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Predicting Traffic Growth in Australian Cities

Staff Paper

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PREDICTING TRAFFIC GROWTH IN AUSTRALIAN CITIES

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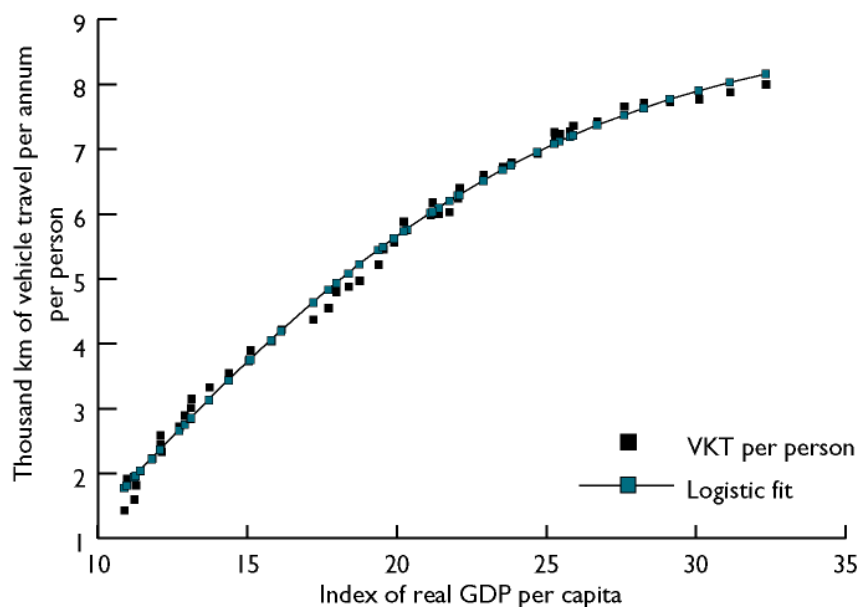
Introduction

Traffic growth is obviously important for planning road systems. This is especially true in cities, where growth is occurring within the confines of a semi-constrained spatial system. The Bureau of Transport and Regional Economics (BTRE) has recently completed an exercise in forecasting the growth in traffic expected in each of Australia's capital cities over the coming decades (BTRE 2003), using a complicated methodology. This paper presents a 'short-cut' methodology to that of BTRE (2003) that allows an overview of how we see the various causal factors operating to produce traffic growth in our cities.

Car traffic growth

A simplifying framework for explaining car traffic (vehicle kilometres travelled or vkt) is the following: $Car\ traffic = Car\ travel\ per\ person * Population$

The advantage of this formulation is that, for Australia, it turns out that car travel per person has a simple relationship to economic activity levels. The trend in per capita car travel (kilometres per person) in Australia has in general been following a logistic (saturating) curve against real per capita income – measured here by real Gross Domestic Product (GDP) per person (see Figure 1).



Source: BTRE (2002a) p.14, annual interpolations from ABS (2003) and earlier (from 1965).

Figure 1 Per capita historical trend in annual passenger travel versus real Australian income levels

Here, then, we have the basis for understanding the relationship between car traffic and economic development. As incomes per person increase, personal car travel per person also increases, but at a slowing rate over time. In other words, more car travel is attractive as incomes rise, but there reaches a point where further increases in per capita income elicit no further demand for car travel per capita. However, traffic continues to respond in a one-to-one relationship to population growth (that other component of aggregate economic activity levels).

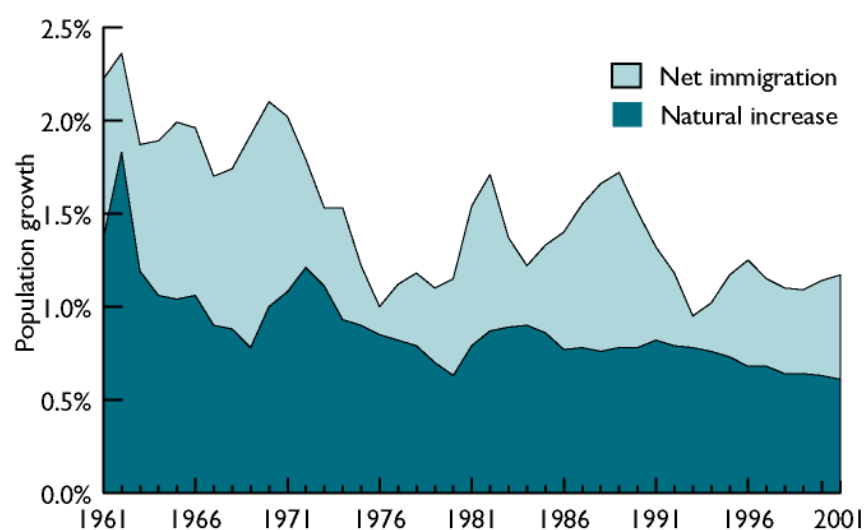
Car traffic projections for Australian cities

Once again, our formula for understanding the relationship between car traffic growth and economic growth is: $\text{Car traffic} = \text{Car travel per person} * \text{Population}$

The assumed base case rate of GDP growth of 2.7 per cent per annum over the 18 years from 2002 to 2020 (Treasury 2002) implies that Australia-wide per capita car travel should level out at around 9000 kilometres per person by 2020 – about a 12% increase on 2002. After 2020, growth coming from this first term in the equation will be insignificant.

There is still the growth in car travel resulting from population growth. The two main sources of population growth are natural increase and immigration. The contribution each has made to population growth over the last 40 years is shown in figure 2 (where the two components have been stacked). The average growth rate of both components has tended to decline over time.

The Australian Bureau of Statistics has previously produced three scenarios for population growth – see www.abs.gov.au for details – projecting national population to be between about 22 million and 24 million people by 2020. The following analysis uses population projections based on the trend to 2020 of the ABS Series III projections (ABS 2001b). This assumes a net immigration level of about 70,000 persons per year and a further decline in the rate of natural increase (due to a fairly rapid ageing of the population, coupled with a fairly low fertility rate). The population of Australia is forecast to reach about 22.2 million in 2020 under this scenario.



Source: BTRE (2002a) p.16.

Figure 2 Components of Australian population increase

The ABS population projections are also available for Australia's cities. If we use national car travel per person percentage increases and capital city population projections (BTRE 2003, p 361), Table 1 gives the resulting (unconstrained) car traffic projections. For example, the national percentage projected increase in car travel per person is $(8.87-7.94)/7.94*100 = 11.7\%$. Increasing Sydney's 7.035 thousand vkt per person by that amount gives the projected 2020 level of 7.858 thousand per person. Multiplying this by Sydney's projected 2020 population of 4.999 million gives projected 2020 Sydney car vkt of 39300 Mvkt. It should be noted that the national level of vkt per person is higher than the metro level, but it is assumed the latter will saturate in a like manner to the national total.

Table 1: Car traffic projections for Australian cities

City	2002			2020			Percent change
	Car	Popul ^(a)	Car ^(b)	Car ^(c)	Popul ^(a)	Car	
	VKT/	(000)	VKT(m)	VKT/	(000)	VKT(m)	2002-
	Person			Person			2020
	(000)			(000)			
Sydney	7.035	4207.5	29,600	7.858	4999.0	39300	+33%
Melbourne	8.089	35556.8	28,770	9.035	4058.4	36700	+28%
Brisbane	6.903	1681.8	11,610	7.711	2188.0	16,900	+46%
Adelaide	7.474	1111.9	8,310	8.348	1170.4	9,800	+18%
Perth	7.163	1430.9	10,250	8.001	1798.1	14,400	+41%
Hobart	7.155	193.0	1,381	7.992	187.7	1500	+9%
Darwin	6.041	93.2	563	6.748	127.2	860	+53%
Canberra	8.962	318.0	2,850	10.011	354.9	3,550	+25%
Metro	7.412	12,593	93,334	8.279	14,884	123,200	+33%
Rest Aust	8.886	7,026	62436	9,994	7,885	78,800	+26%
Total Aust.	7.94	19619	155,770	8.87	22769	202,000	+30%

(a) BTRE(2003) p320-321

(b) BTRE(2003) pp.3-30

(c) The Australia level per cent increase from 7.94 to near saturation at 8.87 is assumed to apply to each city. At the level of the 8 capitals, the increase from car travel per person is 12%, and from population 18.5%. The overall increase in Australia Metro car traffic is then $(1.12 * 1.185 - 1.0) * 100$ or about 33% in 18 years.

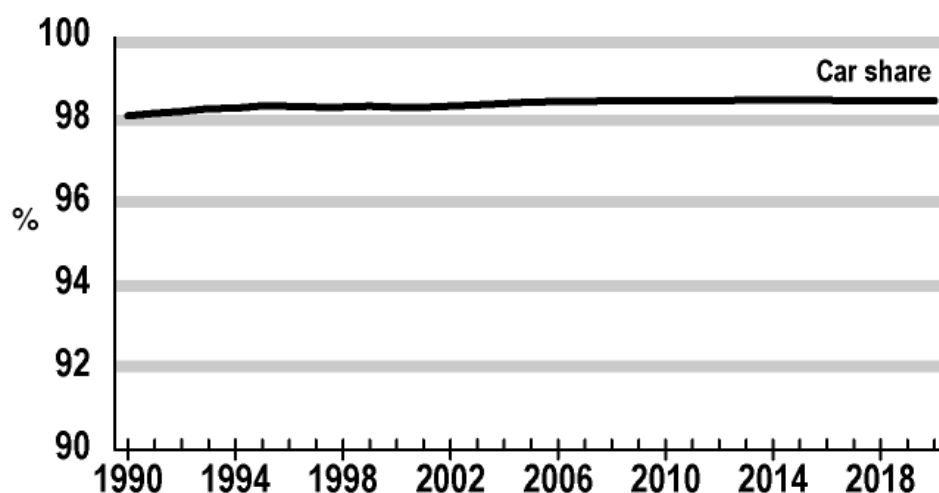
The average increase in car traffic in Australian capital cities is projected to be on the order of 33% (close to the Sydney and Melbourne levels of growth, with the highest growth is in Brisbane, because of its high population growth). Even with a proportion of this growth occurring at the city fringes, this still implies substantial increases in the (unconstrained) level of car traffic on our current city networks.

Buses, motorcycles and traffic growth

Buses and motorcycles form a small part of passenger vehicle traffic in Australian cities. In most of our cities, they account for 2-3 per cent of the total, ie cars routinely account for 97-98 per cent of passenger vehicle traffic. This car share has almost saturated. Within the small bus and motorcycle share, buses have been growing faster, motorcycles slower. A rule of thumb, then, would say that bus and motorcycle traffic combined grows a little slower than car growth. Within the combined traffic, buses are gaining share and motorcycles losing it.

Bus and motorcycle traffic projections for Australian cities

We have forecasts of car vkt by city from previous sections of the paper. If we use trends in national metro car vkt vs national metro passenger vehicle vkt, the following car share graph is generated for the 1990s (see Figure 3). BTRE (2003) p.5 projects the national car share of metro passenger vehicle traffic as rising from 98.3 per cent in 2002 to 98.5 per cent in 2020.



Source: BTRE (2003) p.5.

Figure 3 Cars as a percentage of passenger vehicle traffic

Thus for Sydney, we can use the 2002 car share (98.3 per cent of passenger vehicle traffic) times the national level increase in car share to 2020 ($98.5/98.3$ or 1.002) to calculate the projected Sydney car share in 2020 of 98.5. Using the car vkt projections for Sydney of 39,300 M vkt, and dividing by .985, we get a projection in total Sydney passenger vehicle vkt of 39,998 M. This implies combined Sydney bus and motorcycle vkt of $39,898 - 39,300 = 598$ Mvkt, close to the 638 Mvkt of BTRE (2003) p.9.

The split of this forecast into buses and motorcycles uses national Metro-level competitiveness indices. The national split of combined motorcycle and bus traffic is forecast to go from buses 49.7%, motorcycles 50.3% in 2002, to buses 53.1%, motorcycles 46.9% in 2020. Using these assumptions, competitiveness indices of 1.0037 for buses and 0.9961 for motorcycles are generated. These are simply $(1.0 + \text{the annual growth rate}/100)$, the growth rate being, for example, that annual growth rate needed to turn 49.7% into 50.3% over a period of 18 years.

Applying these, national Metro competitiveness indices to the base Sydney shares of buses and motorcycles, we get the following rough projected 2020 split:

	Sydney 2002 Share		National metro growth factors		Sydney 2020 Share
Buses	47.44%	*	(1.0037)** ¹⁸	=	50.70%
Motorcycles	52.56%	*	(0.9961)** ¹⁸	=	48.99%
Total	100.00%				99.69%

Noting that the total of the shares comes to only 99.69%, we raise each share by 100/99.69 to get the final projected shares in 2020 of 50.86% buses and 49.14% motorcycles.

These are close to the BTRE (2003) p.9, figures of 51.3 and 48.7 percent.

Multiplying these shares by our projected total Sydney bus and motorcycle vkt in 2020 (598 Mvkt), gives projections of 2020 Sydney bus traffic of 304 Mvkt and motorcycle traffic of 294 Mvkt.

Truck traffic growth

The basis mechanism generating truck traffic is as follows:

$$\text{Truck Traffic (vkt)} = \text{Road Freight Task} / \text{Average Load per Truck}$$

In other words the number of truck kilometres is performed in order to carry out the freight task in each city. The number of vehicles travelling is determined by the average load.

In fact, in order to understand the relationship further, it is better to think of truck traffic as the product of numbers of vehicles times the yearly average km they each perform.

The influences of the economy and technological shifts can then be illustrated as below:

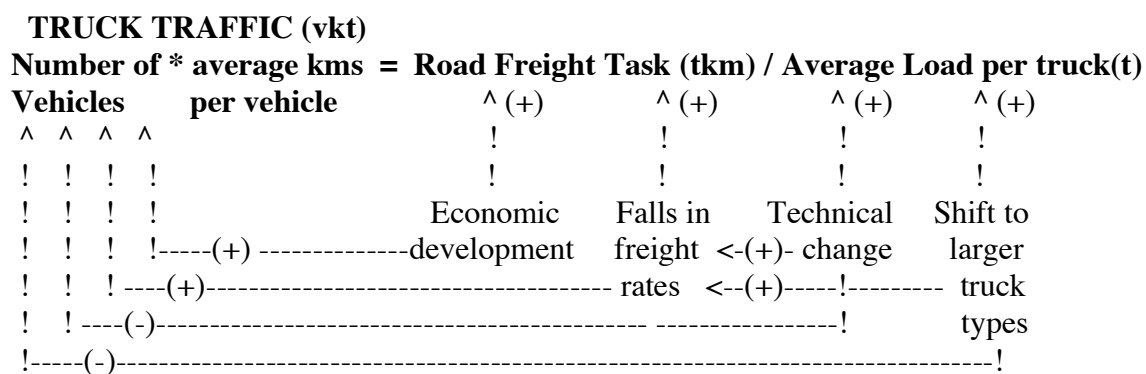
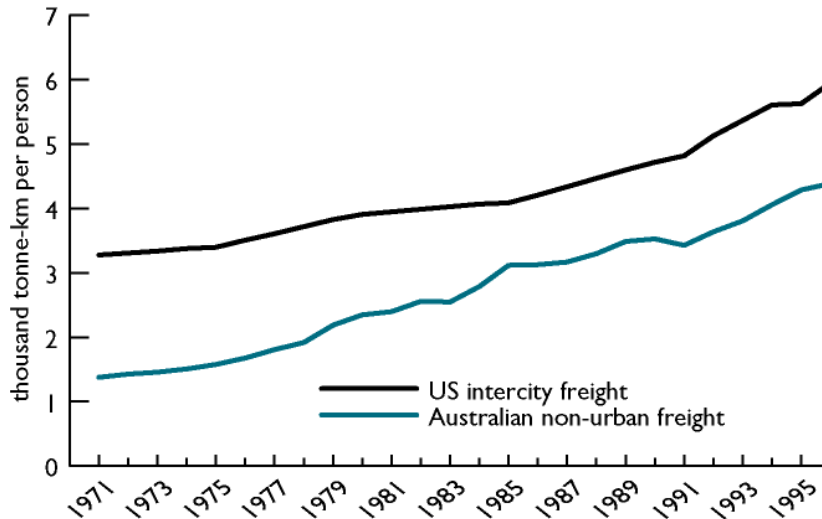


Figure 4 Causes of truck traffic growth

The main influence of economic development is through increases in the freight task. In Gargett (2004), freight task growth was found to react greater than proportionally to the growth rate of the economy - about 1.21 times economic growth. While this relationship cannot continue indefinitely, there are no signs yet of saturation in Australian truck freight use per person (as there are in car travel per person). Similarly, there are no signs of saturation in current levels of United States truck freight per person, and American levels of road freight per person are already much higher than those in Australia (see figure 5).



Source: BTRE (2002a) p. 20, annual interpolations from ABS (2003) and earlier.

Figure 5 Comparison of Australian non-urban per capita road freight and US intercity per capita road freight

The other influence on the aggregate demand for freight transport is the real freight rate. Real road freight rates in Australia have fallen dramatically since 1965, mainly driven by the progressive introduction of larger articulated vehicles, but also by technological change which has made possible lighter vehicles, improved terminal efficiencies, etc. Real freight rates fell 45 per cent from 1965 to 1990, and then another 3 per cent in the 1990s. (BTRE 2002b). In Gargett (2004) a one per cent fall in real road freight rates was found to cause a 0.89 per cent increase in the freight task.

The other influence of technological change is direct. For example, the same weight-reducing technological change that lowers freight rates also makes possible direct increases in average loads.

However, the main influence on average loads has been the continuing shift to the larger articulated vehicles. This directly increases average load and thus has a negative effect on the number of vehicles on the road, and thus truck traffic.

Overall, then, the effects of economic development and its associated technical change can be summarised as follows:

- (1) as the economy grows, the road freight task grows even quicker.
- (2) the shift to larger vehicles makes possible larger loads and therefore less traffic (albeit composed of larger vehicles), but at the same time makes possible lower real freight rates which causes additional demand for freight transport.

- (3) general technological change has a similar “double-edged” effect on truck traffic.

Truck traffic projections for Australian cities

All this can be put into a framework for projecting truck and LCV traffic in our cities. The following exposition of the procedure uses Sydney as an example. The text in italics highlights assumed factors that affect commercial vehicle traffic growth in our cities.

Project the national road freight task

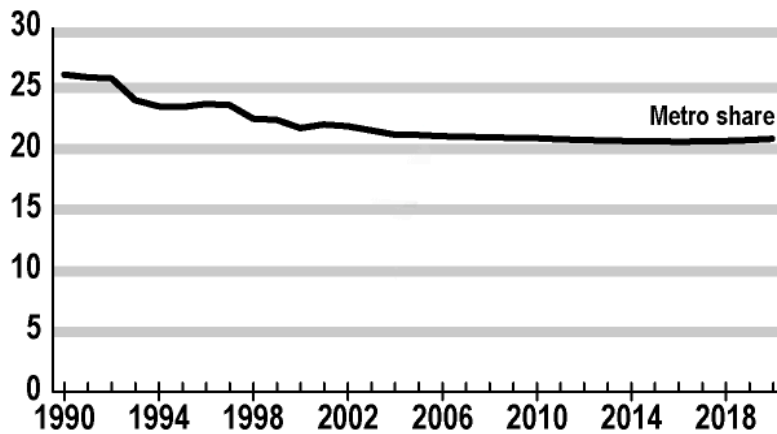
Assume the economy grows on average 2.7 per cent per year from 2002 to 2020 (Treasury 2002). Assume further that real road freight rates fall 0.5 per cent per year over the same period. Then taking 145.66 billion TKM in 2002 as the base (BTRE, 2003 p.365), the 2020 projection becomes:

$$\begin{aligned}
 \text{2020 National freight task} &= \text{2002 National freight task} * (1.0 + (\text{economic growth} * \text{freight multiplier}))^{**\text{no. of years}} \\
 &\quad * (1.0 + (\text{real freight rate change} * \text{freight rate multiplier}))^{**\text{no. of years}} \\
 &= 145.66 * (1.0 + (.027 * 1.21))^{18} * (1.0 + (-.005) * (-0.89))^{18} \\
 &= 145.66 * 1.7836 * 1.0832 \\
 &= 281.4 \text{ B tkm}
 \end{aligned}$$

Which is close to the 287.71 B tkm figure in BTRE (2003, p365), and represents a near doubling of the *national road* freight task in 18 years.

Project the metropolitan (capital cities) share of this

The 8 capital cities share of the national task declined during the 1990's, but the decline slowed towards 2000 (see figure 6). *BTRE 2003 (pp.365-66) projected the share of the capital cities in the national freight task would decline further from 21.9 per cent in 2002 to 20.9 per cent in 2020.* There is indeed uncertainty here as to whether the metro share will in fact flatten off as forecast, but analysts are free to make their own assumptions.



Source: BTRE (2002a) p. 20.

Figure 6 Comparison of Australian non-urban per capita road freight and US intercity per capita road freight

Calculate the projected growth ratio of the Australian metropolitan freight task per person

The metropolitan freight task is calculated as the national freight task times the metropolitan share. To get a per person figure we simply divide by the population of the eight capitals. The projected growth in the Australian metropolitan freight task per person is simply the ratio of the 2020 calculation to the 2002 figure. Thus:

$$\text{Metropolitan Freight Per Person} = \frac{\text{National Freight Task (B tkm)} * \text{Metro share}}{\text{Metro Population (in billions)}}$$

$$\text{Year 2002} = \frac{145.66 * .219}{.012593} = 2,533 \text{ tkm/person}$$

$$\text{Year 2020} = \frac{287 * .209}{.014884} = 4,030 \text{ tkm/person}$$

$$\text{Growth Ratio Metropolitan Freight Task per Person} = 4030 \text{ tkm} / 2533 \text{ tkm} = 1.591 \text{ times}$$

Project each city's freight task

This is done by using the current city's freight task per person, and increasing it by the national growth ratio in freight per person *times the projected population.*

For example, for Sydney:

$$\begin{aligned}
 \text{2002 Sydney Freight Task Per Person} &= \frac{\text{2002 Sydney Freight Task}}{\text{2002 Sydney Population}} \\
 &= \frac{10.73 \text{ B tkm (BTRE 2003, p 326)}}{.0042075 \text{ B people (BTRE 2003, p 321)}} \\
 &= 2550 \text{ tkm per person}
 \end{aligned}$$

Then to calculate the projected 2020 freight task per person for Sydney, the following equation is used:

$$\begin{aligned}
 \text{2020 Sydney Freight Task Per Person} &= \text{2002 Sydney Freight Task Per Person} * \text{Metro Freight Growth Ratio} * \text{Projected Sydney 2020 Population} \\
 &= 2550 \text{ tkm (from above)} * 1.591 \text{ (from step 3)} * .004999 \text{ (BTRE 2003,p361)} \\
 &= 20.3 \text{ B tkm}
 \end{aligned}$$

Which is close to the 20.14 B tkm forecast for Sydney in 2020 given in BTRE 2003 (p.366).

Project the truck type split nationally to get competitiveness indices by vehicle types

In BTRE 2003 (p.363), *the vehicle type split of the Metro freight task in 2002 and a projection for 2020* is given as follows:

	<u>Share of MetroFreight Task (%)</u>	
	2002	2020
Articulated	50.2%	59.5%
Rigids	39.2%	29.5%
LCVs	<u>10.6%</u>	<u>11.0%</u>
Total	100%	100%

If one calculates the annual multiplier needed to get from 50.2% to 59.5% for articulated vehicles over 18 years, one gets 1.0085.

This can be used as a rough “competitiveness index”, where a number above 1.0 indicates that the truck type is gaining in its share of the freight task.

Using the assumed share changes above from BTRE 2003, one gets competitiveness indices for rigids and LCVs of 0.98559 and 1.0019 respectively.

Use the national metro competitiveness indices to project each city's truck type shares

Taking Sydney as our example, and calculating the base Sydney freight shares by vehicle type from the Survey of Motor Vehicle Use (ABS 2003), one can roughly project the shares to 2020 as follows:

	2002 Share of Sydney Freight Task (%)	Growth Factor	2020 Share of Sydney Freight Task (%)
Articulated	46.0% *	$(1.0085)^{18} =$	53.4%
Rigids	44.8% *	$(0.9859)^{18} =$	34.7%
LCVs	<u>9.2%</u> *	$(1.0019)^{18} =$	<u>9.5%</u>
Total	100.0%		97.6%

Noting that the projected shares add to only 97.6%, we increase each estimate by 100/97.6 to get the final estimated city truck type shares in 2020: ie, articulated 54.7%, rigids 35.6% and LCVs 9.7%

Project each city's freight task by vehicle type

For example, for Sydney, the projected total city freight task (from step (4) above) of 20.3 BTKM is multiplied by the truck type shares from step (6), to give the following projected Sydney freight task by vehicle type in 2020:

Articulated	54.7% * 20.3 BTKM	=	11.1 BTKM
Rigids	35.6% * 20.3 BTKM	=	7.2 BTKM
LCV's	9.7% * 20.3 BTKM	=	<u>2.0 BTKM</u>
Total			20.3 BTKM

Project the growth in average load by vehicle type for each city

This is done using assumptions about national Metro load increases. These growth assumptions are then applied to the base city loads. It should be noted that the load figures coming from the ABS Survey of Motor Vehicles have been raised by an average of 12% in BTRE (2003), a BTRE estimate of the under-enumeration of that survey (see Cosgrove & Mitchell 2001). Using the 12% increase on the Sydney tonne-kms by vehicle type, and the vehicle kilometres travelled by vehicle type from BTRE (2003, p.9), average load in 2002 is calculated as follows:

Average Load by Vehicle Type 2002, Sydney

	SMVU BTKM	Correction		BTRE (2003) BTKM	BTRE (2003) BKM		Average Load (t)
Articulated	4.410 *	1.12	=	4.939 /	0.350	=	14.111
Rigids	4.291 *	1.12	=	4.806 /	1.450	=	3.315
LCV's	<u>0.876</u> *	1.12	=	<u>0.981</u> /	6.430	=	0.153

Total	<u>9.578</u>			<u>10.726</u>		
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Similar calculations can be made at the national Metro level, (from BTRE (2003) p.363, Projections of Metro Freight Task by Type of Vehicle, and p5. Projections of Metro Vehicle Kilometres Travelled by Type of Vehicle).

If this is done for 2002 and 2020, it can be seen that, *national metro load per vehicle is assumed to increase at an annual average rate of 0.42% per year for articulated, 0.90% per year for rigids, and 0.30% per year for LCVs over the next 18 years.*

Applying these growth rates to the base Sydney loads, we get the following projected Sydney average loads by vehicle type:

	2002	Growth		2020
	Average load (t)	Factor		Average load (t)
Articulated	14.111 *	$(1.0042)^{18}$	=	15.217
Rigids	3.315 *	$(1.0090)^{18}$	=	3.895
LCVs	0.153 *	$(1.0030)^{18}$	=	0.161

Project Sydney vkt by vehicle type

The last step in coming up with commercial vehicle traffic projections is a relatively simple one. Projected tonne-kilometres in 2020 from step (7) above are matched with average load projections from step (8).

The following calculations are the result.

	Projected 2020		Projected 2020		Projected 2020
	tonne- kms (Btkm)		average load (t)		veh kms (B kms)
Articulated	11.1	/	15.217	=	0.729
Rigids	7.2	/	3.895	=	1.849
LCV's	<u>2.0</u>	/	0.161	=	12.422
Total	<u>20.3</u>				

These numbers are close to the projections in BTRE (2003) of articulateds 0.72, rigids 1.75, and LCVs 11.95.

The advantage of the simplified framework above, lies in the understanding of and control of the assumptions that go into the projections of commercial vehicle traffic. All of the items in italics in the sections above are assumptions about economic and technical changes. The framework shows how these changes generate commercial vehicle traffic growth in a city like Sydney.

Projections of total traffic for Australian cities

The forecast growth in total traffic in the various cities is as below:

Table 2 Traffic projections to 2020 for Australian capital cities

	2002 VKT	2020 VKT	Change 02-20
Sydney	38.35	54.65	43%
Melbourne	34.53	47.12	36%
Brisbane	15.12	22.87	51%
Adelaide	10.05	12.95	29%
Perth	13.47	19.97	48%
Hobart	1.75	1.98	13%
Darwin	0.88	1.26	43%
Canberra	<u>3.56</u>	<u>4.76</u>	34%
Metro	<u>117.70</u>	<u>165.56</u>	41%

Variations in city growth rates (eg the high growth in Brisbane, Perth and Darwin, and the low growth in Hobart) are due mainly to variations in projected population growth. However, the average Metro growth in traffic is 40-plus per cent over the 18 years.

Tables giving details of traffic forecasts by type of vehicle for each Australian capital city are given below. The first table summarises the unconstrained projections for the 8 capital cities combined. (It should be noted that there might be several reasons for traffic growth to be constrained below these forecasts, not the least of which is increasing levels of congestion).

Cars continue to be the largest component of the traffic stream. Their growth of 33 per cent is, as we have seen, composed of 12% growth coming from the effect of rising income levels on per person travel, and the rest from the projected increase in population of the 8 capital cities. Buses and motorcycles continue to be a small part of the traffic stream. Articulated trucks grow quickly, but their numbers are small.

However, LCVs are projected to be a substantial and an extremely quickly growing part of the traffic stream. It is essentially their projected growth that substantially lifts the growth in total Metro traffic to 41% vs the 33% for cars.

A subsequent paper (Gargett & Gafney 2004) discusses the implications of this large increase in Metro traffic, and how policy measures might help to either reduce it or cater for it. Suffice to say, increases in traffic of the size foreseen here will have major implications for mobility and amenity in our cities.

Summary

The methodology summarised here allows one to grasp the essentials of traffic growth in our cities.

For cars, the level of car travel per person in the city is increased by the growth expected in the national figure (whose growth is driven at a decreasing rate by growth in GDP per person). Then the expected growth in car traffic for the city is simply the predicted car travel per person times the predicted population.

Buses and motorcycles are a tiny fraction of the passenger vehicle traffic and can be predicted with share models working off national-level assumptions.

Commercial vehicle traffic predictions are slightly more involved. The method suggested here starts with the predicted national road freight task. It then goes by way of a share analysis to the expected national Metro road freight task and the increase in the national Metro task per person. Each city's base freight task per person is then increased by that amount and multiplied by population to give the prediction for the city's freight task.

Next, national-level vehicle type split forecasts are used to predict the city's future freight task by truck type. National-level trends are also used to project each city's load per truck per truck type.

The last step to getting traffic forecasts by vehicle type for each city is to divide the task forecasts by vehicle type by the forecasts by vehicle type for average load.

The traffic forecasts derived using the methodology outlined can be extended to forecasts of overall congestion levels, fuel use, greenhouse gas emissions, and detailed pollution inventories for each capital city (see BTRE 2003).

The mechanical nature of the methodology means that 1) it can be done on a calculator, 2) a relationship is established between national trends and trends in each of our cities, and 3) analysts can easily change any of the assumptions involved and generate their own forecasts for their own city. This means that the specific assumptions adopted in this paper about underlying generating variables (income growth, city populations, etc) are not limiting, and that the approach can be used for each of our capitals as well as for other cities around the world.

We hope that the 'short-cut' methodology outlined here contributes to a better understanding of the mechanisms that produce traffic growth in our major cities.

Table 3 Base case projections of metropolitan vehicle kilometres travelled by type of vehicle, 1990-2020
(billion kilometres)

Year	Cars	Light Commercial Vehicles	Articulated trucks	Rigid and other trucks	Buses	Motor cycles	Total
1990	73.43	12.20	0.69	4.13	0.59	0.84	91.88
1991	73.84	11.56	0.64	3.89	0.60	0.79	91.33
1992	75.07	11.67	0.67	3.80	0.60	0.78	92.60
1993	76.98	12.46	0.70	3.75	0.59	0.77	95.26
1994	78.56	12.65	.75	3.77	0.62	0.76	97.11
1995	81.96	13.29	0.81	3.90	0.64	0.75	101.35
1996	84.30	14.49	0.86	3.89	0.66	0.78	104.98
1997	85.21	14.89	0.91	3.87	0.69	0.78	106.35
1998	86.92	15.22	0.94	3.79	0.72	0.78	108.38
1999	89.21	16.03	1.01	3.82	0.74	0.78	111.60
2000	91.24	15.88	1.02	3.73	0.79	0.79	113.44
2001	91.21	16.85	1.03	3.76	0.78	0.78	114.43
2002	93.33	17.79	1.08	3.90	0.79	0.79	117.70
2003	96.78	18.53	1.10	3.91	0.81	0.81	121.94
2004	100.12	19.26	1.14	3.99	0.82	0.82	126.15
2005	103.14	20.12	1.19	4.00	0.83	0.82	130.10
2006	104.91	20.79	1.24	4.05	0.84	0.83	132.67
2007	106.67	21.60	1.30	4.12	0.85	0.84	135.38
2008	108.40	22.32	1.36	4.17	0.86	0.84	137.95
2009	110.04	23.06	1.42	4.22	0.88	0.85	140.47
2010	111.63	23.95	1.49	4.29	0.90	0.86	143.11
2011	113.07	24.72	1.55	4.33	0.91	0.86	145.44
2012	114.46	25.52	1.61	4.38	0.92	0.87	147.76
2013	115.78	26.34	1.68	4.42	0.93	0.87	150.02
2014	117.05	27.18	1.75	4.46	0.94	0.88	152.26
2015	118.28	28.05	1.82	4.50	0.95	0.89	154.49
2016	119.44	28.94	1.90	4.53	0.97	0.89	156.67
2017	120.58	30.01	1.98	4.59	0.99	0.90	159.05
2018	121.68	30.95	2.06	4.63	1.00	0.90	161.22
2019	122.74	31.93	2.15	4.66	1.01	0.91	163.39
2020	123.77	32.93	2.23	4.69	1.03	0.91	165.56
Change 2002 to 2020	33%	85%	106%	20%	30%	14%	41%

Note: 'Metropolitan' results refer to all activity within the greater metropolitan areas of the 8 State and Territory capital cities

Sources: BTRE (2003, p5)

Table 4 **Base case projections of vehicle kilometres travelled by type of vehicle for Sydney, 1990-2020**

(billion kilometres)

<i>Year</i>	<i>Cars</i>	<i>Light Commercial Vehicles</i>	<i>Articulated trucks</i>	<i>Rigid and other trucks</i>	<i>Buses</i>	<i>Motor cycles</i>	<i>Total</i>
1990	23.49	4.44	0.22	1.54	0.189	0.294	30.17
1991	23.66	4.20	0.21	1.45	0.190	0.278	29.99
1992	23.87	4.24	0.22	1.42	0.192	0.274	30.21
1993	24.48	4.53	0.22	1.40	0.188	0.270	31.09
1994	24.98	4.59	0.24	1.41	0.197	0.266	31.68
1995	26.06	4.81	0.26	1.45	0.202	0.262	33.05
1996	26.80	5.24	0.28	1.44	0.209	0.271	34.23
1997	27.13	5.38	0.29	1.44	0.219	0.271	34.73
1998	27.45	5.49	0.30	1.41	0.228	0.270	35.15
1999	28.05	5.79	0.32	1.42	0.236	0.270	36.09
2000	28.93	5.73	0.33	1.38	0.250	0.273	36.90
2001	28.92	6.09	0.33	1.40	0.247	0.275	37.26
2002	29.60	6.43	0.35	1.45	0.250	0.277	38.35
2003	30.70	6.69	0.35	1.45	0.257	0.279	39.74
2004	31.78	6.96	0.37	1.48	0.260	0.282	41.12
2005	32.75	7.27	0.38	1.48	0.264	0.284	42.43
2006	33.32	7.52	0.40	1.50	0.268	0.286	43.29
2007	33.90	7.81	0.42	1.53	0.271	0.288	44.21
2008	34.46	8.07	0.44	1.55	0.275	0.290	45.08
2009	35.00	8.34	0.46	1.57	0.278	0.292	45.94
2010	35.52	8.67	0.48	1.59	0.285	0.294	46.84
2011	36.00	8.95	0.50	1.61	0.289	0.296	47.64
2012	36.46	9.24	0.52	1.63	0.292	0.298	48.43
2013	36.90	9.54	0.54	1.64	0.296	0.299	49.21
2014	37.32	9.85	0.56	1.66	0.300	0.301	49.99
2015	37.73	10.17	0.59	1.67	0.304	0.303	50.76
2016	38.12	10.49	0.61	1.69	0.307	0.305	51.52
2017	38.50	10.88	0.64	1.71	0.314	0.306	52.36
2018	38.87	11.23	0.67	1.72	0.318	0.308	53.12
2019	39.23	11.59	0.69	1.74	0.322	0.309	53.88
2020	39.59	11.95	0.72	1.75	0.327	0.311	54.65

Source: BTRE 2003 p9

Table 5 **Base case projections of vehicle kilometres travelled by type of vehicle for Melbourne, 1990-2020**

(billion kilometres)

<i>Year</i>	<i>Cars</i>	<i>Light Commercial Vehicles</i>	<i>Articulated trucks</i>	<i>Rigid and other trucks</i>	<i>Buses</i>	<i>Motor cycles</i>	<i>Total</i>
1990	22.57	2.80	0.20	1.18	0.136	0.192	27.07
1991	22.62	2.65	0.19	1.11	0.137	0.181	26.89
1992	22.89	2.67	0.20	1.08	0.137	0.178	27.14
1993	23.49	2.83	0.20	1.06	0.134	0.174	27.90
1994	23.99	2.87	0.22	1.07	0.140	0.171	28.45
1995	25.04	3.00	0.24	1.10	0.143	0.168	29.68
1996	25.78	3.25	0.25	1.09	0.148	0.173	30.69
1997	26.06	3.34	0.26	1.08	0.154	0.173	31.07
1998	26.82	3.41	0.27	1.06	0.161	0.173	31.90
1999	27.59	3.59	0.29	1.07	0.167	0.173	32.88
2000	28.09	3.56	0.29	1.04	0.177	0.174	33.34
2001	28.10	3.78	0.30	1.05	0.174	0.176	33.58
2002	28.77	4.00	0.31	1.09	0.177	0.178	34.53
2003	29.80	4.16	0.32	1.09	0.181	0.179	35.73
2004	30.79	4.33	0.33	1.11	0.183	0.181	36.92
2005	31.68	4.52	0.34	1.12	0.185	0.182	38.03
2006	32.19	4.67	0.36	1.13	0.188	0.183	38.72
2007	32.69	4.85	0.38	1.15	0.190	0.185	39.44
2008	33.19	5.01	0.39	1.16	0.192	0.186	40.13
2009	33.66	5.17	0.41	1.18	0.194	0.188	40.80
2010	34.11	5.37	0.43	1.20	0.198	0.189	41.49
2011	34.51	5.54	0.45	1.21	0.200	0.190	42.10
2012	34.90	5.72	0.46	1.22	0.202	0.191	42.70
2013	35.26	5.90	0.48	1.23	0.204	0.193	43.27
2014	35.60	6.09	0.50	1.24	0.206	0.194	43.84
2015	35.94	6.28	0.52	1.25	0.208	0.195	44.40
2016	36.25	6.48	0.54	1.26	0.210	0.196	44.94
2017	36.55	6.72	0.57	1.28	0.215	0.197	45.53
2018	36.84	6.93	0.59	1.29	0.217	0.198	46.06
2019	37.12	7.14	0.62	1.30	0.219	0.199	46.59
2020	37.39	7.36	0.64	1.31	0.222	0.200	47.12

Sources: BTRE 2003 p12

Table 6 Base case projections of vehicle kilometres travelled by type of vehicle for Brisbane, 1990-2020

(billion kilometres)

<i>Year</i>	<i>Cars</i>	<i>Light Commercial Vehicles</i>	<i>Articulated trucks</i>	<i>Rigid and other trucks</i>	<i>Buses</i>	<i>Motor cycles</i>	<i>Total</i>
1990	9.04	1.65	0.09	0.49	0.085	0.163	11.51
1991	9.12	1.56	0.08	0.46	0.086	0.156	11.47
1992	9.38	1.59	0.09	0.46	0.088	0.156	11.76
1993	9.59	1.71	0.09	0.46	0.088	0.156	12.10
1994	9.78	1.75	0.10	0.46	0.093	0.156	12.34
1995	10.19	1.86	0.11	0.48	0.096	0.156	12.90
1996	10.47	2.05	0.12	0.49	0.100	0.163	13.39
1997	10.57	2.12	0.12	0.49	0.105	0.164	13.56
1998	10.76	2.17	0.13	0.48	0.111	0.165	13.82
1999	11.21	2.30	0.14	0.48	0.114	0.165	14.41
2000	11.29	2.28	0.14	0.47	0.122	0.167	14.47
2001	11.31	2.42	0.14	0.48	0.120	0.169	14.65
2002	11.61	2.56	0.15	0.50	0.123	0.172	15.12
2003	12.10	2.68	0.15	0.50	0.126	0.174	15.73
2004	12.57	2.79	0.16	0.51	0.129	0.176	16.34
2005	13.01	2.92	0.17	0.51	0.131	0.178	16.92
2006	13.29	3.03	0.18	0.52	0.134	0.180	17.33
2007	13.57	3.16	0.18	0.53	0.136	0.183	17.76
2008	13.85	3.27	0.19	0.54	0.139	0.185	18.17
2009	14.11	3.39	0.20	0.55	0.142	0.187	18.58
2010	14.38	3.53	0.21	0.56	0.146	0.189	19.01
2011	14.62	3.65	0.22	0.57	0.148	0.191	19.40
2012	14.86	3.78	0.23	0.57	0.151	0.193	19.79
2013	15.09	3.91	0.24	0.58	0.154	0.195	20.17
2014	15.32	4.05	0.25	0.59	0.156	0.197	20.55
2015	15.54	4.19	0.26	0.59	0.159	0.199	20.94
2016	15.75	4.33	0.27	0.60	0.162	0.201	21.31
2017	15.96	4.50	0.29	0.61	0.166	0.203	21.72
2018	16.16	4.65	0.30	0.61	0.169	0.205	22.11
2019	16.37	4.81	0.31	0.62	0.172	0.207	22.49
2020	16.56	4.97	0.33	0.63	0.175	0.209	22.87

Sources: BTRE 2003 p15

Table 7 **Base case projections of vehicle kilometres travelled by type of vehicle for Adelaide, 1990-2020**

(billion kilometres)

<i>Year</i>	<i>Cars</i>	<i>Light Commercial Vehicles</i>	<i>Articulated trucks</i>	<i>Rigid and other trucks</i>	<i>Buses</i>	<i>Motor cycles</i>	<i>Total</i>
1990	6.50	0.96	0.06	0.28	0.062	0.067	7.92
1991	6.62	0.91	0.05	0.26	0.063	0.063	7.96
1992	6.69	0.91	0.05	0.26	0.063	0.062	8.03
1993	6.86	0.96	0.06	0.25	0.061	0.061	8.25
1994	6.99	0.97	0.06	0.25	0.064	0.060	8.39
1995	7.29	1.01	0.06	0.26	0.065	0.058	8.74
1996	7.49	1.09	0.07	0.25	0.066	0.060	9.03
1997	7.56	1.11	0.07	0.25	0.069	0.059	9.12
1998	7.93	1.13	0.07	0.24	0.071	0.059	9.51
1999	8.00	1.18	0.08	0.24	0.073	0.058	9.63
2000	8.21	1.16	0.08	0.23	0.077	0.059	9.82
2001	8.16	1.22	0.08	0.24	0.075	0.059	9.82
2002	8.31	1.28	0.08	0.24	0.076	0.059	10.05
2003	8.56	1.33	0.08	0.24	0.077	0.059	10.35
2004	8.82	1.38	0.09	0.25	0.078	0.059	10.66
2005	9.04	1.43	0.09	0.25	0.078	0.060	10.94
2006	9.15	1.47	0.09	0.25	0.079	0.060	11.11
2007	9.26	1.53	0.10	0.25	0.079	0.060	11.28
2008	9.37	1.57	0.10	0.25	0.080	0.060	11.43
2009	9.47	1.62	0.10	0.26	0.080	0.060	11.58
2010	9.56	1.67	0.11	0.26	0.082	0.060	11.74
2011	9.64	1.72	0.11	0.26	0.082	0.061	11.87
2012	9.71	1.77	0.12	0.26	0.083	0.061	12.01
2013	9.78	1.82	0.12	0.26	0.083	0.061	12.13
2014	9.85	1.87	0.13	0.26	0.084	0.061	12.25
2015	9.91	1.92	0.13	0.27	0.084	0.061	12.37
2016	9.96	1.98	0.14	0.27	0.084	0.061	12.49
2017	10.01	2.04	0.14	0.27	0.086	0.061	12.62
2018	10.06	2.10	0.15	0.27	0.086	0.061	12.73
2019	10.11	2.16	0.15	0.27	0.087	0.061	12.84
2020	10.15	2.22	0.16	0.27	0.088	0.062	12.95

Sources: BTRE 2003 p18

Table 8 **Base case projections of vehicle kilometres travelled by type of vehicle for Perth, 1990-2020**

(billion kilometres)

<i>Year</i>	<i>Cars</i>	<i>Light Commercial Vehicles</i>	<i>Articulated trucks</i>	<i>Rigid and other trucks</i>	<i>Buses</i>	<i>Motor cycles</i>	<i>Total</i>
1990	7.99	1.63	0.09	0.44	0.070	0.068	10.30
1991	8.01	1.55	0.09	0.41	0.071	0.065	10.19
1992	8.24	1.57	0.09	0.40	0.072	0.064	10.44
1993	8.46	1.68	0.10	0.40	0.071	0.063	10.77
1994	8.64	1.72	0.10	0.41	0.075	0.063	11.00
1995	9.02	1.81	0.11	0.42	0.077	0.062	11.50
1996	9.28	1.99	0.12	0.42	0.081	0.065	11.96
1997	9.38	2.05	0.13	0.42	0.085	0.065	12.12
1998	9.46	2.10	0.13	0.41	0.089	0.066	12.27
1999	9.68	2.22	0.14	0.42	0.092	0.066	12.62
2000	9.97	2.20	0.14	0.41	0.097	0.067	12.89
2001	10.00	2.34	0.15	0.41	0.096	0.067	13.06
2002	10.25	2.48	0.15	0.43	0.098	0.068	13.47
2003	10.66	2.58	0.16	0.43	0.101	0.069	14.00
2004	11.06	2.69	0.16	0.44	0.103	0.070	14.52
2005	11.42	2.81	0.17	0.44	0.104	0.071	15.02
2006	11.65	2.91	0.18	0.45	0.106	0.071	15.36
2007	11.88	3.03	0.19	0.46	0.108	0.072	15.72
2008	12.10	3.13	0.19	0.46	0.110	0.073	16.07
2009	12.31	3.24	0.20	0.47	0.112	0.074	16.41
2010	12.52	3.37	0.21	0.48	0.115	0.074	16.77
2011	12.72	3.48	0.22	0.48	0.117	0.075	17.10
2012	12.91	3.60	0.23	0.49	0.118	0.076	17.42
2013	13.09	3.72	0.24	0.49	0.120	0.076	17.74
2014	13.26	3.84	0.25	0.50	0.122	0.077	18.05
2015	13.43	3.97	0.26	0.50	0.124	0.078	18.37
2016	13.60	4.10	0.27	0.51	0.126	0.078	18.68
2017	13.76	4.26	0.28	0.52	0.129	0.079	19.03
2018	13.92	4.40	0.30	0.52	0.131	0.080	19.34
2019	14.07	4.54	0.31	0.52	0.133	0.080	19.66
2020	14.22	4.69	0.32	0.53	0.135	0.081	19.97

Sources: BTRE 2003 p21

Table 9 **Base case projections of vehicle kilometres travelled by type of vehicle for Hobart, 1990-2020**

(billion kilometres)

<i>Year</i>	<i>Cars</i>	<i>Light Commercial Vehicles</i>	<i>Articulated trucks</i>	<i>Rigid and other trucks</i>	<i>Buses</i>	<i>Motor cycles</i>	<i>Total</i>
1990	1.130	0.186	0.011	0.095	0.017	0.011	1.450
1991	1.107	0.176	0.010	0.089	0.017	0.010	1.410
1992	1.147	0.177	0.011	0.087	0.017	0.010	1.449
1993	1.178	0.188	0.011	0.085	0.017	0.010	1.489
1994	1.203	0.189	0.012	0.085	0.018	0.009	1.517
1995	1.257	0.198	0.013	0.087	0.018	0.009	1.581
1996	1.293	0.214	0.014	0.087	0.018	0.009	1.636
1997	1.308	0.217	0.014	0.086	0.019	0.009	1.653
1998	1.283	0.218	0.014	0.084	0.019	0.009	1.629
1999	1.347	0.226	0.015	0.084	0.020	0.009	1.700
2000	1.389	0.220	0.015	0.082	0.021	0.009	1.735
2001	1.367	0.230	0.015	0.082	0.020	0.009	1.723
2002	1.381	0.239	0.016	0.085	0.020	0.009	1.750
2003	1.414	0.246	0.016	0.085	0.020	0.009	1.790
2004	1.448	0.252	0.016	0.086	0.020	0.009	1.831
2005	1.475	0.259	0.016	0.086	0.020	0.009	1.866
2006	1.484	0.264	0.017	0.086	0.020	0.009	1.880
2007	1.492	0.271	0.017	0.086	0.020	0.009	1.896
2008	1.500	0.276	0.018	0.086	0.020	0.009	1.908
2009	1.506	0.281	0.018	0.086	0.021	0.009	1.920
2010	1.511	0.288	0.019	0.086	0.021	0.008	1.932
2011	1.514	0.293	0.020	0.086	0.021	0.008	1.940
2012	1.515	0.298	0.020	0.085	0.021	0.008	1.947
2013	1.516	0.303	0.021	0.085	0.021	0.008	1.954
2014	1.517	0.308	0.021	0.084	0.021	0.008	1.959
2015	1.515	0.313	0.022	0.084	0.021	0.008	1.963
2016	1.513	0.318	0.022	0.083	0.021	0.008	1.966
2017	1.511	0.325	0.023	0.083	0.021	0.008	1.971
2018	1.507	0.330	0.024	0.082	0.021	0.008	1.972
2019	1.504	0.335	0.024	0.082	0.021	0.008	1.974
2020	1.500	0.340	0.025	0.081	0.021	0.008	1.975

Sources: BTRE 2003 p24

Table 10 Base case projections of vehicle kilometres travelled by type of vehicle for Darwin, 1990-2020

(billion kilometres)

<i>Year</i>	<i>Cars</i>	<i>Light Commercial Vehicles</i>	<i>Articulated trucks</i>	<i>Rigid and other trucks</i>	<i>Buses</i>	<i>Motor cycles</i>	<i>Total</i>
1990	0.395	0.162	0.010	0.049	0.013	0.009	0.637
1991	0.418	0.154	0.009	0.047	0.013	0.008	0.648
1992	0.446	0.155	0.009	0.045	0.013	0.008	0.677
1993	0.455	0.165	0.010	0.045	0.013	0.008	0.695
1994	0.461	0.167	0.010	0.045	0.013	0.008	0.706
1995	0.479	0.176	0.011	0.047	0.014	0.008	0.735
1996	0.490	0.193	0.012	0.047	0.015	0.009	0.766
1997	0.497	0.196	0.013	0.047	0.015	0.009	0.777
1998	0.517	0.198	0.013	0.046	0.016	0.009	0.798
1999	0.526	0.207	0.014	0.046	0.017	0.009	0.819
2000	0.546	0.204	0.014	0.045	0.018	0.009	0.836
2001	0.547	0.215	0.014	0.046	0.018	0.009	0.849
2002	0.563	0.226	0.015	0.048	0.018	0.009	0.878
2003	0.588	0.233	0.015	0.048	0.019	0.009	0.912
2004	0.610	0.240	0.015	0.049	0.019	0.009	0.943
2005	0.630	0.249	0.016	0.049	0.020	0.009	0.973
2006	0.643	0.255	0.016	0.050	0.020	0.009	0.993
2007	0.656	0.262	0.017	0.050	0.021	0.009	1.015
2008	0.669	0.268	0.017	0.050	0.021	0.009	1.035
2009	0.681	0.275	0.018	0.050	0.022	0.009	1.055
2010	0.693	0.283	0.019	0.051	0.022	0.009	1.076
2011	0.705	0.289	0.019	0.051	0.023	0.010	1.096
2012	0.715	0.296	0.020	0.051	0.023	0.010	1.114
2013	0.726	0.302	0.020	0.051	0.024	0.010	1.133
2014	0.736	0.309	0.021	0.051	0.024	0.010	1.151
2015	0.747	0.316	0.022	0.051	0.025	0.010	1.169
2016	0.757	0.323	0.022	0.051	0.025	0.010	1.187
2017	0.767	0.332	0.023	0.051	0.026	0.010	1.209
2018	0.777	0.339	0.024	0.051	0.026	0.010	1.227
2019	0.787	0.346	0.025	0.051	0.027	0.010	1.245
2020	0.797	0.353	0.025	0.050	0.027	0.010	1.263

Sources: BTRE 2003 p27

Table 11 **Base case projections of vehicle kilometres travelled by type of vehicle for ACT (Canberra), 1990-2020**

(billion kilometres)

<i>Year</i>	<i>Cars</i>	<i>Light Commercial Vehicles</i>	<i>Articulated trucks</i>	<i>Rigid and other trucks</i>	<i>Buses</i>	<i>Motor cycles</i>	<i>Total</i>
1990	2.316	0.384	0.004	0.059	0.020	0.034	2.818
1991	2.300	0.364	0.004	0.056	0.021	0.033	2.777
1992	2.412	0.367	0.004	0.054	0.021	0.033	2.891
1993	2.472	0.393	0.004	0.054	0.021	0.032	2.975
1994	2.520	0.399	0.004	0.054	0.021	0.032	3.031
1995	2.626	0.421	0.005	0.056	0.022	0.031	3.161
1996	2.698	0.461	0.005	0.057	0.023	0.032	3.276
1997	2.723	0.479	0.005	0.058	0.023	0.032	3.321
1998	2.701	0.494	0.006	0.058	0.024	0.031	3.314
1999	2.804	0.522	0.006	0.059	0.025	0.031	3.447
2000	2.822	0.519	0.006	0.058	0.026	0.032	3.463
2001	2.803	0.552	0.006	0.060	0.026	0.032	3.478
2002	2.850	0.583	0.007	0.062	0.026	0.032	3.560
2003	2.947	0.607	0.007	0.063	0.026	0.032	3.683
2004	3.054	0.629	0.007	0.065	0.027	0.032	3.813
2005	3.136	0.655	0.007	0.066	0.027	0.032	3.923
2006	3.179	0.676	0.008	0.066	0.027	0.032	3.988
2007	3.221	0.700	0.008	0.067	0.028	0.032	4.057
2008	3.262	0.722	0.008	0.068	0.028	0.032	4.119
2009	3.300	0.744	0.009	0.069	0.028	0.032	4.181
2010	3.336	0.770	0.009	0.070	0.029	0.032	4.246
2011	3.367	0.794	0.009	0.070	0.029	0.032	4.302
2012	3.396	0.818	0.010	0.071	0.029	0.032	4.355
2013	3.424	0.842	0.010	0.071	0.030	0.032	4.409
2014	3.449	0.867	0.010	0.072	0.030	0.032	4.460
2015	3.474	0.893	0.011	0.072	0.030	0.032	4.511
2016	3.495	0.919	0.011	0.073	0.030	0.031	4.561
2017	3.517	0.952	0.012	0.074	0.031	0.031	4.617
2018	3.536	0.981	0.012	0.074	0.031	0.031	4.666
2019	3.555	1.010	0.013	0.074	0.031	0.031	4.715
2020	3.573	1.040	0.013	0.075	0.032	0.031	4.764

Note: For simplicity, all VKT within the ACT is assigned to ‘metropolitan’ travel.

Sources: BTRE 2003 p30

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Paper Submission Form

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Abstract (200 words):

Traffic growth is obviously important for planning road systems. This is especially true in cities, where growth is occurring within the confines of a semi-constrained spatial system.

The Bureau of Transport and Regional Economics (BTRE) has recently completed an exercise in forecasting the growth in traffic expected in each of Australia's capital cities over the coming decades (BTRE 2003). This paper presents a 'short-cut' methodology that allows an insight into how we see the various causal factors operating to produce traffic growth in our cities.