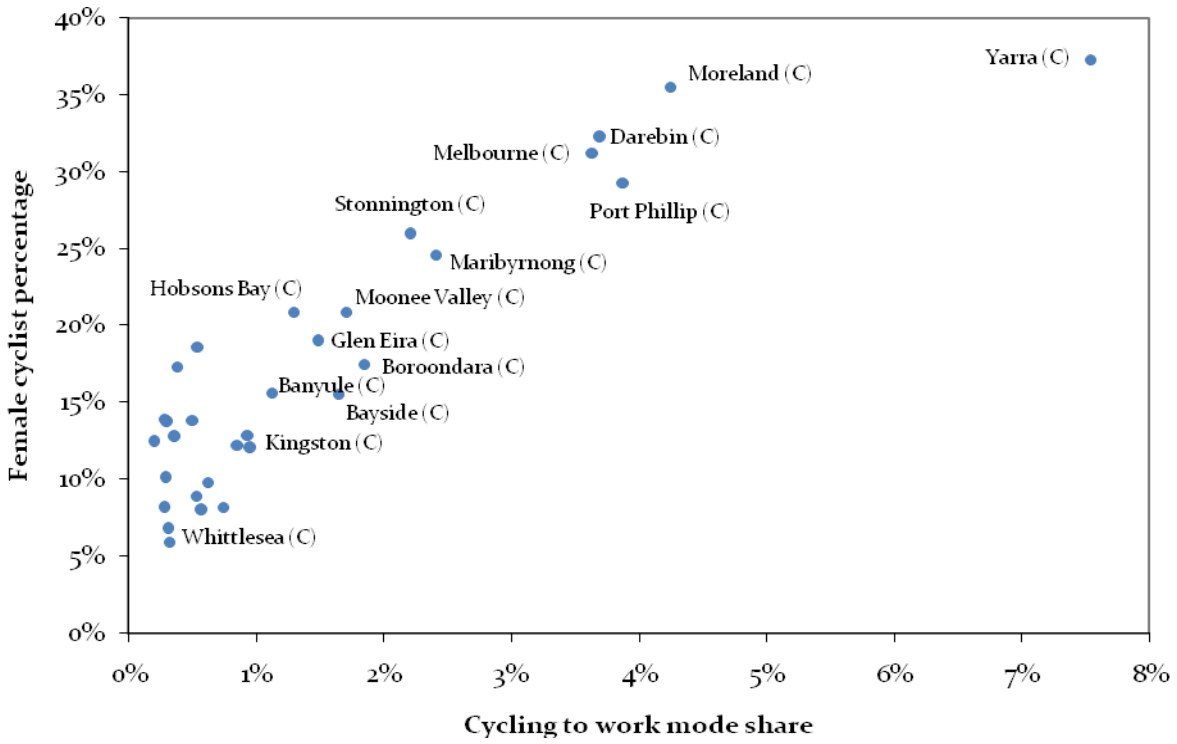

Figure 4: Relationship between bicycle mode share and proportion of bicycle trips by females, Melbourne Metropolitan Area, 2006
Source: Analysis of Australian Bureau of Statistics 2006 Census conducted for VicRoads by Cameron Munro, Sinclair Knight Merz Pty Ltd.

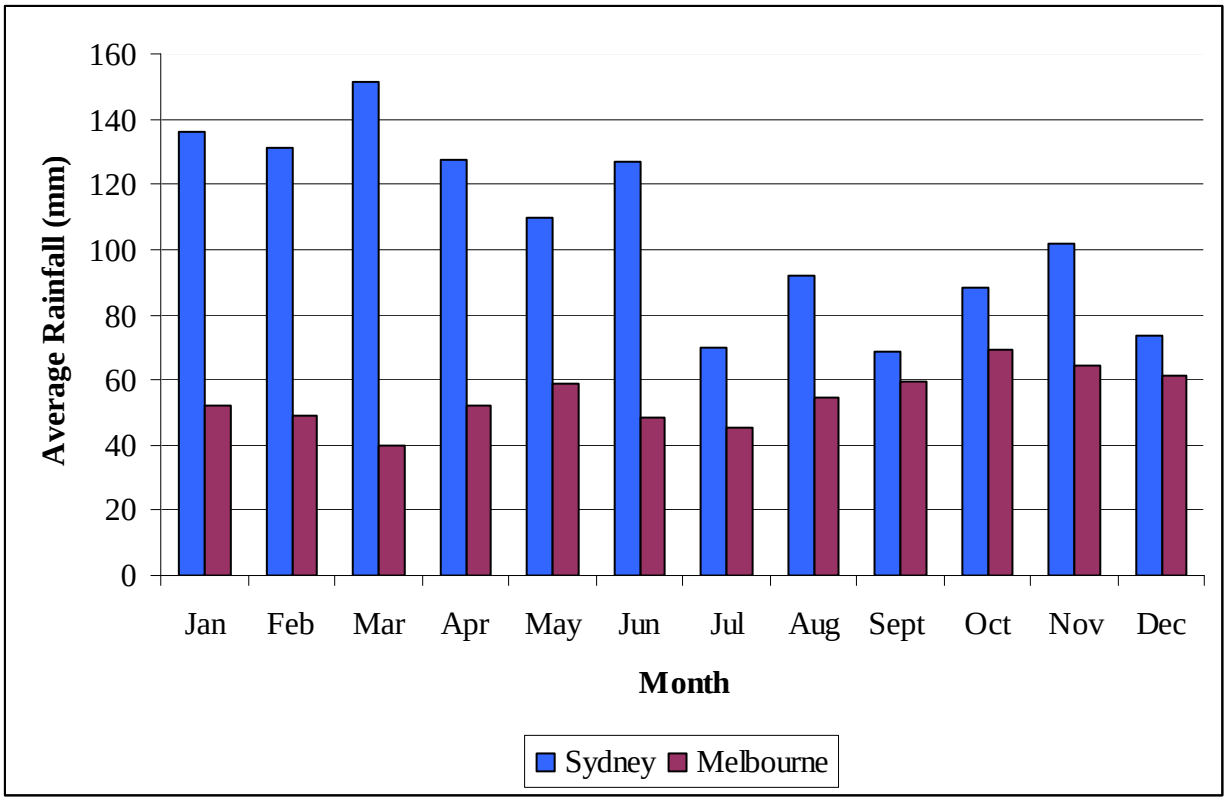

Figure 5: Monthly average rainfall in Sydney in Melbourne

Source: Developed by the authors using data from the Australian Government Bureau of Meteorology. Accessible at http://www.bom.gov.au/climate/averages/

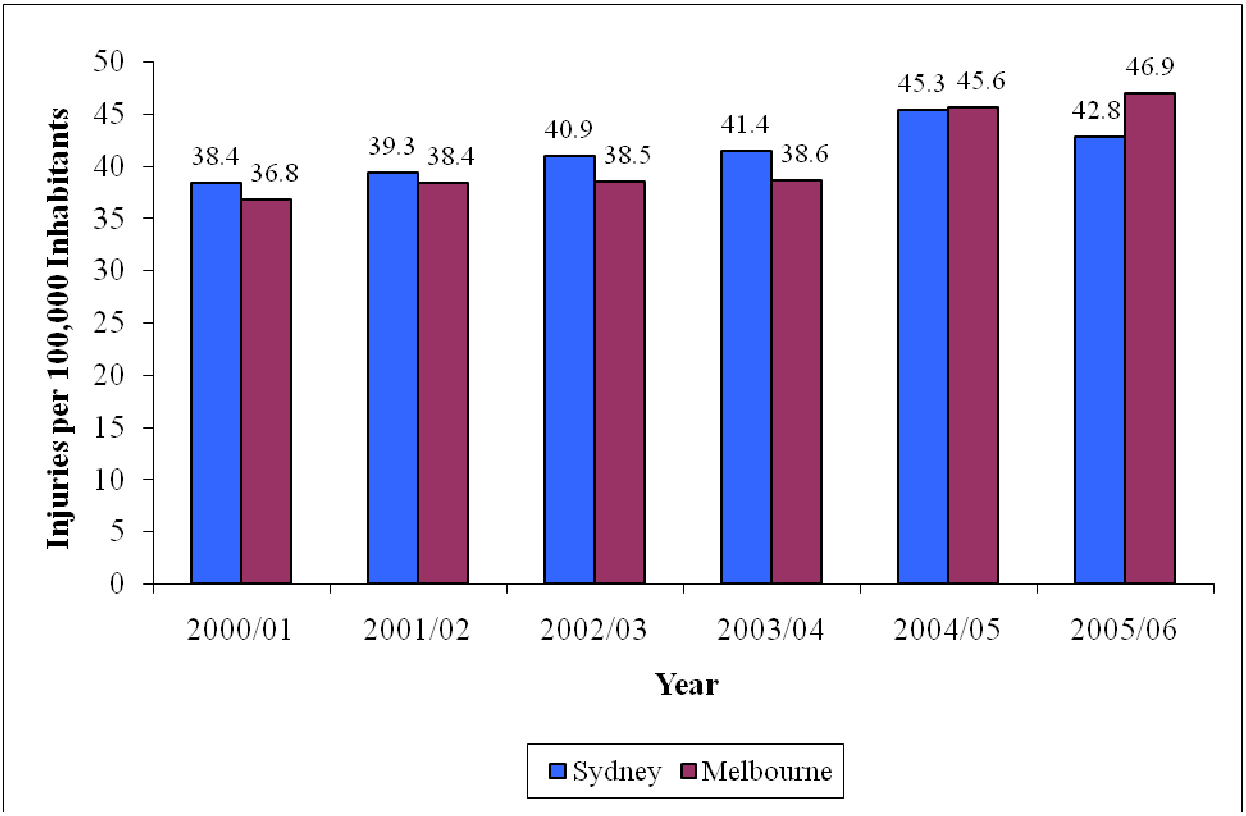

Figure 6: Serious cyclist injuries in Melbourne and Sydney, 2000-2006 (per 100,000 persons)

Sources: Calculated by the authors on the basis of data obtained from the NSW Admitted Patients Data Collection (with access to NSW hospitalisation data provided by the Centre for Epidemiology and Research at the NSW Health Department); and the Victorian Admitted Episodes Dataset (data provided by the Victorian Injury Surveillance Unit, Monash University Accident Research Centre, Monash University).

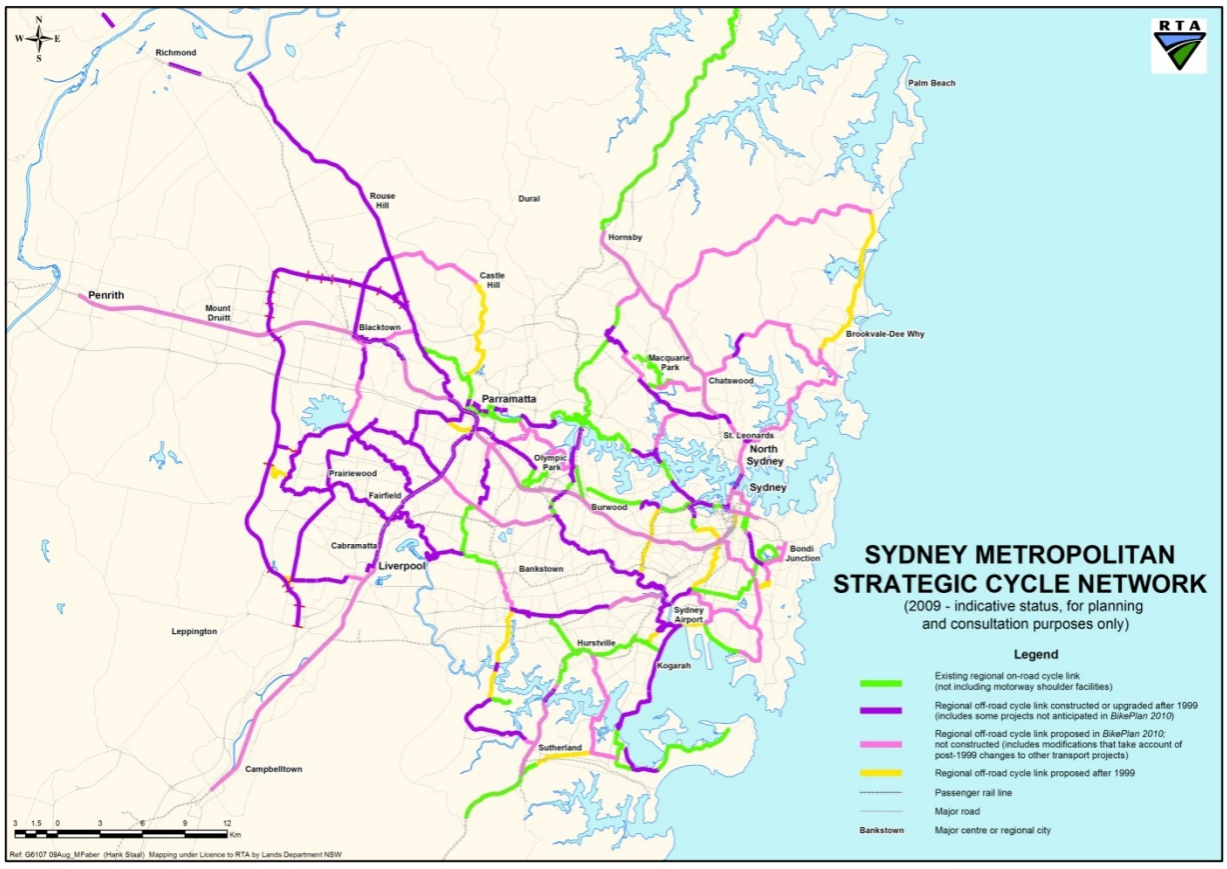

Figure 7: Indicative status in 2009 of Sydney Metropolitan Strategic Cycle Network (regional routes only; local routes not shown)

Source: RTA (2009)

Note: Green lines indicate regional bike routes existing in 1999; purple lines indicate new regional routes constructed or upgraded since 1999; pink and yellow lines indicate uncompleted sections whose priority is under review.

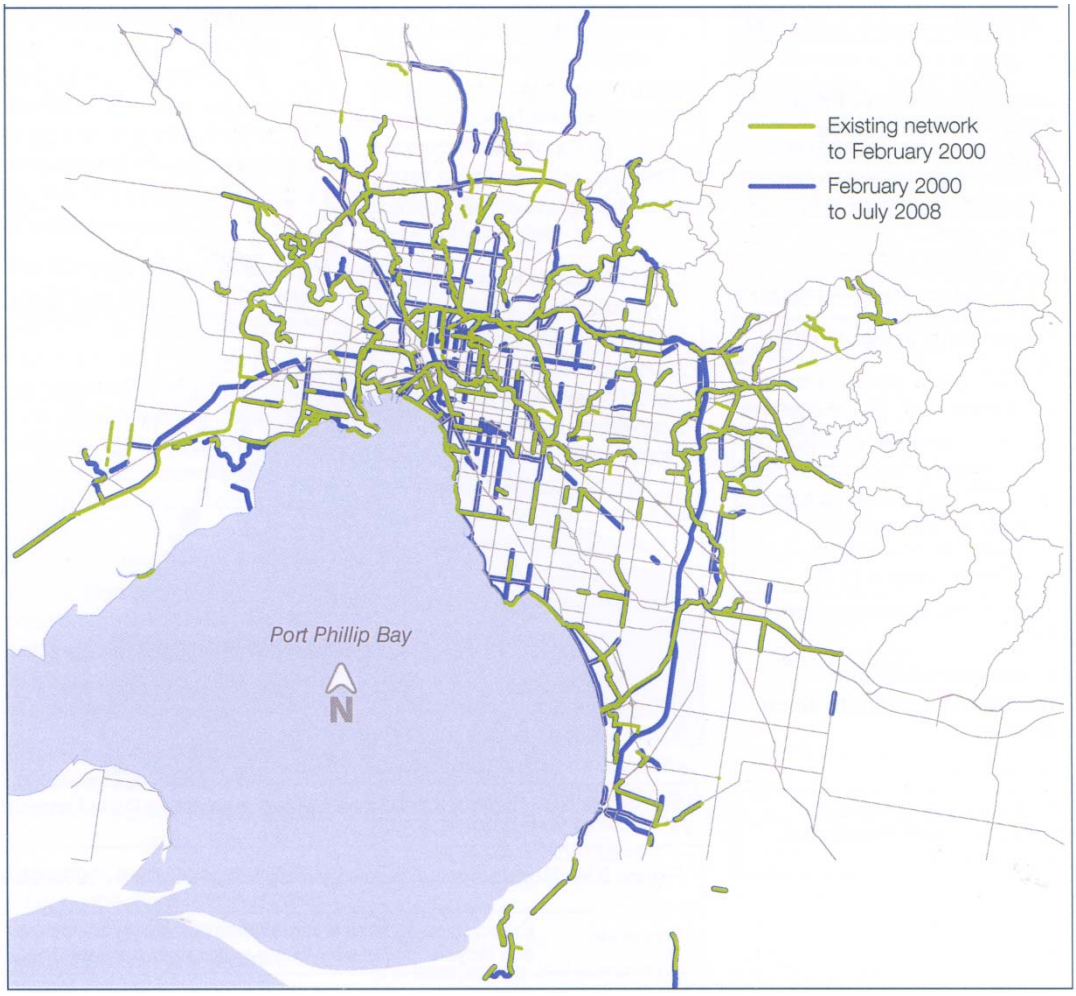

Figure 8. VicRoads bicycleway network expansion between 2000 and 2008

Source: State of Victoria 2009

Note: Green lines indicate existing bicycle routes in 2000; blue lines indicate new routes constructed from 2000 to 2008