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Understanding international road safety disparities: Why is Australia so much safer than the United States?

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ABSTRACT

Despite similarities to the US in terms of transportation, land use, and culture, Australia kills 5.3 people per 100,000 population on the roads each year, as compared to the US rate of 12.4. Similar trends hold when accounting for distance driven and the number of registered cars. This paper seeks to understand what is behind the road safety disparities between these two countries.

The results suggest that a number of inter-related factors seem to play a role in the better road safety outcomes of Australia as compared to the US. This includes Australia's strategies related to seat belt usage and impaired driving as well as their efforts to help curb vehicle speeds and reduce exposure. Design-related differences include a much greater reliance on roundabouts and narrower street cross-sections as well as guidelines that encourage self-enforcing roads. Policy-related differences include stronger and more extensive enforcement programs, restrictive licensing programs, and higher driving costs.

Combined with a more urban population and multimodal infrastructure, Australia tends to discourage driving mileage and exposure while encouraging safer modes of transportation such as transit, at least more so than in most of the US. Australia also enacted their version of Vision Zero – called the Safe System Approach – more than a decade before similar policies began cropping up in US cities. While it is difficult to attribute recent road safety successes to any specific policy, Australia continues to expand their lead on the US in terms of safety outcomes and is a road safety example worthy of consideration.

1. Introduction

Road crashes take the lives of more than 1.2 M people worldwide each year and purge more productive years of life than any other disease, including cancer and heart disease combined. Road safety engineers look to the safest motorized countries in the world – such as the Netherlands – but often make the argument that culturally, their approaches would never work in countries such as the US. While many of the Dutch approaches to transportation may work well in the US, we rarely get the chance to find out. This paper focuses on critically analyzing the transportation system of a country that is much safer than the US but also more similar in terms of transportation, land use, and culture than most European countries. Australia – with 5.3 road fatalities per 100,000 population as compared to the US rate of 12.4 – stands out as an ideal candidate.

In 1970, Australia's road fatality rate greatly exceeded that of the US, as shown in Fig. 1. By 1980, the two countries were dead even. Since then, Australia has seen remarkable safety gains, far exceeding those of the US. Having adopted their version of Vision Zero in 2003 – and cut their road fatality rate by more than one-third since then – there seems to be much the US can learn from Australia. This paper seeks to figure out what those lessons might be. After a brief background section comparing the various historical road fatality rates back to 1925, I systematically analyze reasons why Australia might be safer and attempt to use data to substantiate or refute each supposition. This includes engineering, enforcement, education, and exposure. More specifically, this comparison includes differences in: vehicles with respect to issues such as seat belt legislation; roadway designs in terms of built environment, intersection, and street designs; and road users in terms of differences in travel behaviors, licensure, enforcement, and impaired driving. The discussion section then considers differences regarding the overarching road safety policies between Australia and the United States as well as some of the structural differences in governance in order to determine where Australia is finding their road safety gains.

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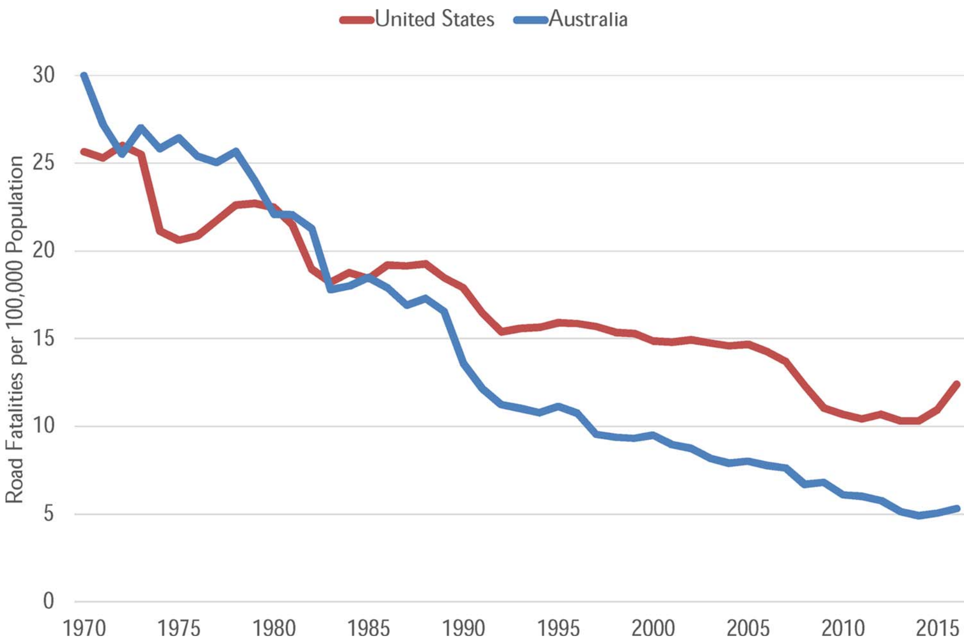

Fig. 1. Road Fatalities per 100,000 Population: US vs. Australia (1970–2016).

2. Background

2.1. Viability of Australia as a comparison to the US

Before trying to assess Australia's current road safety successes, it seems worthwhile to further gauge its viability as a comparison to the US. The US and Australia share a common heritage in terms of being relatively young countries that were both colonized by the British. Both are now democratic societies with a federal system of government and somewhat similar divisions of power divvied to the state level (Williams and Haworth, 2007). English is the primary language in both the US and Australia even though both countries grew via historically high levels of immigration.

Some of the more prominent work on international road safety comparisons originated in Europe and focused on the SUN countries (i.e. Sweden, the United Kingdom, and the Netherlands) (Koornstra et al., 2002; Luoma and Sivak, 2014). Such papers pointed out the appropriateness of the SUN countries as comparisons to the US on the basis of similarities in economic situations and demographics (Luoma and Sivak, 2014). To assist with this overview, Table 1 compares Australia to the US and the SUN countries (IndexMundi, 2017). GDP per capita for the SUN countries, for instance, ranges from between 69% and 89% of that in the US; Australia has a GDP per capita that is just over that of the US. The Australian populations are also more similar to the US in terms of median age, the percent of the population that is elderly, and the percent of the population between the ages of 15 and 24. These latter percentages related to older and younger populations are particularly important when it comes to road safety outcomes. Both the US and Australia also have the same percentages of couples with children and relatively similar rates of adult obesity. In terms of total area, Australia is also much closer to the US than any of the SUN counterparts. While the US population is larger, thus resulting in a much higher population density than Australia, the UK and the Netherlands have population densities that dwarf both the US and Australia. Since it is important to also recognize that population density is potentially endogenous to road safety outcomes, Section 3.2.1 on the built environment delves deeper into population density differences between the US and Australia. The same can be said regrading levels of motorization even though the US and Australia have been cited as being "sufficiently similar on these dimensions to allow reasonably valid comparisons" (Williams and Haworth, 2007). While Section 3.3.1 considers the impact of motorization in terms of travel behavior and exposure on road safety outcomes, this next section compares safety outcomes while controlling for these potential differences.

2.2. Historical comparison of US/Australia road safety outcomes via exposure metrics that control for the level of motorization

Fig. 2 depicts Australia's road fatality rate per 100,000 population against US outcomes back to 1925. In this figure, we see that the US was generally more dangerous between 1925 and 1950, followed by Australia becoming more dangerous until 1980, and then both countries experienced remarkable safety improvements – to what might be considered historic levels of road safety during the automobile era – over the last few decades. The difference is that the road safety improvements in Australia were an order of magnitude better. If the US had the same population-based fatality rate as Australia, 23,000 lives would have been saved in just 2016 alone and over 294,000 lives in total since 2000.

Table 1
Comparison of US to Australia and SUN Countries.

Country	GDP (per capita)	Age (median)	Percent Elderly	Percent Age 15–24	Percent of Couples with Children	Percent Obesity	Total Area	Pop. Density (people per mi^2)
United States	$57,771	37.9	12.4%	13.5%	28.0%	33.0%	36,77,647 mi^2(95,25,067 km^2)	87.4
Australia	$58,961	38.6	12.9%	13.0%	28.0%	26.8%	29,69,906 mi^2(76,92,024 km^2)	7.2
Sweden	$51,549	41.2	17.3%	11.6%	31.0%	12.0%	1,73,732 mi^2(4,49,964 km^2)	57.1
UK	$40,055	40.5	16.0%	12.2%	52.0%	26.9%	94,058 mi^2(2,43,610 km^2)	697.9
Netherlands	$45,275	42.5	14.0%	12.1%	56.0%	18.8%	16,033 mi^2(41,526 km^2)	1,062.3

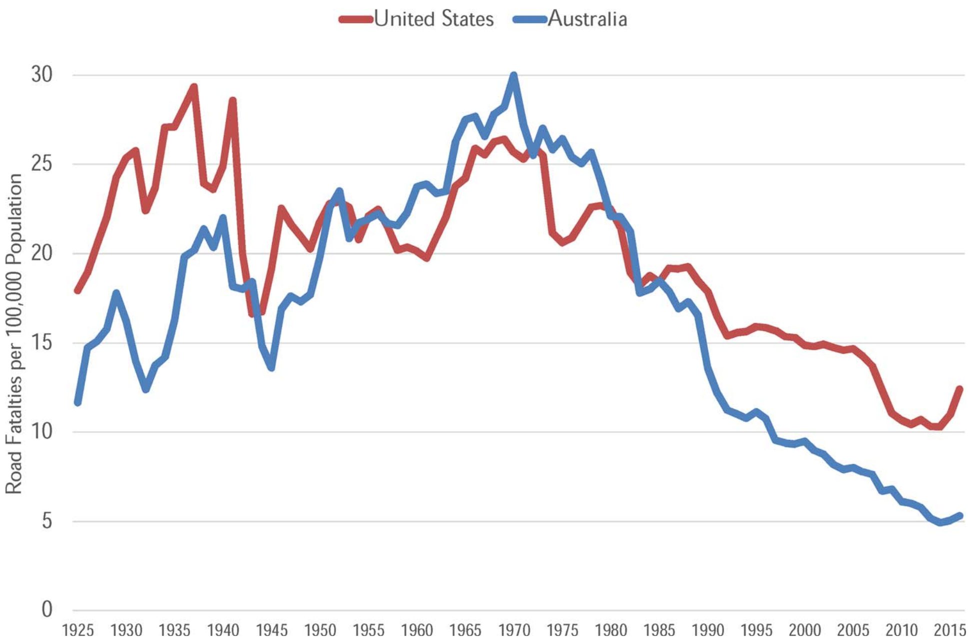

Fig. 2. Road Fatalities per 100,000 Population: US vs. Australia (1925–2016).

While population-based road safety metrics are often considered a good means of measuring the public health impact of road safety, they do not account for differences in the level of motorization between these two countries (Marshall and Ferenchak, 2017). For instance in Fig. 2, the differences found in the first half of the 20th century might be explained by the US having widely adopted cars earlier. Thus, Fig. 3a looks at the same time period using the number of vehicles in each country as the exposure metric instead of population. This graph suggests that Australia was actually the more dangerous country from 1925 through 1990. Fig. 3b more closely details the same graph since 1990, and akin to what we see with the population-based exposure metric, the US now seems to be more than twice as dangerous as Australia on a per vehicle basis. Given the most recent data, the US kills 1.33 people for every 10,000 vehicles while Australia kills approximately 0.47 people for every 10,000 vehicles. Australia's vehicle-based road fatality rate would have saved over 22,728 lives in 2015 alone and over 246,000 since 2000.

After controlling for the number of vehicles, it makes sense to ask how much are these vehicles being driven. In other words, Australians may be driving much less than their American counterparts, which may, in turn, be reducing their overall risk and the number of road fatalities. The Australian data for driving distances was a bit more limited, only going back to 1975, so Fig. 4a illustrates the number of road fatalities per 100 million miles (161 M km) driven for the years 1975 through 2016. Here, we see Australia as the more dangerous country until around the year 2000. Fig. 4b highlights this more recent time period where we see Australia gradually becoming increasingly safer than the US. The most recent data sees 1.27 road fatalities in the US every 100 million miles (161 M km) driven as compared to 0.83 road fatalities every 100 million miles (161 M km) driven in Australia. This difference is not quite on the order of the population-based and vehicle-based rates but is still striking. For instance, if the US had the same mileage-based road fatality rate as Australia, we would expect 13,805 fewer fatalities in 2016 and over 97,000 since 2000.

Whatever the underlying exposure metric used, the consistent trend is that the surface transportation system in Australia is safer than in the United States. The question is: why? The next section attempts to answer this question by aggregating data from a variety of sources to see if the plausible reasons for these differences in road safety outcomes hold true.

3. Why is Australia safer than the USA?

When trying to answer such a broad road safety question, it is sometimes difficult to know where to start; thus, it seemed appropriate to seek out a relevant conceptual framework to help guide this effort. Fig. 5 depicts the Safe Road Transport System model, originally developed by the Swedish Transport Agency and now used more broadly, including by the Organisation for Economic Co-operation and Development (ITF, 2016). The main premise behind this conceptual model is that human body has physiological limits, and when crashes push the body beyond those limits, severe injuries and fatalities result. While safe speeds represent the primary pathway towards a safer system, the models breaks that down into three key elements: i) safe vehicles; ii) safe roads; and iii) safe road users. The next part of the paper covers safe vehicles, and historically, the issue of seat belts set forth the modern era of vehicle and road safety, so it seemed like a good place to begin. Section 3.2 then covers safe roads by analyzing differences in the built environment, intersection designs, and street designs. Lastly, the focus shifts to safe road users by comparing differences in travel behavior and exposure, licensing, enforcement, and impaired driving.

3.1. Safe vehicles

3.1.1. Vehicle occupant protection

Seat belts were required to be installed in new cars as of 1968 and 1969 in the US and Australia, respectively (Anon, 2015). In 1974, Victoria, Australia required the retrofitting of car models from 1964 through 1968, in which seat belt anchorages had previously been required (Milne, 1985). During this same time period, the National Highway Traffic Safety Administration in the US passed a law mandating seat belt ignition locks, which prevents an unbelted driver from starting the car, on all new cars starting in 1974 (Krafft et al., 2006). Public outcry compelled Congress to ban this requirement before the year was over.

In terms of potential occupant protection differences (such as air bags) between overall vehicle fleets of these countries, the data suggests that the overall fleets are similar in age. The average age of a registered vehicle in the US is 11.5 years compared to 10.1 years in Australia (Australian Bureau of Statistics, 2016; Naughton, 2015). Given similar vehicle safety standards between these countries, there are unlikely to be systematic differences on this front. However, there are likely to be

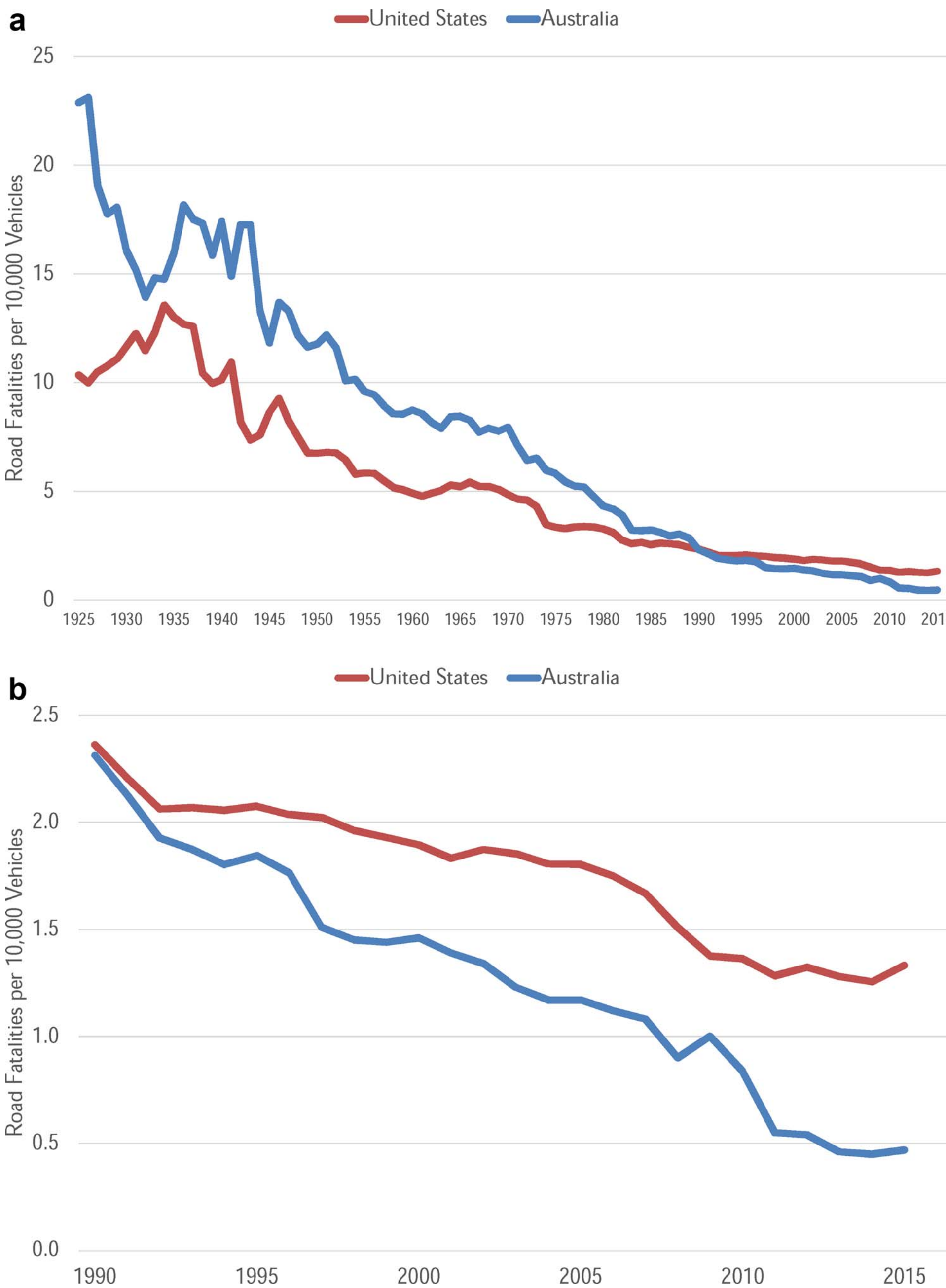

Fig. 3. a) Road Fatalities per 10,000 Vehicles (1925–2015). b) Road Fatalities per 10,000 Vehicles (1990–2015).

greater differences in terms of vehicle size. In the US, 59.5% of new car sales in the US are SUVs or light trucks (Wall Street Journal, 2017). In Australia, SUVs and light trucks comprise only 46.2% of new vehicles (Australian Bureau of Statistics, 2016). While larger vehicles may help in terms of occupant protection, they can also inflict more damage (Mayrose and Jehle, 2002; Jehle et al., 2013).

While seat belt usage laws might logically fit under the safe road users element, it is included within the larger discussion on vehicle occupant protection in this section for the sake of clarity. The first laws requiring drivers to use seat belts from these two countries came in Victoria, Australia in 1970. By the end of 1973, the laws had spread nationwide in Australia (Milne, 1985). In terms of the seat belt laws we are familiar with today, the US was a step behind Australia with the first seat belt law not being seen until 1986 in New York. Although New Hampshire still remains the lone holdout, all other US states had mandatory seat belt laws in place by 1995 (IIHS, 2017a).

Despite the relative ubiquitousness of seat belt law in both countries, there are some differences in both enforcement and fines. While the seat belt law is a primary enforcement law (meaning that an officer can pull someone over just for violating the seat belt law) across Australia, it remains a secondary enforcement law (meaning that an officer would need to pull them over for something besides the seat belt first) in 15 US states (IIHS, 2017a). Moreover, the fine structure is quite different as well. As will expanded upon in the enforcement section below, a seat belt violation in Queensland, for instance, would cost a driver $302 USD and would multiply based on the number of unbelted passengers.[1] In the US, Texas has the largest seat belt fine of $200 USD; most are significantly less, averaging just $35 USD (IIHS, 2017a).

US survey data from the National Occupant Protection Use Survey (NOPUS) estimates 88.5% seat belt usage, up from 83% in 2008

[1] Australian dollars through the paper were converted to US dollars using a conversion rate of 1.25 Australian dollars for every US dollar, which represents the exchange rate as of 7/31/17.

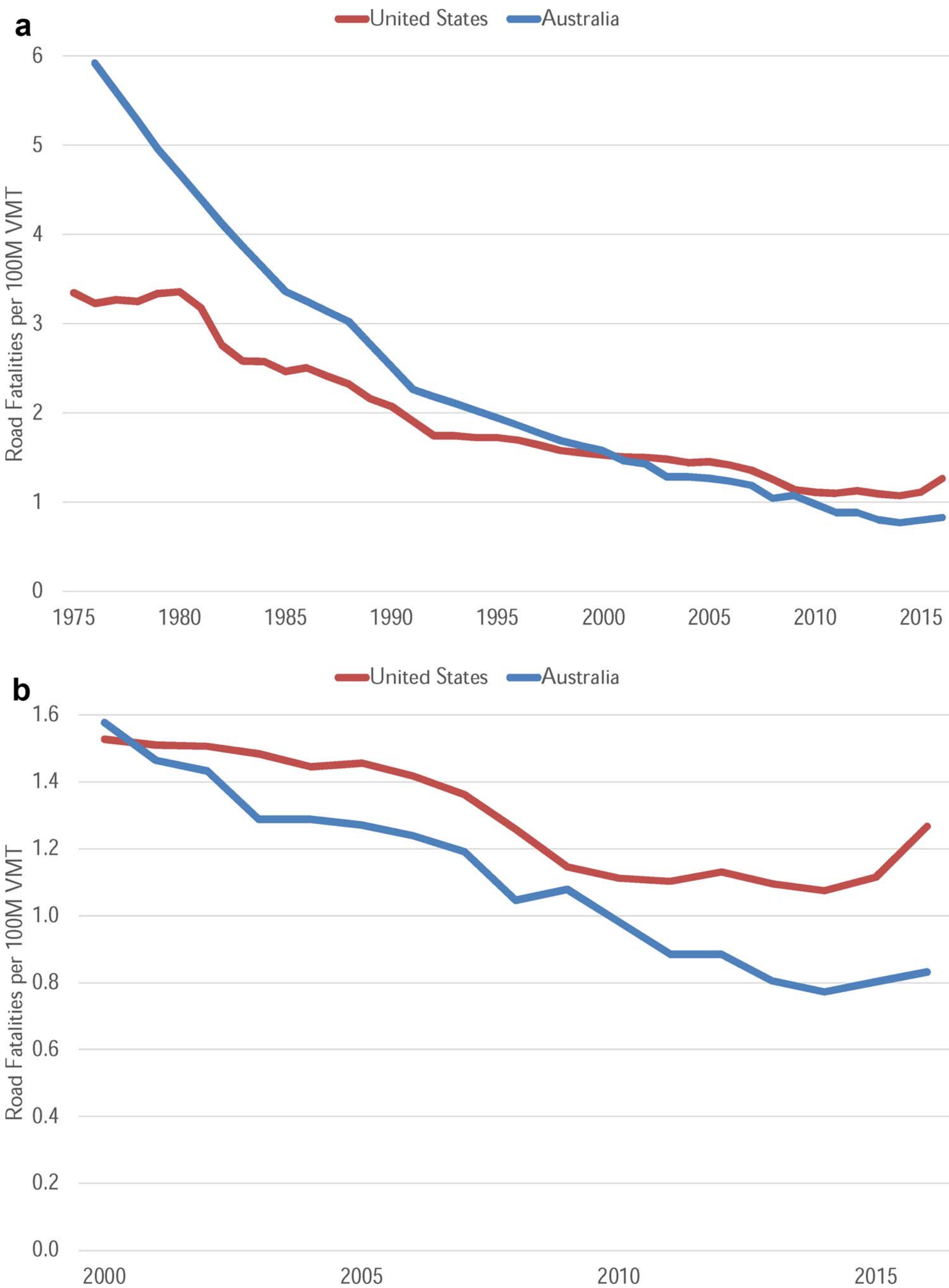

Fig. 4. a) Road Fatalities per 100 Million Vehicle Miles (161 M km) Traveled (1975–2016). b) Road Fatalities per 100 Million Vehicle Miles (161 M km) Traveled (2000–2016).

(NHTSA, 2016a). In terms of overall road safety outcomes in the US, 47.6% of vehicle occupants killed in 2015 were not wearing seat belts (NHTSA, 2017a). This does not include the 1945 people where restraint use was unknown. While usage data is harder to come by in Australia, rates from the early 2000s suggested 95% usage rate (Fildes et al., 2002). More recent observational studies suggest overall seat belt usage rates in Australia as high as 98 or 99% (Roads, 2013; Motor Accident Commission, 2017). The corresponding percent of vehicle occupants killed in Australia that were not wearing seat belt is correspondingly lower than the US and ranges from 33 to 35% (Fildes et al., 2002; Motor Accident Commission, 2017).

Clearly, the solution is not as simple as seat belts because many of these deaths also include alcohol or other contributing factors. However, seat belt laws seem to make a difference in terms of usage, as evidenced by the varied usage rates in the US, ranging from 69.5% in New Hampshire – where there is no seat belt law – to as high as 97.3% in California (NHTSA, 2016a). Nevertheless, seat belts have proven to be an effective means of preventing death, and those that do not use seat belts are eight times more likely to die in a road crash (CARRS-Q, 2016).

3.2. Safe roads

3.2.1. Built environment

With more than 60% of its population living in the vicinity of its eight capital cities, Australia is often cited as one of the most urbanized countries in the world (Nations, 2014). In terms of road safety, higher levels of urbanization typically correspond with better road safety outcomes, particularly in terms of fatal and severe crashes (Lucy, 2003; Lucy and Lewis, 2009). In a recent paper, for example, the author looked at more than twenty years of fatality data in the US and found that residents of the most rural areas had road fatality rates more than six times those of their urban counterparts (Marshall and Ferenchak, 2017). The possible reasons for such differences include lower levels of

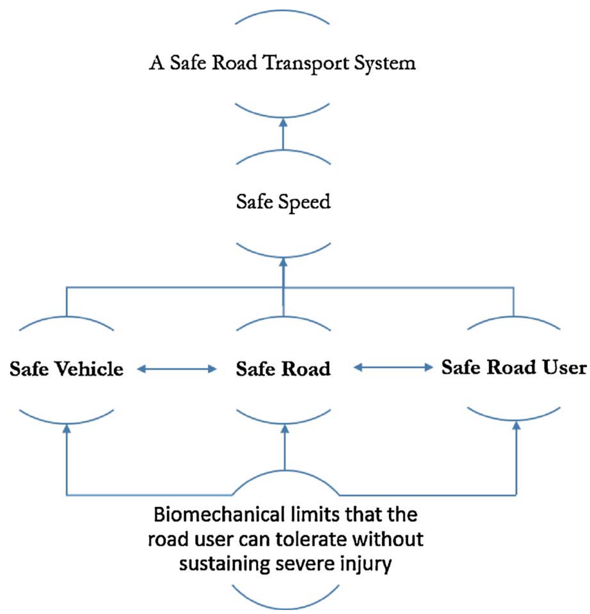

Fig. 5. Model of a Safe Road Transport System (ITF, 2016).

access to emergency medical services (Lucy, 2003), the likelihood of higher vehicle speeds (Rakauskas et al., 2009), increased per capita driving (Litman and Fitzroy, 2005), less transit use (Litman, 2016), as well as differences with respect to alcohol consumption (Voas et al., 2000), vehicle type (Rakauskas et al., 2009), and seat belt norms (Lerner et al., 2001; Wells et al., 2002).

How urbanized is Australia compared to the United States? Given that there is no single standard for differentiating urban from rural, it is difficult to answer this definitively. On the whole, Australia is pretty sparsely populated with only 7.2 people per sq. mile (2.8 people per sq. km). The US averages 87.4 people per sq. mile (33.7 people per sq. km). However, these numbers do not account for the how the population is distributed. In other words, simply calculating the average population density of the country does not necessarily equate to what would be the population density experienced by the average person. As a result, it is common for researchers to also calculate population-weighted population densities – or the perceived population densities – to better compare relative built environment differences (Richardson et al., 1999; Spencer et al., 2015). For example, say there are two buses, each with a 50-passenger capacity. For the sake of this example, one bus is carrying 49 passengers and the second only has one passenger. Averaging the two would tell us that the average bus carries 25 passengers and is half-full. However if we consider what the average bus experience is like from the perceptive of the passengers, one passenger sits on a bus that is almost completely empty while 49 passengers are on a bus that is nearly full. Thus, the average passenger is experiencing a much fuller bus than a simple average might suggest (in this case, the passenger-weighted demand – which represents the perceived experience of the average passenger – would be just over 48 passengers).

The same problem can arise with population density calculations, particularly in places with non-uniform distributions of populations such as the US and Australia. Instead of an average population density of 7.2 people per square mile (2.8 people per sq. km), Australia's population-weighted population density is 6717 people per sq mile (2593 per sq. km). In the US, the average population density of 87.4 people per square mile (33.7 people per sq. km) jumps to 5369 people per sq. mile (2073 people per sq. km). Given the national averages, one would think that the US is approximately twelve times denser than Australia. However, based on the population densities that people experience on a daily basis, Australia is just over 25% denser than the US.

In the US, 54% of road fatalities occur in rural areas (NHTSA, 2015). Given that only 18.4% of Americans live in rural areas, they are significantly overrepresented in terms of road fatalities (World Bank, 2017). While these numbers do not account for the possibility of urban residents dying in rural crashes (or vice versa), rural residents are still two times more likely to be in a fatal car crash when controlling for the home zip code of the driver (Marshall and Ferenchak, 2017). With Australia, the percentage of road fatalities in rural areas was a bit lower at 48% (CARRS-Q, 2012). However, only 10.6% of Australians live in rural areas (World Bank, 2017).

Given these numbers, the rural road fatality rates for each country are 36.4 deaths per 100,000 population in the US versus 24.0 in Australia. Even though Australia's rural areas are considerably safer than those in the US, neither figure is commendable, and both remain much higher than their overall national fatality rates of 12.4 and 5.3 for the US and Australia, respectively.

The trends in both countries suggest that they are becoming more and more urban, which based on the existing literature, should lead to better road safety outcomes. In 1960, for instance, Australia's percentage of rural residents was 18.5%, just over what the US is now (World Bank, 2017). In the US in 1960, approximately 30% of the population was rural (compared to 18.4% now) (World Bank, 2017). However, while both counties are becoming relatively more urban over time, the raw number of rural residents in both countries climbed with the adding of nearly 5 M new rural residents over this time span in the US as compared to just over 600k new rural residents in Australia (World Bank, 2017). Now, the US and Australia have rural populations of over 59 M and 2.5 M, respectively. With more than 23 times the rural population, the US likely experiences higher levels of exposure in more dangerous areas.

3.2.2. Intersection design

When it comes to intersection design, the use of roundabouts in Australia is noteworthy. According to a recent international intersection analysis, Saunder's found that the US averages one roundabout for every 1118 intersections while Australia averages one for every 65 intersections (Metcalfe, 2016). This is more than a seventeen times increase in the relative prevalence of roundabouts. In terms of road safety, roundabouts eliminate many conflict points and the most dangerous types of crashes found in a conventional intersection. Roundabouts may see more sideswipe or rear-end crashes, but these crash types are less likely to result in a fatal or severe injury. The AASHTO Highway Safety Manual states that when compared to conventional intersections, roundabouts experience 78–82% fewer serious injury or fatality crashes (AASHTO, 2010).

Since 1990, Australia has been funding what is known as the Black Spot Program that focuses on reducing road fatalities at hazardous locations. The annual budget for the current iteration of the program exceeds $100 M while funding approximately 350 interventions annually. The most recent evaluation report looked at seven years of data and found roundabouts to be their most effective treatment (BITRE, 2012). Their data suggests a 70% reduction in fatalities and a 50% reduction in the number of total crashes after transitioning from a conventional intersection to a roundabout. Although these figures do not control for regression to the mean, the program makes a concerted effort to account for this issue during the project selection phase.

All roundabouts are not created equal. A well-designed roundabout – such as the one from Sydney, Australia shown in Fig. 6a – forces cars entering the roundabout to slow down with horizontal deflection. When crashes do occur, they take place at slower speeds. While there are valid concerns about pedestrians at roundabouts, Australian designers typically set their crosswalks back considerably and use splitter islands − especially when the crossing is not a marked crosswalk. In such situations without a marked crosswalk, the driver has the right-of-way. It is not uncommon in Australia for a roundabout with four crossings to only stripe some of them, as shown in Fig. 6b. Drivers have the right-of-way

Fig. 6. a) Roundabout in Sydney, NSW, Australia. b) Roundabout with Marked Crossing on Left and Unmarked on Right (Arrow in inset picture indicates angle from which photo was taken).

at the two crossings without the striping on the right, while pedestrians have the right-of-way at the other two on the left.

Another advantage – that is hard to overstate – is that Australian drivers seem to actually stop at unsignalized, marked crosswalks. In the US, the research suggests that more than 50% of drivers do not stop or yield to pedestrians when waiting at a typical, unsignalized crosswalk (APR, 1998; Bertulis and Dulaski, 2014; Hunter et al., 1996; Kim et al., 1999; Nasar, 2003), despite the fact that drivers in all states are legally obligated to do so (NCSL, 2016). While Australia has similar legal requirements, comparable compliance data was not available. My own investigation into this issue found 100% driver compliance at 10 different Australian marked crosswalks that included more than 250 pedestrian crossing maneuvers conflicting with an oncoming car. Admittedly, this is a small sample size, but it is a stark contrast from the US and would clearly have safety implications well beyond roundabouts. It is also speaks to one of the common criticisms of roundabouts in the US in that they do not work well for the visually impaired. Being able to depend upon drivers stopping at marked crosswalks would help that cause.

In terms of overall pedestrian fatalities, the most recent year of data shows that pedestrians comprise 12.3% of road fatalities in Australia, as compared to 15.3% in the US. This difference does not seem like much, but given that Australia is more urban than the US – and the corresponding higher levels of walking (walking commute mode shares of 4.5% for Australia versus 2.8% for the US) – it is a difference worthy of future research (McCrindle Research, 2014; McKenzie, 2015). This is especially true since a recent San Francisco report finds that one-third of pedestrian fatalities occurred in a crosswalk when the pedestrian had the right-of-way (Elinson, 2013).

Another interesting Australian intersection treatment that can help crossing pedestrians as well as reduce turning vehicle conflicts is known as the Melbourne Hook. While the hook turn maneuver is gaining traction for bicyclists in other places (such as in Denmark or even Canada, where it is called a perimeter-style turn), Melbourne in Victoria, Australia also uses it for right-turning vehicles (cars drive on the left in Australia) and bicyclists in and around their Central Business District, as shown in Fig. 7. Interestingly, the hook turns

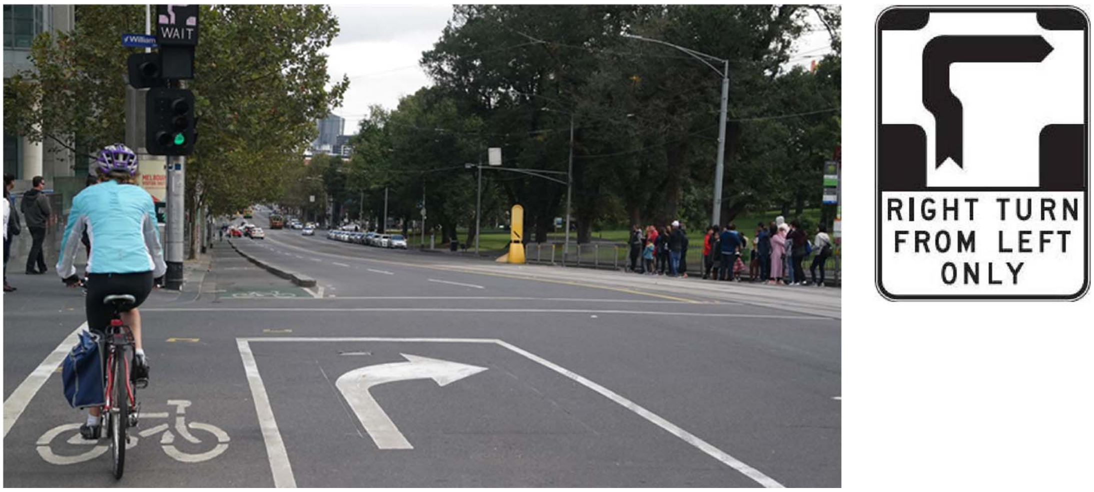

Fig. 7. Queuing Area for Melbourne Hook Turn (image to right depicts official sign).

requires drivers to make right turns from the left-most lane. The way it works is that when the light turns green, cars looking to turn right queue at the far left side of the intersection, almost near where the opposing pedestrian crossing is placed. After the light turns red for the through traffic, the light will turn green for the opposing traffic with the queued cars leading the way. If the queueing area is full, then right-turning cars must wait for the next cycle. In terms of safety, the advantage is that there are no conflicts with the opposing through traffic, which was deemed especially important in Melbourne with the city's extensive tram network. While originally intended to help accommodate trams and not as a pedestrian safety intervention, the Melbourne Hook reduces the chance of hitting a crossing pedestrian because the hook turn eliminates the conflict that happens when vehicles are turning into a simultaneous walk phase. This type of crash – where pedestrians have the right-of-way – is especially common in cities where the turning vehicles need to consider crossing pedestrians while simultaneously looking for gaps in multiple lanes of opposing traffic (FHWA, 2006; New York City, 2010). Another advantage is that the hook turn eliminates the need for a dedicated turn lane. This facilitates narrower roads and reduced pedestrian crossing distances. While Melbourne Hook road safety studies remain somewhat limited and do not consider pedestrians, the results suggest improved safety outcomes (Currie and Reynolds, 2011; O'Brien, 2000). Their usage is probably not extensive enough to have a considerable impact on national road safety statistics, but they are common in downtown Melbourne within a metropolitan area that houses 16.5% of Australia's overall population.

In terms of overall intersection safety, 20.3% of road fatalities in Australia occurred at intersections in 2014 (BITRE, 2016a). For the most recent year of US data, 24.1% of fatalities occur at intersections (IIHS, 2016). While a significant difference, this probably underestimates the relative safety advantage of Australian intersections. Generally, the percent of road fatalities occurring at intersections is much higher in urban areas as opposed to rural. For instance in the US, 16% of road fatalities in rural areas occur at intersections, as compared to 32% in urban areas (IIHS, 2016). While a similar urban-rural breakdown of intersection-related crashes in Australia was not available, the fact that Australia is decidedly more urban – and also kills a lower percentage of people at intersections than the US – suggests that the safety difference is likely greater than the statistics imply.

3.2.3. Street design

Street designs in Australia tend to be relatively similar to the US. Signage and road markings are not overtly different, with some minor exceptions. For instance when approaching an area with significant pedestrian activity or a pedestrian crossing – especially when sight distance might be limited by curve, crest, or sag in the road – Australia uses zig-zag striping, as shown in Fig. 8, to warn the driver that slowing down would be prudent.

Overall street widths within both countries vary considerably. It is not uncommon to find extremely narrow residential streets, especially in older cities, in either country. It is also not uncommon to find overly wide streets in either country. Systematically comparing differences in street width at a national scale is difficult; as a result, I looked more specifically at two more recently planned communities: Rouse Hill Regional Centre in Sydney's western suburbs; and Stapleton, a relatively new community in Denver, CO on the site of the old airport. In terms of street width and road safety, the research suggests negative safety implications of wider streets (Swift et al., 1997; Dumbaugh, 2005; Noland, 2000), primarily because wider streets result in faster speeds (Daisa and Peers, 1997; Martens et al., 1997; Ivan et al., 2009). While the size of the effect is difficult to isolate, it can explain differences in road safety (Gattis, 2000; Gattis and Watts, 1999).

Both Rouse Hill and Stapleton are master planned developments located within well-established cities. Both are mixed use and include significant residential and commercial/retail as well as some industrial. Both are also representative of relatively new communities designed to accommodate cars but also with multimodal transportation at the forefront. This includes extensive pedestrian and bicycling networks as well as transit accessibility. In addition to good bus service, each will be connected to their downtowns via train: the A Line in Denver opened in 2016 while the Metro Northwest line will open in 2019.

Local and collector streets in both communities tend to be the most comparable because they have generally been designed for two-way traffic with on-street parking on both sides. Such a cross-section in the Rouse Hill neighborhood is designed to be 27.9′ (8.5 m) curb-to-curb; in Stapleton, a similar local street would be designed at 32′ (9.5 m) across (although 30′ or 9.1 m would be allowed on streets with fewer than three underground utilities, this is rare). Collector streets have an even greater disparity. Rouse Hill's collector streets are designed to be 31.2′ (9.5 m) curb-to-curb, which is quite a bit less than the 38′ (11.6 m) widths of collector streets in Stapleton.

One reason for these differences might come in the application of the design speed concept. First off, design speed is essentially defined as the selected speed used to determine the geometric configuration of a street. In US street design guidelines, it is further explained as follows (AASHTO, 2011):

> *Except for local street where speed controls are frequently included intentionally, every effort should be made to use as high a design speed as practical to attain a designed degree of safety.*

Fig. 8. Zig-zag Markings on the Approach to an Unsignalized, Marked Pedestrian Crossing in Sydney, Australia.

This line of thinking suggests that drivers, inevitably, err, but when they do, the higher design speed selection essentially functions as a factor of safety. The AASHTO Green Book goes on to say that "*above-minimum design values should be used, where practical*" (AASHTO, 2011). The 2011 version of the book added "*particularly on high-speed facilities*" to this statement as well as acknowledging that: "*on lower speed facilities, use of above-minimum design criteria may encourage travel at speeds higher than the design speed*" (AASHTO, 2011). However, conventional thinking in the US has historically been that higher design speeds are better.

In contrast, Australian guidelines suggest setting the design speed at just 10 km/h (6.2 mph) over the intended speed limit. The underlying intent is for speed limits to be self-enforcing, which represents a more active approach to street design and safety. In the case of Rouse Hill, this would mean a design speed of 40 km/h (24.9 mph) on local streets and 50 km/h (31.1 mph) on collectors (The Hills Shire Council, 2012). The AustRoads Guide to Road Design, which seems to be the Australian equivalent of the AASHTO Green Book, suggests design speeds 10 km/h (50 km/h on local roads and 60 km/h on collectors and minor arterials) over the Rouse Hill guidelines. Other than for highways, most US guidelines do not offer specific design speed suggestions, leaving the decision in the hands of the engineer. While a US engineer could similarly select a design speed that comports with the intended speed limit, the guidelines seem to encourage higher values.

Related to the design speed issue, there is also a difference in the application of the 85th percentile speed concept. In the US, the 85th percentile speed is intended to help set an appropriate speed limit at a number lower than the design speed (AASHTO, 2011). In Australia, the design speed is intended to be the same as the 85th percentile speed (The Hills Shire Council, 2012). Australia does not use the 85th percentile speed to set speed limits (Mooren et al., 2011). While these sound like similar philosophies, the difference could be quite substantial, especially given the nature of design speed selection processes. If a US engineer, for example, sets their design speed to be just 10 mph (16.1 km/h) over the intended speed limit and drivers happen to follow the design speed instead of the speed limit, which the research suggests is the case in most situations (Edquist et al., 2009), then the protocol would be to increase the speed limit to match driver preference. Even if a US municipality does not increase the speed limit to better match the 85th percentile speed, the reality is then that the posted speed limit would be significantly below the 85th percentile speed (Fitzpatrick et al., 2004). In fact, NCHRP Report 504 found that only 23% of free-flow vehicles were at or below the posted speed limit on suburban and urban collector roads located across seven US cities; on local roads, this percentage increased to 52%, but this still means that almost half of drivers exceeded the speed limit on local roads in populated areas (Fitzpatrick et al., 2004). Given the underlying design philosophies in Australia, where the 85th percentile speed is intended to be the same as the design speed, this is less likely to be the case. Such speed reductions can impact road safety outcomes, particularly with respect to fatal and severe injury crashes (Elvik, 1997; Weller et al., 2008; TRB, 1998). A 2004 meta-analysis by Elvik and Vaa, for instance, found that increasing the speed limit by 15 km/h (9.3 mph) would correspond to a 26% increase in fatal crashes (Elvik and Vaa, 2004).

3.3. Safe road users

3.3.1. Travel behavior & exposure

Since vehicle speeds were already covered in the street design section and the enforcement section adds more to this discussion, the travel behavior section instead focuses on differences in exposure with respect to distances driven and mode choices. Table 2 aggregatesthe data discussed in this section.

In terms of driving distances, the average driver in the US travels nearly 13,500 miles (21,726 km) each year (FHWA, 2016), as compared to under 10,000 miles (16,093 km) per year in Australia (Morris, 2013). For the average driver, this equates to 28.4% fewer miles driven. All other things being equal, a driver with less exposure should have better road safety. If we normalize total national mileage by the entire population of each country, the US drops to just under 10,000 miles (16,093 km) per year while Australia sits at 6400 miles (10,300 km) per year. Lower levels of mobility are often assumed to be a negative; however, this assumption is not as critical when we are comparing two first-world countries. If the average Australian can fulfill their daily needs with 35% fewer miles driven, that can help explain some of the differences in road safety outcomes. How can Australians manage that? In more urban places, location efficiency can be a major advantage. For instance, the average American commutes 11.8 miles (19.0 km) to work as compared to 9.7 miles (15.6 km) for an Australian (BITRE, 2015a; Santos et al., 2011). Traveling an extra four miles (6.4 km) to work each day is potentially unnecessary exposure that, when multiplied by

Table 2
National Differences in Driving Distance, Commute Mode Shares, Car Ownership, Vehicle Fleet, and Enforcement Fines.

	United States	Australia	*Difference*
Driving Distances			
Annual Mileage per Driver	13,476 mi. *21,687 km*	9650 mi. *15,530 km*	*−28.4%*
Annual Mileage per Person	9788 mi. *15,752 km*	6378 mi. *10,264 km*	*−34.8%*
Daily Mileage per Driver	36.9 mi. *59.4 km*	26.4 mi. *42.5 km*	*−28.5%*
Daily Mileage per Person	26.8 mi. *43.2 km*	17.5 mi. *28.1 km*	*−34.8%*
Average Commute Distance	11.8 mi. *19.0 km*	9.7 mi. *15.6 km*	*−17.8%*
Commute Mode Shares			
% Driving	85.6%	79.4%	*−7.2%*
% Transit	5.2%	12.5%	*140.4%*
% Active Transportation	3.4%	5.8%	*70.6%*
% Work from Home	4.6%	5.0%	*8.7%*
Car Ownership & Vehicle Fleet			
% Households with Zero Cars	8.9%	8.4%	*−5.6%*
Avg. Age of Registered Vehicles	11.5 years	10.1 years	*−12.2%*
% SUV or Light Trucks	59.5%	46.2%	*−22.4%*
Cost of Gasoline(per gallon)	$2.34 USD	$4.09 USD	*74.8%*
(per liter)	*$0.62 USD*	*$1.08 USD*	
Example Enforcement Fines (based upon Denver, Colorado & New South Wales)			
Selt Belt Infraction	$65 USD	$260 USD	*300.0%*
Distracted Driving (e.g. cell phone)	$50 USD	$255 USD	*410.0%*
Running Red Light by Officer	$160 USD	$347 USD	*116.9%*
Running Red Light by Camera	$75 USD	$347 USD	*362.7%*
Speeding by Officer (10 mph over)	$151 USD	$212 USD	*40.4%*
Speeding by Camera (10 mph over)	$40 USD	$212 USD	*430.0%*

millions of people, can have significant road safety implications.

Another reason for these differences is that driving is significantly more expensive in Australia. In the US, the average annual cost of driving – including licensure, insurance, registration, taxes, depreciation, finance charges, maintenance, tires, and fuel – is $8558 USD (BTS, 2016). Australia does not aggregate their costs in quite the same way, but a recent report suggests that the average annual cost of running a car ranges from $11,274 USD to $17,429 USD, depending upon where you live in Australia (Dowling, 2016). One big difference in the variable costs of driving is the cost of fuel. Recent data from the US suggests an average gas price of $2.34 USD per gallon ($0.62 USD per liter) (AAA, 2017a). In Australia, an equivalent volume of regular gasoline would cost about $4.09 USD ($1.08 USD per liter), a 75% increase.

The US federal gas tax is $0.184 USD per gallon ($0.049 USD per liter). The state gas taxes range from $0.1675 USD per gallon ($0.044 USD per liter) in South Carolina to $0.504 USD per gallon ($0.133 USD per liter) in Pennsylvania (Kaeding, 2017). Together, these taxes represent between 15% and 29.4% of the cost of gasoline in the US. Moreover, these percentages continue to drop since the tax rates do not adjust to inflation. The Australian federal gas tax is currently $1.20 USD per gallon ($0.32 USD per liter), and it adjusts semi-annually to inflation (AAA, 2017b).

A recent report compared the costs of fourteen cars and found that, due to issues such as market size and geographic isolation, cars cost approximately 35% more in Australia (Dowling, 2011). When combined with higher initial car costs, it is understandable that this may also play a factor in reduced driving – and thus exposure – in Australia.

Higher driving costs can also impact mode shares, which can further help explain differences in safety outcomes. Transit, for example, is typically a much safer mode of transportation than driving. With fewer than 0.06 fatalities per 100 million passenger transit miles (161 M km) traveled, transit is approximately nineteen times safer than driving (Politifact. com, 2011). Accordingly, a country with a relatively high percentage of people traveling by transit should be safer than the typical automobile-based country. For instance, an international study by Kenworthy and Laube concluded that places with higher transit use tended to have lower overall fatality rates (Kenworthy and Laube, 2000). Other researchers have found that per capita fatality rates are lower with increased transit use and that residents of automobile-oriented communities have traffic fatality rates five times those living in transit-oriented communities (Litman, 2009; Litman, 2013; Stimpson et al., 2014). One reason behind these results is that transit can substitute for driving. When comparing the commute mode shares of the US to Australia, transit use in the US sits at 5.2%, less than half that of Australia's 12.5% (BITRE, 2016b; Polzin, 2016).

Australians also rely upon active transportation modes at a far higher rate than Americans. When compared on a per mile basis, both walking and bicycling are far more dangerous than driving (Pucher and Dijkstra, 2003; Mapes, 2009). Using the same logic applied to transit, it stands to reason that countries with high levels of active transportation should have worse road safety records. Yet, this rarely turns out to be the case (Jacobsen, 2015; Jacobsen et al., 2015; Marshall and Garrick, 2011). For instance, the Netherlands – with one of the highest active transportation rates in the world – is also one of our safest countries with only 3.4 fatalities per 100,000 population. The reasons for this vary but include shifts in driver expectations and behaviors due to the increased chance of encountering pedestrians and bicyclists, built environment differences, demographic changes, and vehicle speeds. It also speaks to the increased level of urbanity in Australia as compared to the US.

3.3.2. *Driver licensure*

Another possible explanation of the road safety outcomes differences between the US and Australia could come with differences in acquiring driver's licenses, particularly with teens and older populations, two of the most over-represented age groups in road fatalities (NHTSA, 2017c; NHTSA, 2017d).

In the US, driver's licensing rules vary greatly by state. In South Dakota, for example, the age of licensure is 14 years, 3 months. At the high end of the spectrum is New Jersey at 17 years. Almost every state runs a graduated licensing program that limits driving privileges (via curfews and passenger restrictions) for new or inexperienced drivers. Even with the graduated licensure programs, the minimum age of a full, unrestricted license is never greater than 18. While the age of licensure (excluding learner's permits) also varies by state in Australia – ranging from 16½ years old in the Northern Territory to 18 years old in Victoria, with 17 being the median age – the graduated licensure steps tend to be longer and much more restrictive.

Most Australian states have a four-stage process. With each of the first three phases, a special colored placard must be placed on the car that indicates the licensure status of the driver. For instance in Victoria, it starts with a yellow learner's license, which allows for supervised driving, that can be obtained at age 16. At age 18, after successfully holding a learner's permit for a full year, a candidate must then pass a computerized exam, a driving test, and an eye test to receive the P1 red probationary license. This P1 license limits both the size and power of the vehicle driven, bans all mobile device usage regardless of hands-free, prohibits towing, restricts the number of 16–21 years olds that can be in the car to one, as well as places the driver in the zero BAC category (despite the fact that the legal drinking age is 18 in Australia). After one year of a good record with the red P1 probationary license, the driver automatically graduates to a green P2 probationary license. All of the P1 restrictions continue to apply except that peer passengers and towing are now allowed. After three years of a good record with a P2 license, the driver is then eligible for a full driver's license. Thus, the youngest that a driver can possibly obtain a full driver's license in Victoria is 22 years of age.

Multiple Australian states also have speed restrictions with each phase. For instance in New South Wales, those with a learner's or P1 provisional license cannot drive over 90 km/h (55.9 mph), and those with a P2 provisional license cannot driver over 100 km/h (62.1 mph). This limitation applies regardless of the posted speed limit, and a violation would result in a 3-month suspension.

Despite these extensive graduated licensure programs, young drivers are still overrepresented in Australian road fatalities. However, the road fatality rate for the 15–24 age group has also dropped by nearly 43% over the last decade (BITRE, 2013). While some of these gains can probably be attributed to broader trends of lower licensure rates among young people, it is still headed in the right direction (Loader, 2015). The most recent figures show that the number of road deaths per 100,000 Australians aged 15–24 is 8.9; in the US, the rate for the same age group (15–24) is 15.6 road fatalities from 100,000 population (NHTSA, 2017d; BITRE, 2013). This is significant disparity, and if the US were able to equal this rate, it would save the lives of nearly 3000 young Americans every year.

3.3.3. Enforcement

Traffic enforcement cameras (both red-light and speed) are becoming more common in the US. In a recent report, the Washington DC metropolitan area had the most extensive program with 716 total traffic enforcement cameras, followed by the New York and Chicago metropolitan areas with 605 and 507 cameras, respectively (Kliff, 2017). The numbers then drop sharply to the next metropolitan area on the list, Dallas/Ft. Worth, with 270. Despite their proven safety benefits, traffic enforcement cameras remain a politically contentious issue, to the point where at least ten states (such as Maine, Mississippi, New Hampshire, and West Virginia) have state laws prohibiting them (IIHS, 2017b).

In comparison, New South Wales, Australia has 171 red-light cameras, 106 fixed speed cameras, and more than 1000 locations on the annual mobile speed camera schedule (Transport for NSW, 2017a). These cameras cover more than 1100 miles (1770 km) of the roadway network. Victoria, which started their camera enforcement program in the late 1980s, now has 277 fixed cameras and approximately 2000 mobile camera locations on their schedule (Victoria State Government, 2017a). In 2014, Victoria police added distracted driving cameras – shown in Fig. 9 – that can capture images of drivers using their cell phones, eating, or putting on make-up from 2300′ (700 m) away (Moor and Devic, 2014). These cameras are now starting to be used in other Australian states. The US does not seem to have made this leap, despite recent US statistics suggesting that more than 10% of fatal crashes and 15% of injury crashes include distracted driving as a contributing factor (NHTSA, 2017b).

The cost of a violation in Australia also tends to be much steeper than a comparative offense in the US, as shown in Table 2. For instance, running a red light would cost you $347 USD in New South Wales, Australia. Using a mobile device while driving would cost $255 USD or $347 USD if in a school zone. Driving 10 km/h (6.2 mph) over the speed limit would cost $212 USD while driving more than 45 km/h (27 mph) over the speed limit would set you back $1880 USD. Not wearing a seat belt would cost $260 USD, but it would jump to $1097 USD if you had four unrestrained passengers in the car. In Denver, CO, for instance, a camera-enforced speeding violation would cost $40 USD ($80 USD if in a school zone) and running a red-light would cost $75 USD.

Another difference is that the most Australian states treat the demerits originating from cameras the same as a police officer pulling over the driver. All of the Australian examples would add significant demerit points and would even add double demerit points for mobile phone offenses or those that take place in a school zone. However, the Denver examples would not add points to your driving record unless you are pulled over by an officer.

Most of Australia also has relatively strict bicycling laws and fines. Running a red light, not stopping at a pedestrian crossing, or riding dangerously in New South Wales would cost $340 USD, not wearing a helmet would cost $255 USD, while all other offenses (including not carrying an ID or having a bell) would cost $85 USD. These fines are cumulative as well, so if you ran a red light without a helmet or bike bell, it could cost you $680 USD. Bicycling helmets have been mandatory in Victoria since 1990, and the other Australian states followed suit by 1992. The data suggests that Australians tend to follow the bicycling rules better than US residents (Marshall et al., 2017). Is bicycling also safer in Australia? It is difficult to say, but despite similar rates of bicycling in both countries (Pucher and Buehler, 2008), bicyclists comprise 3.9% of all road fatalities in Australia as compared to 2.3% in the US (BITRE, 2015b; McKenzie, 2014). While the fatality numbers are over-representative of mode usage in both cases, Australia's relative record on bicyclist safety is significantly worse than that of the US.

3.3.4. Impaired driving

Alcohol has long been a significant issue in terms of road safety outcomes, and these countries have their share of differences in terms of both policy and enforcement.

Fig. 9. Distracted Driving Camera in Melbourne, Victoria, Australia.
Source: Herald Sun, Melbourne, Victoria, Australia.

In terms of policy differences, the US legal blood alcohol concentration (BAC) limit is set at 0.08%. For commercial drivers, the limit is half that at 0.04%. Australia, notably, has lower BAC limits of 0.05%, which dates back to Victoria's initial law in 1966, and 0.02% for commercial drivers as well as for drivers of any truck over a certain weight. Moreover, the BAC limit is zero for driver's holding a driver's license from another country or anyone with a provisional license (although these are commonly enforced at 0.02%, which is consistent with the recommendation of the World Health Organization).

Despite the lower BAC limits that would classify more crashes as alcohol-related, Australia experiences a lower percentage of alcohol-related road fatalities. In the US, 29% of 2015 traffic fatalities involved alcohol as a contributing crash factor (NHTSA, 2016b). This number has dropped significantly from over half of all road fatalities in 1990 to just over 42% in 2009 (Chambers et al., 2012). Alcohol as a contributing factor in Australia's road fatalities, on the other hand, dropped from 44% in 1981, to 28% in 1999, to 13% in 2015 (Australian Transport Safety Bureau, 2004; Transport Accident Commisson, 2016).

In addition to lower BAC limits, Australia is known for strict enforcement. Random breathalyzers are extremely common in Australia, having been around since 1976 in Victoria and in all states by 1988. For instance in 1985, Tasmania conducted more than 200,000 random breathalyzer tests on a driving population of only 268,887 (Sutton et al., 1986; Homel, 1990). With their random breath testing program, Australia seems to focus more on deterrence than maximizing arrests via a highly visible and intense approach.

Random drug testing is also becoming common in Australia, and interestingly, the percentage of positive results is almost ten times higher than for alcohol. For instance, New South Wales conducted over 6 million alcohol tests (finding less than 1% positive) and over 100,000 drug tests (finding approximately 10% positive) in 2015 (Transport for NSW, 2017b).[2] Saliva-based drug testing is common in Australia but is currently only able to test for three drugs: THC (i.e. cannabis), methamphetamine (i.e. speed, ice or crystal meth), and MDMA (i.e. ecstasy). Law enforcement in Australia, however, has the power to test for other drugs via blood testing. Blood tests are also mandatory for any driver admitted to a hospital with injuries suffered in a road crash. So while Australia tests all drivers killed for drugs, the US only tested 57% of drivers killed in crashes last year (Hedlund, 2017). The data is harder to come by, but the initial reports suggest that US drug-related crashes may be similar in numbers to alcohol-related crashes, if not more (Hedlund, 2017; Wheeler, 2015).

Related to the alcohol enforcement issue is the fact that alcohol is significantly more expensive in Australia than in the US. Multiple cost of living indices suggest that ordering similar alcoholic drinks at a restaurant would cost 20% more in Australia than the US (Adamovic, 2017; Sanyal, 2013). The bigger difference comes when buying alcohol at a liquor store where beer or spirits cost approximately 40% more in Australia. Similar level wines, on the other hand, are slightly more expensive in Australia (~8%).

While the reasons behind these price differences are multi-fold, one contributing factor is the alcohol excise tax. The specifics are overly complicated for this paper (e.g. depending on alcohol volume and packaging, Australia has eight possible tax rates for beer alone); however, Australia generally has four federal alcohol taxes: an excise tax that varies semi-annually based on inflation; the Wine Equalisation Tax (WET) based on sales; a customs duty based on alcohol content and sales; and a 10% tax on all retail sales (Chung, 2014; Anderson, 2014). The bottom line is that these taxes combine to comprise a significant portion of the cost of alcohol in Australia. When compared to the US, a liter of pure alcohol would come with a tax of $32 USD in Australia and only $2 USD in, for example, California (Hudson, 2013).

What does the cost of alcohol have to do with road safety? The authors of a meta-analysis of more than 100 studies reported significant elasticities between price and consumption of −0.46 for beer, −0.69 for wine, and −0.80 for spirits in addition to significant reductions in heavy drinking (Wagenaar et al., 2009). Several longitudinal studies also suggest that a larger excise tax on alcohol can play a significant role in reducing related crashes (Saar, 2015; Son and Topyan, 2011).

4. Discussion

4.1. Vision zero policies

Similar to the US, Australia is a federation of semiautonomous states and territories, and the role of the federal government in road safety has essentially been limited to vehicle standards and infrastructure funding (Mooren and Grzebieta, 2013). Nevertheless, Australia's National Road Safety Strategy established their version of Vision Zero – called the Safe System Approach – in November 2003 (Langford, 2009). Based upon the Vison Zero program first adopted by Sweden in 1997, albeit with less of a moral imperative, Australia's road safety strategy has now been adopted by all six Australian states and is the principal policy behind road safety efforts nationwide (Williams and Haworth, 2007; Mooren et al., 2011). Similar to Sweden's Vision Zero, the intent is to eliminate all traffic fatalities; for instance, Australia's current National Road Safety Strategy (2011–2020) states:

No person should be killed or seriously injured on Australia's roads.

As opposed to the conventional, epidemiological approach to road safety – where dollar values are placed on health and life (and a certain number of fender benders equates to a fatality) in order to conduct cost/benefit analyses of interventions − the supposed paradigm shift is that traffic deaths and injuries are preventable, and therefore, unacceptable. Given the relative autonomy among Australian states, it is difficult to attribute specific interventions to their national safety program. In turn, this means that definitively linking Australia's road safety gains since the program began to a national program is not realistic (Mooren et al., 2011). One of the keys to Australia's approach, however, is to shift responsibility from road users for their behavior on the roads to the engineers, planners, and policymakers. This includes actively managing vehicle speeds so that when crashes do occur, the chance of a fatality is reduced (Langford and Oxley, 2006). Much of the evidence found in this paper suggests that Australia is moving in the right direction with respect to this particular issue.

In the US, the US Department of Transportation and the Federal Highway Administration initiated their Towards Zero Deaths program in 2015, more than a decade after Australia's version. Similar to Australia, the federal policy is by no means a mandate – especially because there is no meaningful funding tied to it – and a shift away from the conventional approach to road safety requires state and local support. Thus far, only a couple states (e.g. Ohio and Oregon) have followed suit (Schmitt, 2016). Support has been stronger at the city level. Starting with New York City and San Francisco in 2014, variations of Vision Zero now include 26 US cities and one county. Still, these adopters represent a small fraction of the overall US. Moreover, there is little evidence to suggest that these US Vision Zero cities and states are doing much differently (Schmitt, 2016). However, it is still early and not one of the US-based Vision Zero or Towards Zero Deaths programs has been around more than a few years. Thus, it is difficult to assess changes in road safety, especially those that might be related to infrastructure.

4.2. Governance and other institutional factors

With such an investigation, it is also worth considering differences in governance and other institutional factors that may contribute to road safety outcomes. In a 2007 paper comparing the safety cultures of

[2] The primary reason behind testing for alcohol sixty times more than for drugs seems to be that the drug test takes approximately ten times longer for police to administer.

the US and Australia, Williams and Haworth found that, in general, the Australia government seems more willing than the US government to use a scientific approach to adopt policies intended to improve public safety (Williams and Haworth, 2007). In terms of Australia's widespread camera enforcement program, for instance, the research showed the safety benefits of their initial program, and based on empirical evidence of success, Australia continued to grow their program (Delaney et al., 2005). In the US, the debate over camera enforcement and safety tends to get sidetracked by issues of politics, money, and privacy (Al-Turki, 2014). If data does not exist, Australia also seems willing to test programs, such as they have done with graduated driver's licensure and are currently doing with their point-to-point speed enforcement program on highways (Simpson, 2003; Senserrick, 2007).

Australia's approach to road safety even extends to cases when the policy could be perceived as intervening in people's lives such as with random breathalyzers and mandatory helmet laws (Williams and Haworth, 2007). Australia also recently deployed an automatic number plate recognition (ANPR) program. While the ANPR program helps identify unregistered/uninsured vehicles and suspended/unlicensed drivers, it is able to "track vehicles in real time from one side of a city to the other with pinpoint accuracy" (Hannaford, 2015). Potentially invasive programs such as these – even when accompanied by a proven safety benefit – tend to be difficult politically in the US.

A related advantage that Australia seems to enjoy is greater latitude in terms of implementation. With far fewer states and a greater consolidation of powers at the state level rather than at the county or municipal level, Australia can enact policies without as many people or groups involved in the decision-making process (Williams and Haworth, 2007). For instance, the current population distribution makes it possible for two Australian police departments – the states of New South Wales and Victoria – to make decisions for more than 55% of Australia's population (Williams and Haworth, 2007). Greater uniformity in policies and practice could play a role in Australia's improved outcomes. Moreover, most Australian states have bipartisan Parliamentary Committees that are responsible for road safety efforts (Mooren and Grzebieta, 2013) such as the Police and Public Safety Committee in Queensland and the Staysafe Committee in New South Wales. If a member of Parliament does not sit on such a committee, they have little role in such efforts because road safety does not often get addressed above the committee level (Mooren and Grzebieta, 2013). Despite the limited Parliamentary role, road safety is a problem that requires cross-agency cooperation; thus, Australian states also tend to have formal agreements intended to promote such efforts. Overall, Australia tends to have a stronger culture of safety with more direct institutional pathways to achieve success.

5. Conclusions

The reality is that many US engineers, planners, and policymakers look at some of the interventions coming out of the safest countries in world, such as Sweden and the Netherlands, and are often unwilling to make similar changes, even when there is an expected safety benefit. It is all too easy to make the argument that, for instance, Denver is not Copenhagen or Amsterdam, and thus, their approaches would never work here. Australia, however, is more similar to the US in terms of transportation, land use, and culture than most European countries. Australia also has a much better road safety record than the US, particularly in recent years. The question this paper sought to answer: why is this the case?

The results of this analysis suggest that a number of factors are playing a role in the better road safety outcomes of Australia as compared to the US. The US approach to better road safety tends to focus on issues such as seat belt usage and impaired driving (Schmitt, 2016). Australia not only seems to be doing a better job in those areas, but Australia has also made significant strides in programs related to curbing vehicle speeds, which is an issue at the heart of the movement to reduce fatalities. This includes safer roads via design-related differences in the use of roundabouts and narrower roads, policy-related differences in terms of how design speed is used to design self-enforcing roads, as well as a much stronger and more extensive speed camera enforcement program, which incentivizes safer road users. Whether intentional or not, the restrictive licensing programs and higher driving costs in Australia have helped reduce driving mileage and exposure, particularly by some of the most vulnerable drivers. When combined with a greater degree of urbanism and appropriate multimodal infrastructure, Australia's system tends to encourage road users towards safer modes of transportation such as transit.

While transportation planners and engineers have control over some – but certainly not all – of these differences, a portion of Australia's road safety gains can be attributed to the behaviors of the road users themselves. For example, the evidence suggests that Australian drivers overwhelmingly stop for pedestrians in marked crosswalks, even those that are unsignalized. High fines and strong enforcement likely play a role, but with less than half of American drivers stopping for pedestrians in similar circumstances, Australian's seem to take on more personal responsibility over more vulnerable road users, which has its safety benefits.

Australia also seems to possess a greater degree of political will and institutional support. This includes the broader reach of their Vision Zero-like policies that, if truly enacted, would represent a fundamental paradigm shift in our approach to how we plan and design transportation systems. Although neither the US nor Australia has quite made that shift, Australia continues to move in the right direction – and is doing so at a much faster pace than the US.

Transferring successful designs and policies from countries such as Australia to the US context requires a greater understanding of these countries than we currently have. This paper is a start, but it was not able to cover every conceivable difference that might contribute to safety disparities, such as those that might be found with vehicle safety standards or disparities in emergency medical care and post-crash trauma care. Victoria, Australia, for instance, put a great deal of effort into integrating their road trauma management initiatives into their broader trauma management system (Victoria State Government, 2017b). Future research needs to continue gathering empirical evidence – particularly from countries such as Australia – regarding what actually makes our transportation systems safer and how we can save more lives. The US also needs to be more willing to test these international approaches for themselves.

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