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Reviewing the performance of the Australian land transport sector against its counterparts in Canada, New Zealand and the USA.

John F. Odgers

School of Business IT and Logistics RMIT University

john.odgers@rmit.edu.au

Abstract

This paper compares the longitudinal performance of the land transport sectors in Australia, Canada, New Zealand and the United States of America (USA). It comprises analysis of freight transport, passenger transport, energy consumption, CO_2 emissions, road fatalities and gross direct investment. Among its key findings are that annual growth in overall freight transport volumes has been recently increasing overall at a faster annual rate than in Canada, New Zealand and the USA, but has slightly lower than average annual compound growth in GDP. Annual growth in total passenger transport by road and rail on the other hand has been less than one quarter of the average compound rate of growth in GDP over the years 1990-2007. Private motor vehicles are still the predominant mode for passenger transport across the four nations, but Australia has the lowest modal share in comparison to Canada and the USA. The transport sector between 1997 and 2007 has performed relatively well in respect of the percentage increase in final energy consumption. However more needs to be done or at least attempted to reduce or at least keep steady the transport sector's role on CO_2 emissions. Finally Australia's transport sector is achieving average annual percentage reductions in road fatalities that are larger than those in any of the three comparator nations. Based on these findings some broad policy implications are briefly outlined. The paper finally identifies some limitations of this research and proposed areas for future research.

1. Introduction

This paper reviews the performance of Australia's transport sector relative to that of the transport sectors in Canada, New Zealand the USA. The review covers the period from 1970 to 2007 or in some instances 2008.

The primary data source for the comparisons it presents is OECD (2010).

The rest of this paper is divided into the following sections:

- Brief Overview: Australia, Canada, New Zealand and United States of America
- Metrics selected for comparative analysis
- Detailed comparisons against chosen metrics
- Key findings
- Broad policy implications
- Conclusions and future research

2. Brief Overview: Australia, Canada, New Zealand and USA

Table 1 presents data on size, population, GDP (measured in US$ current prices & Purchasing Power Parity), GDP per capita and percentage average annual compound growth (AACG) growth in measured GDP for Australia, Canada, New Zealand and USA

Table 1: Comparative data: Australia Canada, New Zealand and USA

	Australia	Canada	New Zealand	USA
Size [1] (000 km^2)	7,692	9,985	268	9,827
Population 2009 (millions) [2]	21.2	30.7	4.2	307.2
Population density (persons/ km^2)	2.8	3.1	15.8	31.3
GDP 2009 (US$b, current prices and PPPs) [3]	876.5	1275.5	124.6	14043.8
GDP /capita 2008 ($US current prices & PPPs)	$38,637	$38,975	$27,036	$47,186
% Average compound growth GDP 1990-2009	5.7%	4.8%	5.1%	4.8%
% Average compound growth GDP 2000-2009	5.5%	4.3%	4.9%	4.0%
% Average compound growth population 1990-2009	0.9%	1.0%	1.2%	1.1%
% Average compound growth population 2000-09	1.2%	0.9%	1.0%	0.9%

Notes

1. Australia, Dept. Foreign Affairs and Trade (2009). Canada & USA, CIA World Fact Book (23 May 2010); New Zealand - www.virtualoceania.net/newzealand/facts/ accessed 13 October 2010.

2. All population data extracted from *OECD Factbook 2010: Economic, Environmental and Social Statistics* - ISBN 92-64-08356-Population and migration - Population - Total population accessed on February 8 2011.

3. 2009 GDP data extracted from OECD (2010) *Principal Economic Indicators* April Page 219 (ISN - 0474-5523): Secretariat estimates for Canada, US, Australia, France. . PPPs are the rates of currency conversion that eliminate the differences in price levels between countries. The PPPs are given in national currency units per US dollar. The price levels and volume indices derived using these PPPs have been rebased on the OECD average.' (http://stats.oecd.org/Index.aspx accessed August 17 2011)

Canada, New Zealand and the USA were chosen as direct comparators to Australia for several reasons.

- All four nations are fully developed, first world economies with high GDP per capita and with comparatively similar average annual compound growth rates for GDP growth (measured in $US Current prices & PPPs) over the years 1900-2009 and 2000-2009 respectively (OECD 2008). Australia's rate of GDP growth as shown in Table 1 has however been faster than that of the other three nations over both time frames. Australia's rate of average annual growth in Real GDP over the years 2005-2008 has also averaged 3.1% per year, compared with 2.2 in Canada, 1.7% per year in New Zealand and 2.1% per annum in the USA (OECD 2010a).
- New Zealand faces similar challenges to that faced by Australia in that it is a sparsely populated nation, it is physically very distant from its major trading partners, with only a few major cities that are quite distant form each other.
- Canada is very similar to Australia in a range of ways. One is the very large mass it covers and its relatively low population density. Another is that its terrain is varied as its climate. Both of these can represent major transport challenges and at times very strong

productivity impediments. Canada unlike Australia does suffer from extremely low temperatures; this creates additional and sizable transport and logistics challenges.

- Like Canada and Australia the USA has a very large land mass. The USA is one of Australia's major trading partners.

3. Metrics selected for comparative analysis

The following metrics have been used to undertake a comparison of the transport sector's performance across both time and the selected countries.

- Freight transport by roads, by rail, all modes in tonne-kms and in Average annual compound rates of growth
- Ratio of freight transport to GDP
- Passenger transport by main modes in passenger kilometres per year, annual percentage of total passenger transport by private car, and estimated annual passenger-kms per capita
- Final energy consumption in the transport sector and total economy 1997-2007
- CO_2 emissions from fuel combustion over time across whole economy and from transport: 1970 - 2008
- Transport fatalities roads (number of persons and per million inhabitants) 1997- 2007
- Gross direct investment in transport infrastructure.

4. Detailed comparisons against chosen metrics

The first set of comparison presented is in the area of freight transport. Table 2 summarises the total tonne-kilometres of freight transport carried by mode in Australia, Canada, New Zealand and the USA (OECD 2010d). Table 2 also computes a measure of freight transport intensity using GDP as the denominator for the years where the data are available.

Table 2: Freight transport Thousand million tonne-kilometres: Australia, Canada, New Zealand, USA 1970- 2008 1

	Freight transport: Thousand million tonne-kms			
	1970	1990	2000	2008
AUS Rail freight	36	87.9	133.6	201.6
AUS Road freight	24.4	81.6	132.3	na
AUS Total freight transport: All modes	60.4	169.5	265.9	379.1
AUS GDP [2]	56.8	295.7	524.6	831.2
AUS Ratio freight transport: GDP	1.06	0.57	0.51	0.46
CAN rail freight	na	na	267.2	290.7
CAN Road freight	na	na	84.7	na
CAN Total freight transport: Road+Rail	na	na	351.9	…
CAN Pipeline freight transport	na	na	90.5	124.0
CAN Inland waterways	na	na	25.4	na
CAN Total freight transport: All modes	na	na	467.8	577.1
CAN GDP [2]	92.9	520.7	874.1	1300.2
CAN ratio freight transport: GDP	na	na	0.54	0.44

	Freight transport: Thousand million tonne-kms			
	1970	1990	2000	2008
NZ Road freight	na	na	14.3	19.5
NZ Total freight transport: All modes	na	na	18.4	23.4
NZ GDP [2]	11.6	48.9	81.1	116.4
NZ Ratio freight transport: GDP	na	na	0.23	0.20
USA Rail freight	na	1509.6	2140.3	2593.1
USA Road freight	na	1239.2	1741.5	na
USA Total freight transport: Road+Rail	na	2748.8	3881.8	na
USA Pipeline freight transport	na	852.8	842.4	na
USA Inland waterways	227.5	426.9	441.7	na
USA Total freight transport: All modes	na	6,777.3	9,047.7	na
USA GDP [2] (estimate)	1024.8	5754.8	9898.8	14369.4
USA ratio freight transport: GDP	na	1.18	0.91	na

Notes:

1. All data from **OECD (2010d): Trends in the Transport Sector**
2. All GDP values are stated in Billion US dollars, current prices & PPPs

The lack of a full set of comparative data for each of the four nations hinders extensive commentary on the data in Table 2. However one clear trend is that the amount of total freight transport in Australia has increased more than six fold over the period 1970-2008 inclusive. Another notable trend in Australia is that by around the year 2000, road's share of total freight almost equalled that of rail. However by 2008, rail's modal share appears to have exceeded that of road freight (i.e. 201.6 thousand million freight kilometres freighted by rail out of a total of 379.1 thousand million freight kilometres). Third, Table 1 indicates that while Australia's freight transport: GDP ratio has reduced by more than a factor of two over the period 1970-2008, However over the more recent period 1990 to 208 this transport intensity ration has reduced at a slower rate, going from 0.57 in 1990 to 0.46 in 2008.

Table 3 shows the relative rate of average annual compound growth in freight transport over the period 2000-2007 and for each nation. This period is the only one for which all the required data are available.

Table 3: Average Annual Compound Growth in Freight Transport

	% Average annual compound growth 2000-07			
	AUS	CAN	NZ	USA
Rail freight	5.8%	2.2%	na	2.7%
Road freight	4.3%	6.7%	na	1.4%
Total freight transport: Road+Rail	5.1%	3.4%	na	2.2%
Total freight transport: All modes	5.1%	3.6%	3.3%	1.8%
Ratio of freight transport: GDP	-1.6%	-1.7%	-2.4%	-3.2%

Notes

1. All data from OECD (2010d): Trends in the Transport Sector

The first point of note in Table 3 is that the average annual compound growth in rail transport freight in Australia in the years 2000-2007 at 5.8% is more than double that of either Canada or the USA. In terms of road freight, the rate of growth in volumes in Australia is faster than that in the USA but considerably slower than that experienced in Canada. Finally the reduction in freight transport intensity as measured by the ratio of freight tonne-kilometres travelled to current GDP Is the slowest in Australia.

Table 4: Total passenger transport (TPT) across time by mode and nation

	Passenger transport: 000 million passenger-kms [1]				
	1970	1990	2000	2007	2008
AUS Total Transport private cars	100.2	200.7	240.5	263.2	na
AUS Tot Transport buses & coaches	6.5	17.5	17.4	19.2	na
AUS Total Road Passenger Transport	106.7	218.2	257.9	282.4	na
AUS Total transport Rail	13.4	10.4	11.3	12.9	13.6
AUS Total passenger transport (Road + Rail)	120.4	228.6	269.2	295.2	na
AUS Est. total population (millions) [2]	12.5	17.9	19.2	21.0	21.2
AUS Est. passenger-kms/ capita (000s)	9.6	12.8	14.1	14.0	na
AUS: % Tot. passenger transport by private car	83.2%	87.8%	89.3%	89.2%	na
CAN Total Transport private cars	na	na	472.0	488.0	479.0
CAN Tot Transport buses & coaches	na	na	30.0	15.5	na
CAN Total Road Passenger Transport	na	na	502.0	503.5	479.0
CAN Total transport Rail	na	na	1.5	1.4	1.5
CAN Total passenger transport (Road + Rail)	na	na	503.5	504.9	496.0
CAN Est. total population (millions) [2]	21.8	26.7	30.7	33.0	33.4
CAN Est. passenger-kms/ capita (000s)	na	na	16.4	15.3	14.9
CAN: % TPT by private car	na	na	93.7%	96.7%	96.6%
USA Total Transport private cars	2,817.8	3,671.5	4,094.9	4,248.9	na
USA Tot Transport buses & coaches	na	195.4	259	238	na
USA Total Road Passenger Transport	2817.8	3866.9	4353.9	4487	na
USA Total transport Rail	9.9	9.7	8.8	9.3	9.9
USA Total passenger transport (Road + Rail)	2827.7	3876.7	4362.7	4496.3	na
USA Est. total population (millions) [2]	195.1	249.6	282.2	301.3	307.2
USA Est. passenger-kms/ capita (000s)	14.5	15.5	15.5	14.9	na
USA % TPT by private car	99.6%	94.7%	93.9%	94.5%	na

Notes

1. All passenger-kilometre data extracted from OECD 2010 *Trends in the Transport Sector*, OECD Publishing, Paris pp. 62-66.

2. All population data extracted from *OECD Factbook 2010: Economic, Environmental and Social Statistics* - P*opulation and migration - Population - Total population* accessed on February 8 2011.

3. No data are available form OECD 2010 *Trends in the Transport Sector* for Passenger transport in New Zealand over the periods of this study.

The next data analysed are for total passenger transport movements. The first notable element of the data presented in Table 4 is that the private car is still the dominant mode of passenger transport in Australia, Canada and the USA. However while the modal share of passenger transport by private car in Australia over the years 2000 to 2007 has remained virtually static (89.3% compared to 89.2%) it has risen from 93.7% to 96.7% in Canada. The private motor cars' share of passenger transport in the USA has also grown to 94.5% in 2007 from 93.9% in 2000, making it almost equal to its modal share in 1990 of 94.7%. Despite the recent just noted slowdown in the private motor car's share of total passenger transport in Australia, Australian passenger travellers have increased their travel by private motor car on average around 70 kilometres per year over the period 1990-2007 (based on the increase shown in Table 4 from 12800 kilometres per year in 1990 to 14000 kilometres in 2007); their fellow private travellers in the USA have reduced on average their annual kilometres travelled by private car by around 35 kilometres over the same time frame (from 15000 kilometres in 1990 to 14900 kilometres in 2007).

The next noteworthy data presented in Table 4 relate to the estimated total passenger-kilometres travelled per year. The data show that Australian passenger travellers have increased the number of kilometres travelled per year by on average 1200 kms per year over the period 1990-2007: from 12800 passenger kilometres per capita in 1990 to some 14000 passenger kilometres per capita in 2007. Their fellow private travellers in the USA have reduced on average their annual kilometres travelled by some 600 kilometres over the same time frame. In the most recent years for which data are available — 2000 to 2007 — Table 4 shows that Australian personal travellers have slightly reduced their annual kilometres travelled from 14,100 to14, 000; Canadians have reduced their annual private travel by on average 1100 kms to 15,300 kms and US private travellers have dropped some 600 kms to a total of 14900 kms.

The third aspect of this paper's analysis centres on energy usage and energy emissions. Table 5 presents data for the years 1997-2007 on energy consumption by the transport sector and by the economy overall. The percentage change in final energy consumption in the Australian transport sector, at 11.3 % over the period 1997-2007, is the lowest of the four nations. Moreover, Australia is the only one of the four nations in this study where the percentage increase of final energy consumption in the transport sector is lower than the percentage increase final energy consumption for the total economy over the period 1997-2007.

Table 5: Final energy consumption: Transport sector and Total economy 2007

	Final energy consumption: Transport sector [1]		Final energy consumption Total economy		2007 % Transport consumption: total energy consumption
Country	2007 Mtoe [2]	% Change 1997 to 2007	2007 Mtoe[2]	% Change 1997 to 2007	
Australia	27.13	11.3%	75.93	15.8%	35.7%
Canada	58.02	14.6%	204.98	11.9%	28.3%
New Zealand	4.96	29.8%	12.43	9.7%	39.9%
USA	635.78	14.8%	1587.83	10.4%	40.0%
Average	na	17.6	na	12.0%	30.0%

Notes

1. Including non-energy use.

2. Mtoe = Million Tonnes of oil equivalent.

Source: OECD in Figures 2009 : Energy consumption and electricity generation, 2009.

Table 6 shows data on the quantity of CO_2 emissions across the whole economy in five separate years and the percentage average annual growth over the periods 1971-2008, 1990-2008 and 2000-2008 where required data are available. The latter parameters indicate that Australia has had the highest rate of average annual compound growth in CO_2 emissions across each of the three time horizons analysed. The proportion of total greenhouse gas emissions from fuel combustion contributed by the transport sector in Australia in 2005 of 14.4 % was almost half that of the USA transport sector (28 %) and considerably lower than the sector in Canada (26 %) (NTC and Rare Consulting, 2008, p. 5). However, in 2008 the Australian transport sector's share of total CO_2 emissions reportedly rose to 20.1 %, up from 14.1 % in 2005. This sizable increase compares with an increase of 13.1 % in Canada and an increase of 7.9 % in the USA. This is comparatively rapid increase is concerning given that transport emissions 'are one of the fastest growing sources of emissions growth in Australia' with 'strong growth in the emissions from the transport sector … expected to continue, with direct CO_2 equivalent emissions projected to increase 22.6 % over the period 2007 to 2020 (or around 1.58 % a year)' (Infrastructure Australia, 2010) . This expected growth in transport emissions is projected to be met less through productivity improvements and more through the 'addition of approximately 50,000 trucks to the national fleet between 2005 and 2020, approximately half of which are predicted to be large articulated trucks' (NTC and Rare Consulting, 2008, p. 9). Similar predictions are made for the road transport sectors in the United States where greenhouse gas emissions in the road transport sector have been estimated to grow by 28 % from 2004 levels by the year 2020 for the 'business as usual' scenario; in Canada total greenhouse gas emissions are forecast to be '36 % higher than they were in the year 2000; (and) the transport sector is expected to be the largest contributor' (NTC and Rare Consulting, 2008, p. 41).

Table 6: CO2 emissions from fuel combustion over time across whole economy and from transport: 1970 - 2008

	CO_2 emissions from fuel combustion[1] Million tonnes							
	1971	**1990**	**2000**	**2005**	**2008**	%ACG 1971-2008	%ACG 1990-2008	%ACG 2000-2008
AU CO_2 total	143	260.1	338.8	388.8	397.5	2.80	2.38	2.02
AU CO_2 transport	na	na	na	56.0	79.7	na	na	na
CAN CO_2 total	339.4	432.3	532.8	558.8	550.9	1.32	1.36	0.42
CAN CO_2 transport[2]	na	na	na	145.3	162.0	na	na	na
NZ CO_2 total	13.7	22	29.8	33.5	33.3	2.43	2.33	1.40
NZ CO_2 transport	na	na	na	na	13.9	na	na	na
USA CO_2 total	4291.3	4868.7	5698.1	5771.7	5595.9	0.72	0.78	-0.23
USA CO_2 transport [2]	na	na	na	1616.1	1691.6	na	na	na

Notes

1. Data from OECD CO_2 emissions by sector in 2008 Excel analysis accessed 1 February 2011.

2. 2005 estimate of CO_2 emissions million tonnes from transport for USA and Canada based on % of total Greenhouse gas emissions cited in NTC & Rare Consulting 2008, p.5

The next comparison explored is the incidence of road fatalities. Table 7 compares the incidence of road fatalities across the four selected nations over five years. In the most recent period of 2000-2007, Australia has achieved the largest average annual percentage reduction in road fatalities of the four nations, with an average annual drop of over 5 %, compared to 1% in Canada, over 3% in New Zealand, and 0.3 % in the USA.

Australia has also achieved the biggest average drop per annum in road fatalities over the longest period of analysis — 1970 to 2008. Since 2005 however road fatalities in the USA have dropped 25 %, from a total of 43,510 fatalities in 2005 to a total of 32788 in 2010 (NHSTA 2011) due in part by a comprehensive campaign by the Department of Transport 'promoting strong traffic safety laws coupled with high-visibility enforcement and through rigorous vehicle safety programs and public awareness campaign' (NHTSA 2011). In 2009, the US recorded its lowest death toll on the roads for more than sixty years (OECD 2010f). Australia has had success in reducing the number of roads deaths per 100 million vehicle kilometres travelled. In 1976, 3.55 deaths per 100 million kilometres travelled on Australian roads occurred; whereas in 2007, the figure had dropped to 0.74 deaths per 100 million kilometres travelled (Department of Infrastructure, Transport, Regional Development and Local Government, 2009, Table 6, p. 18).

Table 7: Road fatalities 1970- 2008

	Killed in road injuries (000s)					% ACG 1970-08	% ACG 1990-08	% ACG 2000-08
	1970	1990	2000	2007	2008			
Australia	3.8	2.3	2.3	1.6	1.4	-2.5%	-2.56	-5.83
Canada	5.1	4.0	2.9	2.7	2.4	-1.9%	-2.71	-2.35
New Zealand	0.7	0.7	0.5	0.4	0.4	-1.7%	-3.55	-3.86
USA	52.6	44.6	41.9	41.1	37.4	-0.9%	-0.97	-1.42

Source:

OECD (2010) *Trends in the transport sector* Road Injury Accidents Table C3: Killed, p. 69

The number of road fatalities per million of population billion kilometres travelled is another regularly cited statistic. Table 8 presents these data. Each of the four nations has achieved a substantial reduction in road fatalities per capita of population over the term 1990-2009. In this time frame Canada and New Zealand have more than halved the number of road fatalities per million of population; Australia has virtually halved this statistic and the USA has shed slightly more than 41% of road fatalities per million of population. In the most recent period for which data are available, Australia has reduced the rate of road fatalities per million of population at an average annual compound growth rate of rate of 3.48% per annum. This is slower than that achieved by Canada (4.45%) but slightly faster than the reduction achieved by the USA (3.32%) and by New Zealand (3.27%).

Table 8: Road fatalities per million inhabitants over time: 1990 to 2009

	Road fatalities per million inhabitants [1]								
	1990	1993	1996	2000	2002 [2]	2005 [2]	2007 [2]	2009 [2, 3]	% ACG 2000-2009
Australia	137	111	108	95	87	81	77	69	-3.49%
Canada	150	125	103	95	93	91	83	63	-4.46%
New Zealand	217	172	141	120	103	99	100	89	-3.27%
USA	188	156	158	149	149	147	136	110	-3.32%
Average	173	141	128	115	108	105	99	83	-3.57%
SDeviation	36.5	27.9	26.4	25.7	28.1	29.3	26.5	21.3	-2.06%

1. 1990 - 2005 data from OECD (2010) Trends in the transport sector Road Injury Accidents
2. Source: Bureau of Transport, Infrastructure and Regional Economics (2010) *Road deaths Australia 2010 Statistical Summary*
3. 2009 data from OECD (2010) A Record Decade for Safety Press release, Paris,

The final comparison between this study's four nations is the level of gross direct investment in transport sector's infrastructure as detailed in Table 9 to the extent that data are available. One general observation is that the average annual compound rate of growth (ACG) of gross investment into road infrastructure over the period 2000-08 is the fastest in Australia (12.2% pa) compared with 10.5% in New Zealand and only 3.4% in Canada. The second general observation is that the average annual compound rate of growth in total reported gross investment over the years 2000-08 in Australia of 14.1% is higher than for both New Zealand (10.5%) and for Canada (1.2 %).

Table 9: Gross Direct Investment in transport: current prices and exchanges - Million Euros

Direct investment in:	**1995**	**2000**	**2005**	**2007**	**2008**	%ACG 1995-08	% ACG 2000-08
AUS Road infrastructure [1]	2424	3697	6736	8025	9263	10.86%	12.2%
AUS Rail infrastructure [1]	571	411	1493	1962	1727	8.89%	19.7%
AUS Sea Port infrastructure [1]	60	96	577	702	1057	24.69%	35.0%
AUS Tot. reported investment	3055	4204	8806	10689	12047	11.1%	14.1%
CAN Road infrastructure [1]	na	116	119	144	152	na	3.4%
CAN Sea port infrastructure [1]	na	68	65	75	71	na	na
CAN Airports infrastructure	na	25	8	10	7	na	-14.7%
CAN Tot. reported investment	**na**	209	192	229	230	na	1.20%
NZ Road infrastructure[1]	na	181	301	407	403	na	10.5%
NZ Tot. reported investment		181	301	407	403	na	10.5%
USA Road infrastructure [2]	30,352	61,401	na	na	na	na	na
USA Rail infrastructure [1]	3303	7036	7376	na	na	na	na
USA Airports infrastructure [1]	4763	13241	na	na	na	na	na
USA Inland waterways [1], [2]	1117	4436.	na	na	na	na	na
USA Tot. reported investment		86114	7376	na	na	na	na

Source:
1. For Rail investment; OECD 2010d Gross Investment in Transport Infrastructure table D1, D2, D3, D4, D5. 2. For US road and inland waterways gross investment data, Eurostat

5. Key findings

This section outlines in tabular form the key findings from this international comparative analysis. Table 10 summarises areas covered by this comparative study in which the Australian land transport sector has either grown in either quantity or percentage terms more quickly or less quickly relative to its counterpart in Canada, New Zealand or the USA in the period covered by this paper. All the data presented in Table 10 have been extracted from the foregoing analysis and thus are subject to the same limitations and methodological assumptions.

Table 10: Key Findings

Australia's transport sector has grown more quickly in respect of	Australia's transport sector has grown less quickly in respect of
The average annual compound growth in rail transport freight in Australia in the years 2000-2007 at 5.8 % is more than double that of either Canada or the USA.	The reduction in freight intensity as measured by the ratio of freight tonne-kilometres travelled to current GDP is the lowest in Australia.
The rate of growth in road freight transport volumes is faster than that in the USA.	The rate of growth in road freight volumes is considerably slower than that experienced in Canada.
The number of kilometres travelled per year by private motor car in Australia has on average increased around 70 kms per year over the period 1990-2007, whereas private travellers in the USA have reduced on average their annual kilometres travelled by on average 35 kilometres over the same time frame.	The modal share of passenger transport by private car over the years 2000-07 in Australia has dropped by one tenth of one % but risen from 93.7% to 96.7% in Canada and from 93.9% to 94.5% in the USA.
Australia has had the highest total rate of average annual compound growth in CO_2 emissions across each of the three time horizons analysed. In 2008 the Australian transport sector's share of total CO_2 emissions rose to 20.1 % up from 14.1 % in 2005. This increase of 42.5 % compares with an increase of 13.1% in Canada and an increase of 7.9% in the USA.	The percentage change in final energy consumption in the Australian transport sector, at 11.3 % over the period 1997-2007, is the lowest of the four nations. Moreover, Australia is the only one of the four nations in this study where the percentage increase of final energy consumption in the transport sector is lower than the percentage increase final energy consumption for the total economy over the period 1997-2007.
Australia has also achieved the biggest average drop per annum in road fatalities over the longest period of analysis — 1970 to 2008. During 2000-2007, across the four nations Australia has achieved the largest average annual percentage reduction in road fatalities.	During the period 2000- 2009 the average annual rate of reduction in road fatalities per million of population in Australia (3.48%) is slower than that achieved by Canada (4.45%).
The average annual compound rate of growth (ACG) of gross investment into road infrastructure over the period 2000-08 is the fastest for in Australia (12.2% pa) compared with 10.0% in New Zealand and only 3.4% in Canada.	

6. Broad policy implications

This section attempts to briefly outline some broad policy implications that stem from the international comparisons discussed in the earlier sections of this paper and the key areas of Australia's transport system's comparative performance summarised in Table 10. Its overall purpose is neither to blindly praise nor to unfairly criticise current transport policy or policy makers and their advisers; it is to sketch out possible policy reforms or innovations in those areas where the data used in this research indicate that new or amended regulations, or reforms, and at times incentives could assist Australia's transport sector in achieving more optimal, sustainable and internationally laudable outcomes.

Table 10 indicates first that rail freight transport in Australia over the period 2000-2007 grew at more than double the average annual growth achieved in both Canada and the USA. It is difficult to draw out policy implications from these data without disaggregation and

localisation both geographically and by type of produce carried. The freight intensity finding can be more specifically commented on in the sense that the rate of decoupling of economic activity from the freight task in Australia over the years 2000-07 is slowest of the four nations, and thus the impacts of changes in economic circumstances and/ or changes in the freight environment will probably be felt more quickly and directly in the land transport sector in Australia than in this sector in either Canada or in New Zealand or in the USA. Governmental efforts to further reduce freight intensity could activate a broad range of policy levers including changes in vehicle size regulations, taxation and pricing policies, recycling requirements and the removal of barriers or impediments to interstate and international trade (Gleave and Eder 2003 p. 89). However in respect of attempts by Australian governments to road reduce freight intensity it is worth noting as do Gleave and Eder (2003 p. 90) that the main objective of current European road freight policy is not to reduce freight intensity per se, but rather to 'ensure that road freight users pay the full marginal social costs of transport'.

The second finding shown in Table 10 reveals that the average annual rate of growth in road freight transport volumes in Australia is faster than that in the USA but considerably slower than that experienced in Canada. Increases in road freight volumes per se are neither positive nor negative from a marginal long run social cost or benefit perspective. We concur with Christensen (2009) who remarks that such increases in freight transport volumes mean that 'the regulatory and pricing frameworks for each transport mode need to be designed to promote efficient use of existing infrastructure and provide opportunities and incentives for innovation to improve productivity and reduce environmental and safety costs across freight transport as a whole.' Among the required regulatory and pricing interventions for optimal outcomes are 'controls over access to the road network and prescriptive safety and emissions standards' (Christensen 2009). The use of 'technological innovations, such as GPS tracking for route access compliance and mobile information technologies to monitor truck loading without the need to stop vehicles at the roadside' in other countries have enhanced compliance regimes (Christensen 2009). New South Wales in complimented by the ITF/ OECD for its development of its "chain of responsibility" law that has improved regulatory compliance significantly (Christensen 2009). Australia along with several other nations overall has been complimented for adopting a performance based approach to regulation: such an approach 'defines the environmental and safety objectives to be attained whilst leaving the means for achieving them unspecified' (Christensen 2009). The ITF/ OECD also highlight the potentially valuable role that 'appropriate road pricing systems' can play in optimising road freight volumes and modal share by becoming ' a flexible tool for managing the use of the network with a potential for incentivising multimodality where this is an option' (Christensen 2009). The progress of road pricing reforms in Australia, however, seems to be glacial. This is not the place to explore the reasons for such extremely slow progress—perhaps suffice to note that achieving both national and inter-state accord on this rudimentary reform and acceptance by all key non-government stakeholders is arguably easier to aspire than to achieve.

The third key finding in table 10 is that modal share of passenger transport by private car over the years 2000-07 in Australia has dropped by 0.1% and in 2007 is appreciably lower than it is in either Canada or the USA. However modal share of passenger transport by private car is still higher in Australia than in either 1990 or 1970 and shows no signs of reducing on its own. Moreover the annual number of kilometres travelled by private car in Australia on a per capita of population have increased on average around 70 kms per year over the period 1990-2007, whereas the corresponding statistic in the USA has slightly reduced. Evidently the private motor car is entrenched and some would argue enshrined in our private travelling psyche and governments that aspire to reduce this modal share face quite challenging behaviour change seeking agenda. Nonetheless the widely acknowledged need to reduce our national carbon footprint, and to seek ways to reduce the proven and published health effects of vehicle generated air pollution (for instance BTRE 2005), and to curb to the extent possible the national costs of traffic congestion (BTRE 2007) arguably compel policy makers among other things to search for ways 'to frame public transport

people moving strategies that are well researched, that are informed by extensive stakeholder inputs and dialogues, that are long-term in nature, that recognise state differences but seek to develop national standards and best practice approaches, and that are securely funded over the life cycle of projects involved' (Odgers 2010). Other policy initiatives are of course warranted: among them incentives for the purchase and use of environmentally more benign motor vehicles; road pricing so that road users bear the full social cost of road usage; and congestion taxes similar to those in London and other large metropoles.

The next aspect detailed in Table 10 relates to final energy consumption. The percentage total change in final energy consumption in the Australian transport sector, at 11.3% over the period 1997-2007, has been the lowest by a considerable amount, especially as compared to New Zealand. Equally favourable is the fact that Australia is the only one of the four nations in this study where the percentage increase of final energy consumption in the transport sector is lower than the percentage increase final energy consumption for the total economy over the period 1997-2007. Given the previously noted faster than comparator rate of growth in freight transport million tonne kilometres in Australia over the period 2000-07 of 5.1% per year, these data indicate that energy usage in the Australian transport sector has been relatively efficient. The maintenance of current energy efficiency enhancement policies along with the introduction of new policies or policy amendments aimed at encouraging this fuel efficiency to continue are needed to ensure this positive energy efficiency outcome is maintained.

The offset to this comparatively positive outcome however is in relation to the Australian transport sector's relative performance in respect of CO_2 emissions. As Table 10 notes Australia as a nation has had the highest total rate of average annual compound growth in CO_2 emissions across each of the three time horizons analysed. More specific to the purpose of this study, in 2008 the Australian transport sector's share of total CO_2 emissions rose to 20.1 % up from 14.1% in 2005. This increase of 42.5 % compares with an increase of 13.1% in Canada and an increase of 7.9% in the USA. Admittedly in 2005 the Australian transport sector's contribution to CO_2 emissions from fuel combustion was only 14.4%, as compared to 26 % for Canada and 28% for the USA. Nonetheless putting a direct price on carbon and thus signalling that it has a real and calculated economic cost attendant on its creation or occurrence is arguably the most appropriate policy initiative for any government intent on trying to set policy in a conceptually sound, long-term and far-sighted way. Neither the CPRS nor the current carbon tax scheme however has this as policy intent. The current exemption of transport fuel from the federal Government's carbon tax and the payment by 'big business' for the nominal cost of a carbon tax on their fuel through adjustments in the existing excise arrangements (Taylor 2011) also seems at odds with sound socio-economic policy. Perhaps suffice to note there that a full and objective analysis and 'debate' of these very high-level environmental policy issues are however far beyond the scope of the current paper.

The second last finding detailed in Table 10 is that Australia has achieved the biggest average drop per annum in road fatalities over the longest period of analysis — 1970 to 2008. In the period 2000-2008 Australia also recorded an average annual percentage reduction in road fatalities of over 5.8 % per year as compared to New Zealand with just under 3.9%, Canada with 2.35% and the USA with just over 1.4%. During 2000-2007, across the four nations Australia has achieved the largest average annual percentage reduction in road fatalities. A continuance of and continuous improvements to our existing set of road safety policies and legislative regimes clearly is in order.

The final area detailed in Table 10 deals with gross investment levels in transport infrastructure. The average annual compound rate of growth (ACG) of gross investment into road infrastructure over the period 2000-08 is the fastest in Australia (12.2% pa) compared with 10.0% in New Zealand and only 3.4% in Canada. The average annual compound rate of growth in total reported gross investment over the years 2000-08 in Australia of 14.1 % is higher than for both New Zealand (10.5%) and for Canada (1.2%). Given the projected

increase in both the national freight task and the total distance of private travel likely to be undertaken into the foreseeable future coupled with the declining state of at least some of our national infrastructure stock, on-going and long-term investments by both the public and the private are arguably both necessary and potentially a source of competitive advantage. Clearly Infrastructure Australia has a clear and crucial role to play in ensuring that all investment projects calling on government funding are well thought through and subject to rigorous, independent, triple bottom line evaluation.

7. Conclusions and future research

The Australian land transport sector has grown consistently over the last four decades. Annual growth in overall freight transport volumes has been recently increasing overall at a faster annual rate than in Canada, New Zealand and the USA, but has slightly lower than average annual compound growth in GDP. Annual growth in total passenger transport by road and rail on the other hand has been less than one quarter of the average compound rate of growth in GDP over the years 1990-2007. Our over reliance on private vehicles for passenger transport is still evident, although the same is true in Canada, New Zealand and the United States of America. The transport sector between 1997 and 2007 has performed relatively well in respect of the percentage increase in final energy consumption. However more needs to be done or at least attempted to reduce or at least keep steady the transport sector's role on CO_2 emissions. Finally Australia's transport sector is achieving average annual percentage reductions in road fatalities that are larger than those in any of the three comparator nations.

In closing, the analysis presented in this paper has several limitations. This study relies completely on public domain data and is thus limited to the scope and currency and comparability across nations of such data. No attempt has been made to check for significant inconsistencies between either the data collection methodologies or the reliability, validity and integrity of the data collected across the four nations reviewed in this study. It has been assumed that the OECD's data collection methodologies and instructions to contributing nations and specific data gathering and reporting entities would to an adequate extent ensure such data reliability, validity and integrity. Any such differences in data quality obviously negatively impinge on the merit of cross country comparisons and bench marking exercises such as the one undertaken in this paper. Moreover this study can only be described as adopting a very coarse grain method of analysis in the sense that as noted by one of its reviewers, 'it does not have a consistent treatment of data with regard to use of absolute values or normalized for different economic, population and such parameters.' The overall usefulness of its findings may accordingly be questioned. Finally this study does not consider important issues such as traffic congestion, or the relative use of intelligent technologies in transport, or the regional differences both within the nations studied and across the nations.

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