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## **Land use and transport interaction: a tale of two freeways**

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### **Abstract**

Freeway development is noted for its capability to induce greater car travel, reshaping land uses and altering property values. This chain of changes has often been attributed to the accessibility enhancing effects of freeways. Given that increased accessibility is an impetus for change, this implies that unless all new freeways can alleviate accessibility levels in a comparable manner, the ensuing changes triggered by their development would be dissimilar. While the effects of freeway development have been extensively studied, the question of whether these effects apply equally to all freeways regardless of functions remains unanswered. This paper explores the disparate effects generated by freeways designed to link outlying suburbs directly to city centres and those planned to serve as traffic distributors. This is accomplished by examining the before-and-after situations relating to the recent extensions of the Eastern Freeway, which typifies the former, and the Western Ring Road, which exemplifies the latter, in Metropolitan Melbourne. Using data from the Victoria Activity and Travel Survey and Land Victoria's property transaction statistics, this study finds that the extension of the two freeways has led to dissimilar levels of changes in car travel, and property prices within their respective catchments. There were also differences with respect to the ability of the two freeways to attract external traffic into their catchment. The study concludes that freeways designed to serve as radial arteries of major activity centres would help increase the accessibility of the residents living within its catchment. However, it will not be able to attract additional external car traffic into its catchment. Freeways designed to function as traffic distributors to disperse traffic away from city centres, however, tend to produce the opposite effect. Since both the Eastern Freeway and the Western Ring Road confirm the long-established positive relationship between freeway development and house price changes, the study also infers that the nature of the price enhancing effect of freeway development is different for freeways designed with different purposes.

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## **Introduction**

Freeway development is a massive transport investment capable of inducing greater car travel (Bone and Wohl 1959, Litman 1999), reshaping land uses (Adkins 1959, Eyerly 1966, Dyett 1981) and altering property values (Gamble and Davinroy 1974, Palmquist 1982, Huang 1994). Invariably, this chain of changes has been attributed to the accessibility enhancing effects heralded by freeway development (Hanson, 1986). Given that increased accessibility is an impetus for change, this implies that unless all new freeways can alleviate accessibility levels in a comparable manner, the ensuing changes triggered by their development would be dissimilar. While the effects of freeway development have been extensively studied, the question of whether these effects apply equally to all freeways regardless of functions, e.g., serving as a major connector between activity centres or as a by-pass to disperse traffic from the city centre, remains unanswered.

This paper explores the disparate effects generated by two recently completed freeways in Metropolitan Melbourne: the Eastern Freeway Extension and the Western Ring Road Expansion. The former is one of several major radial arteries linking the city centre of Melbourne with its established eastern residential suburbs. The latter is an express route spanning the western middle suburbs, channelling traffic plying between the northern and western parts of the metropolis away from the Central Business District (see Figure 1). The Eastern Freeway Extension, which spans between Doncaster Road and Springvale Road, was opened to traffic in December 1997. The Western Ring Road Expansion, which runs from Hume Highway to Westgate Freeway, became operational in early June 1997. These projects provide two natural settings to investigate the short-term effects of freeway development on travel adjustments made by catchment residents and on price changes of surrounding residential properties.

Specifically, it will examine the extent to which the development of the two freeways has led to dissimilar levels of change in trip generation, trip attraction and property prices within their respective catchments. The implications of these disparate changes will be discussed with respect to the intended functions of the two freeways.

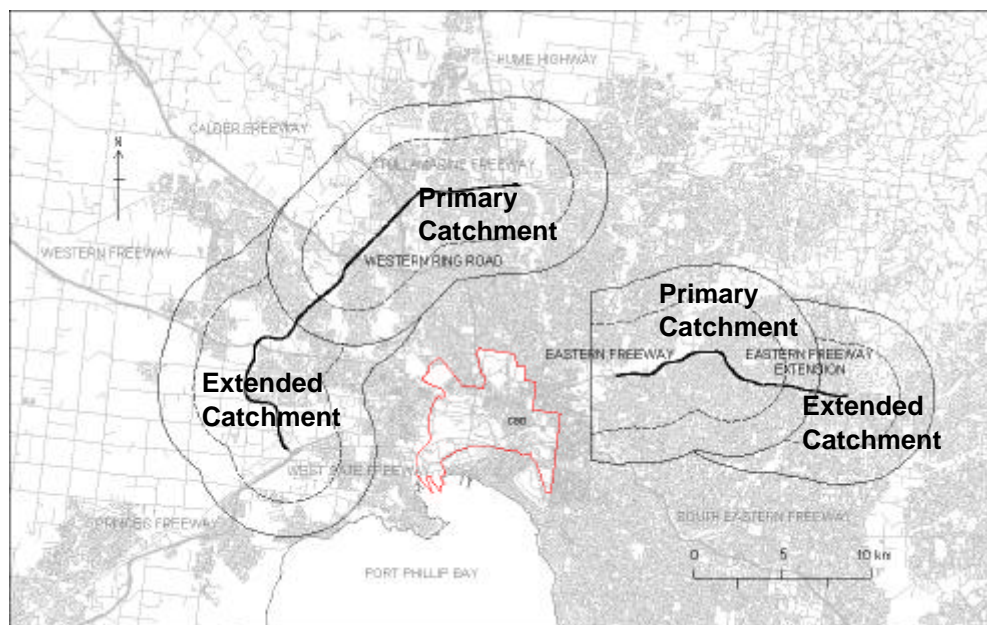
## **Research approach**

To assess the developmental impact of the two extension projects, a quasi-experimental design approach is employed. This involves the identification of a control catchment as well as a treatment catchment for the two case study freeways.

After reviewing 11 highway studies, Ryan (1999) claims that “[t]he accessibility benefits of freeways may not extend beyond 2.5 miles of a freeway” (p. 418). Using 2.5 miles (or 4 km) as a guide, this study adopts a 3 km and a 5 km distance to define an inner and an outer catchment for both freeways, as shown in Figure 1. To facilitate a comparative analysis of the changes before and after the freeway extension, areas enclosed within the catchment boundary of the two freeways prior to their extension will be referred to as the Primary Catchment. Areas falling within the catchment boundaries after the extension will be called the Extended Catchment. From a quasi-experimental design perspective, the primary catchments thus serve as the control group, while the extended catchments, the treatment group.

A major concern regarding a before-and-after study of this nature is that there is always the possibility of covarying influences which could confound the real effect being investigated. In the present case, a concomitant change in socio-demographic profiles, including car ownership rate, could also alter travel patterns of residents in the catchments. Likewise, any major infrastructural developments or public policies being introduced over the same period may render any differences observed, between the primary and extended catchments before-and-after the freeway extension, inconclusive. As such, prior to examining changes in trip generation, trip attraction and house prices, a review is first conducted of the change in levels of some of the plausible factors, other than freeway extension, that could have contributed to any perceived changes in the above parameters before and after 1997.

**Figure 1 Definition of Freeway Catchment Areas**



## **Data sources**

This study uses two sources of data for its analyses: the Victorian Activity and Travel Survey (VATS) conducted by the Transport Research Centre at RMIT and the Property Registry maintained by Land Victoria.

Launched in December 1993, VATS is a household based, year-round survey on the travel behaviour and out-of-home activity patterns of individual household members in Metropolitan Melbourne as defined by the Melbourne Statistical District (MSD). The survey uses a mail-out, mail-back, self-administered questionnaire with four follow-up reminders. The questionnaire consists of a Household Form and one Travel Form for each member of the responding households. Respondents to VATS are selected using a stratified random sampling frame. Addresses selected for the survey are excluded from subsequent samples. To-date, six complete years of data – VATS94, VATS95, VATS96, VATS97, VATS98 and VATS99 - have been released.

The travel information pertaining to the “before-extension” is derived from VATS94, VATS95 and VATS96; those relating to the “after-extension” are based on VATS98 and VATS99. Data for VATS97 have been omitted in this study because 1997 was a transition year when both the Eastern Freeway Extension and the Western Ring Road were opened, but at different months. The decision to omit VATS97 is to avoid data incompatibility due to any plausible changes as a result of the development expectations of the freeway extension.

Discounting sample loss, ie, vacant houses and invalid addresses, the average response rate of VATS94 to VATS99 is about 44%, giving a sample size of approximately 5,000 households each year (Kam, Lau and Goh, 2001). Based on the 3 km threshold boundary, the sample size for the Eastern Freeway primary catchment varies from 273 in 1995 to 455 in 1994, while that for the extended catchment is from 53 in 1996 to 96 in 1994. The corresponding figures for the Western Ring Road are from 171 (1996) to 293 (1994) for its primary catchment and 81 (1999) to 109 (1994) for its extended catchment. For catchments within the 5 km threshold boundary, the sample sizes generally increase by two to three folds.

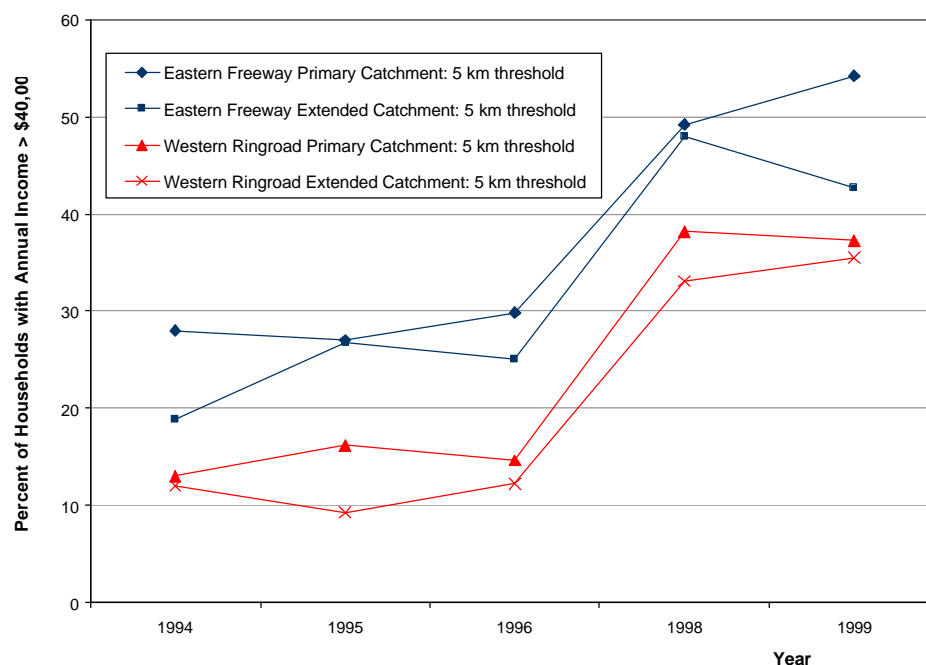
The Property Registry of Land Victoria contains records of all house transactions in Victoria since 1974. The information available in the database includes the date of sale, the transacted price and the address of each transacted property. No physical features pertaining to the transacted properties, however, are available. Information sourced from the Property Registry is used to estimate changes in price levels of residential properties in the catchment regions of the two projects.

### The study catchments: A socio-economic overview

Between 1996 and 1998, there were no other major infrastructural works implemented in the catchment areas of the two extension projects.<sup>1</sup> The majority of the development occurring within the defined catchments is primarily restricted to residential in-filling and road upgrading, the latter was primarily carried out as part of the freeway extension program.

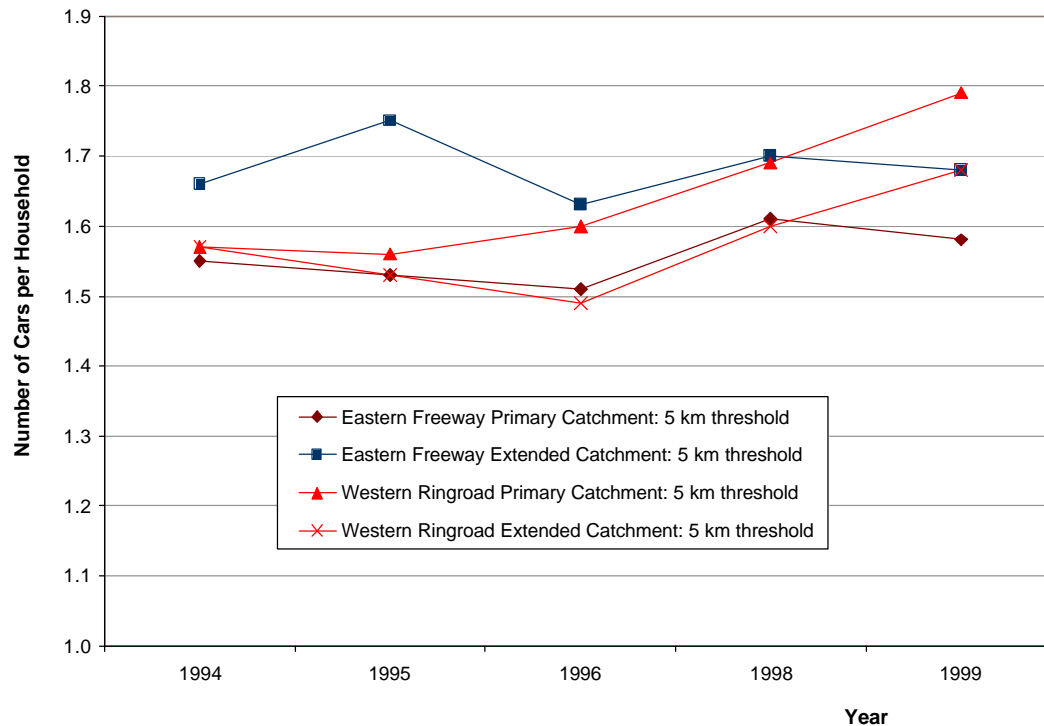
With respect to socio-economic profiles, a comparative analysis of the changes in income levels and car ownership rates based on data from VATS suggests certain changes are discernible. As far as income levels are concerned, there are clear signs that nominal income has increased before and after 1997, as evidenced by the proportion of households with income greater than \$40,000 per annum in the catchment areas of both freeways (Figure 2a). With regard to car ownership, both the primary and extended catchments of the Western Ring Road have experienced an increase in ownership rate since 1996. The same, however, is not true in the case of the Eastern Freeway. While car ownership rate in the primary catchment has surged, that of the extended catchment fails to exhibit a convincing trend of increase (Figure 2b).

**Figure 2a** Percent of households with annual income greater than \$40,000, 1994 to 1999 (source: VATS94, VATS95, VATS96, VATS98 and VATS99)



<sup>1</sup> Based on information supplied by Local Councils having jurisdiction in the defined catchments.

**Figure 2b Household car ownership rate, 1994 to 1999 (source: VATS94, VATS95, VATS96, VATS98 and VATS99)**

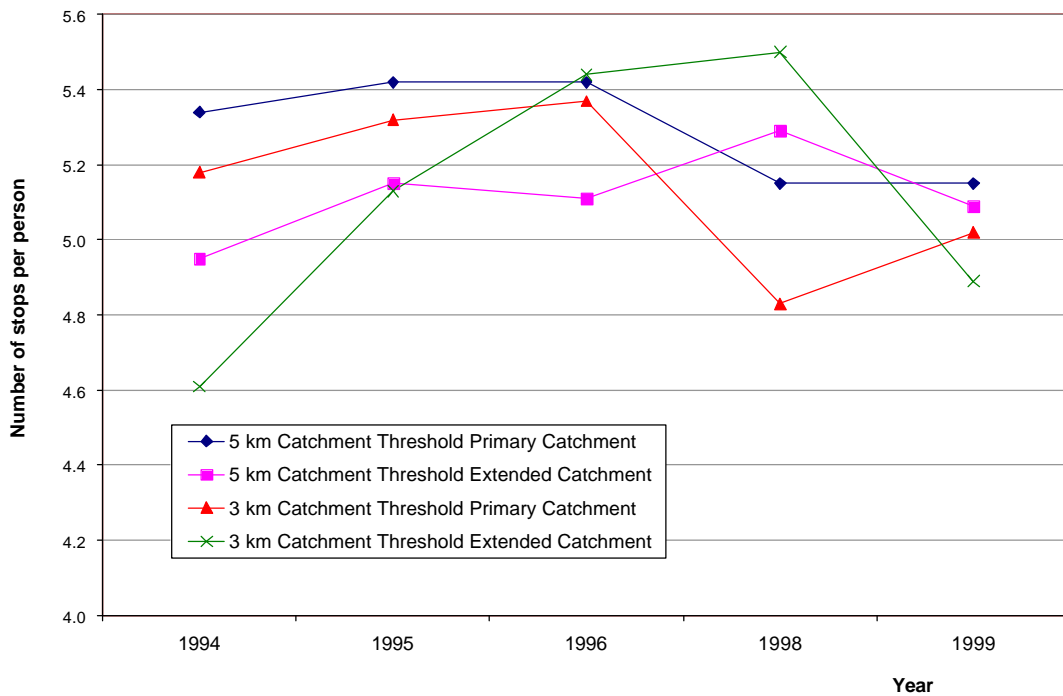


### Freeway and car travel

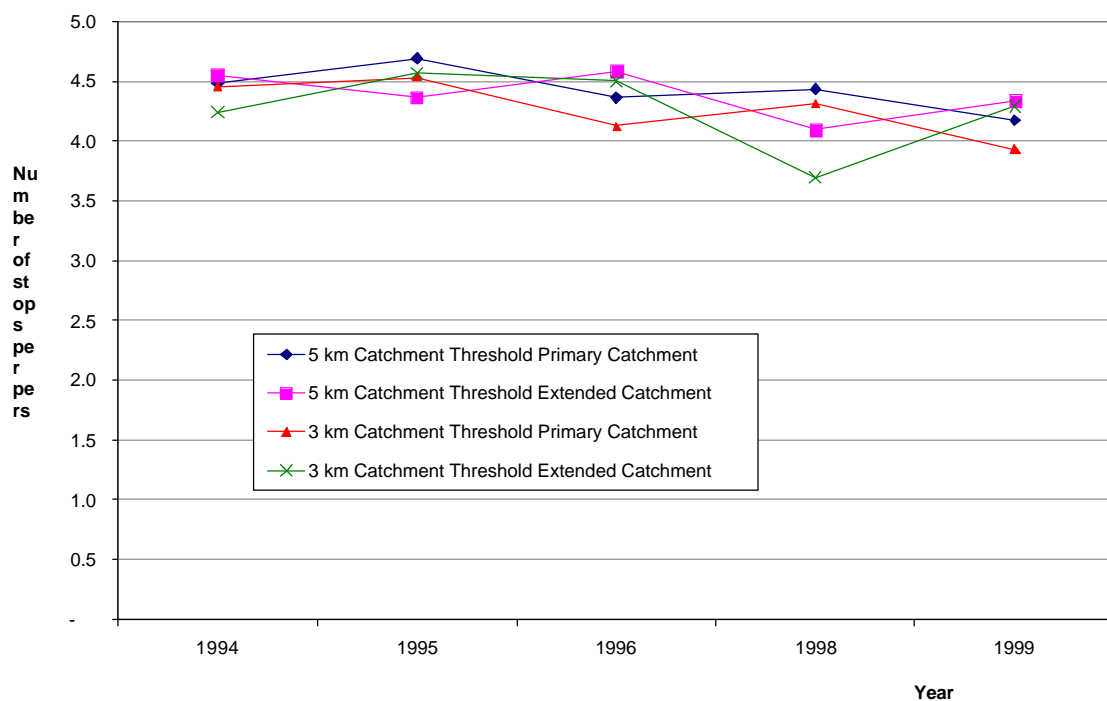
One of the main concerns of freeway development is whether it induces more travel. As Figures 3a and 3b illustrate, there is little evidence to suggest that freeway development increases more travel. Both the extension of the Eastern Freeway and the opening of the Western Ring Road do not seem to have led to an increase in stop rate per capita in both their catchments, regardless of whether the catchment threshold is 3 km or 5 km.<sup>2</sup> However, in terms of inducing car travel, some discernible differences are obvious between the two freeways. First, residents of the Eastern Freeway extended catchment, especially those domiciled within the 3 km threshold, had distinctively increased their frequency of car travel after the opening of the extension (Figure 4a). This, however, is not the case with residents of the Western Ring Road catchment. In fact, there was even a marginal decline in car travel among those residing within the 3km threshold of the Western Ring Road extended catchment (Figure 4b).

<sup>2</sup> In VATS, a “stop” is distinguished from a “trip”. The former includes travel to a destination for changing to another mode. In the latter, all travel activities involving changing mode are considered as part of a trip. For instance, a walk to the bus stop to take the bus to work is a stop; the bus ride to the CBD is another stop; and the walk from the bus stop to the work place is a third stop. The whole journey, including the three stops, is considered a trip.

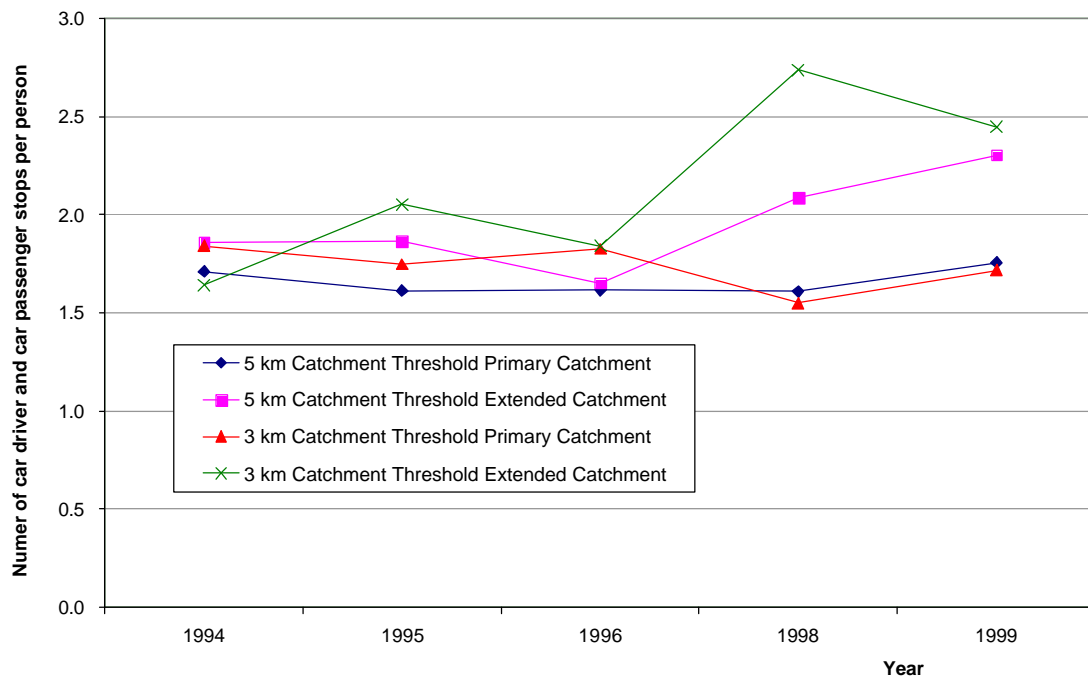
**Figure 3a** Per capita stop rates of Eastern Freeway catchment residents, 1994 to 1999 (source: VATS94, VATS95, VATS96, VATS98 and VATS99)



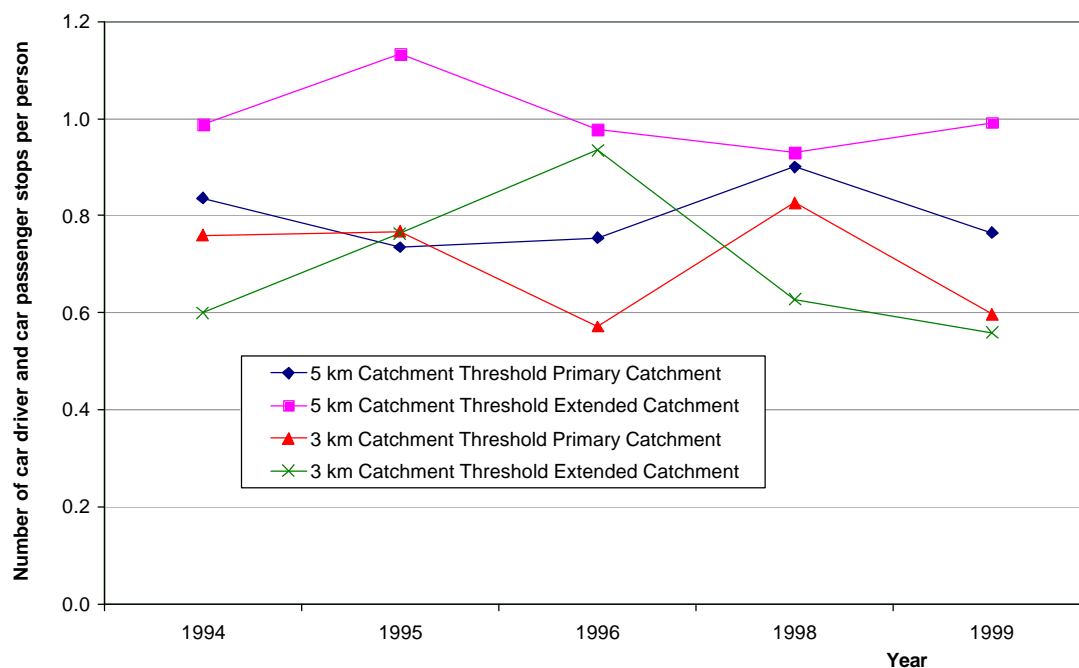
**Figure 3b** Per capita stop rates of Western Ring Road catchment residents, 1994 to 1999 (source: VATS94, VATS95, VATS96, VATS98 and VATS99)



**Figure 4a** Per capita car driver and car passenger stop rates of Eastern Freeway catchment residents, 1994 to 1999 (source: VATS94, VATS95, VATS96, VATS98 and VATS99)



**Figure 4b** Per capita car driver and car passenger stop rates of Western Ring Road catchment residents, 1994 to 1999 (source: VATS94, VATS95, VATS96, VATS98 and VATS99)





Given that car ownership rate among residents of the Eastern Freeway extended catchment has not shown any appreciable increase since 1996, while that of the primary and extended catchments of the Western Ring Road have, the increase in car travel between 1998 and 1999 among residents of the extended Eastern Freeway may be attributable to the opening of the extension. This observation is further supported by the statistics displayed in Table 1. The doubling of the proportion of car trips via the freeway made by residents of the Eastern Freeway extended catchment after its extension is a relatively clear indication that the Eastern Freeway extension has led to greater car travel among its catchment residents. While the share of car trips via the Eastern Freeway by its primary catchment residents has not been as dramatic, the rise in usage is also evident.

**Table 1**      **Percent of Car Trips by Catchment Residents using Eastern Freeway and Western Ring Road (source: VATS94, VATS95, VATS96, VATS98 and VATS99)**

			Before Extension			After Extension	
			1994	1995	1996	1998	1999
Eastern Freeway	5 km Catchment Threshold	Primary Catchment	8.1%	5.9%	7.4%	9.2%	6.4%
		Extended Catchment	3.7%	3.8%	5.8%	10.5%	8.3%
	3 km Catchment Threshold	Primary Catchment	7.5%	7.5%	8.2%	11.9%	8.7%
		Extended Catchment	7.9%	4.7%	4.6%	11.6%	10.2%
Western Ring Road	5 km Catchment Threshold	Primary Catchment	1.8%	2.0%	2.7%	5.7%	5.7%
		Extended Catchment	0.5%	3.3%	2.9%	6.8%	9.1%
	3 km Catchment Threshold	Primary Catchment	1.6%	2.5%	4.6%	6.3%	8.5%
		Extended Catchment	0.6%	4.0%	4.2%	11.1%	15.4%

The Western Ring Road may not have increased the level of car travel among its catchment residents, it does, however, have attracted a higher level of usage. The proportion of car trips using the Western Ring Road by its catchment residents has doubled in almost all instances, including those living in the primary catchment (Table 1). In this sense, it implies that the opening of the Western Ring Road may have reduced the volume of traffic on the surface streets within its catchment. This observation corroborates recent statistics released by VicRoads (1999), which show that traffic volumes on the Western Ring Road have significantly increased but traffic flows on its surrounding local streets had reduced between 1997 and 1998.

These findings suggest that regardless of whether a freeway is designed as a radial artery feeding traffic into the city centre or it is planned as a ring road to disperse cross-town traffic away from the city centre, it does not seem to induce more travel. However, if its function is to facilitate movement into and out-of the city centre, then it would lead to a greater level of car travel. The same, however, is not the case if the freeway is configured as a ring road for traffic dispersion. In either situation, freeway travel would increase.

### **Freeway as an attractor of external car traffic**

While the Eastern Freeway Extension has generated a greater level of car travel among its catchment residents, it has not contributed to increasing the accessibility of its catchment in terms of being able to attract more external car traffic into the area. This is evident from the statistics shown in Table 2a. Regardless of whether the 3 km or 5 km threshold is adopted, the number of external car trips (ie, trips made by non-catchment residents originating from areas outside the defined catchment) entering the primary catchment of the Eastern Freeway before and after the extension does not reflect any appreciable difference. This is despite that the proportion of car traffic entering the primary catchment via the freeway has increased by more than two folds since the opening of the extension. This means that the freeway extension merely redistributes part of the external car traffic from the surface streets onto the freeway.

In the case of the expanded catchment, the extension does seem to have a marginal effect in drawing additional car traffic into its confine. This is inferred from the comparable rise in magnitude of the amount of car traffic entering into the catchment between 1996 and 1998 and that entering via the freeway during the same period. The euphoria, however, did not last long as the amount of car trips entering into the extended catchment returned to the pre-extension level within two years of its opening, albeit the level of car traffic entering the area via Eastern Freeway remained above the pre-extension average.

**Table 2a External car trips into the Eastern Freeway catchment before and after extension (source: VATS94, VATS95, VATS96, VATS98 and VATS99)**

			Before Freeway Extension			After Freeway Extension	
			1994	1995	1996	1998	1999
5 km Catchment Threshold	Primary Catchment	Total External Car Trips Entering Catchment	107,931	118,984	116,563	114,322	127,330
		External Car Trips Entering via Freeway	5,994	6,084	5,933	15,838	14,567
		Percent of External Car trips entering via Freeway	5.6%	5.1%	5.1%	13.9%	11.4%
	Extended Catchment	Total External Car Trips Entering Catchment	65,086	70,646	69,128	72,998	66,442
		External Car Trips Entering via Freeway	1,604	1,998	2,442	5,621	4,550
		Percent of External Car trips entering via Freeway	2.5%	2.8%	3.5%	7.7%	6.8%
3 km Catchment Threshold	Primary Catchment	Total External Car Trips Entering Catchment	94,600	111,472	104,243	105,229	115,419
		External Car Trips Entering via Freeway	5,310	5,874	5,275	14,724	12,293
		Percent of External Car trips entering via Freeway	5.6%	5.3%	5.1%	14.0%	10.7%
	Extended Catchment	Total External Car Trips Entering Catchment	61,028	66,144	67,277	69,980	63,023
		External Car Trips Entering via Freeway	3,494	1,998	2,443	5,241	4,208
		Percent of External Car trips entering via Freeway	5.7%	3.0%	3.6%	7.5%	6.7%

**Table 2b External car trips into the Western Ring Road catchment before and after extension (source: VATS94, VATS95, VATS96, VATS98 and VATS99)**

			Before Freeway Extension			After Freeway Extension	
			1994	1995	1996	1998	1999
5 km Catchment Threshold	Primary Catchment	Total External Car Trips Entering Catchment	32,464	42,247	35,069	40,333	42,371
		External Car Trips Entering via Freeway	472	1,679	2,094	3,614	3,211
		Percent of External Car trips entering via Freeway	1.5%	4.0%	6.0%	9.0%	7.6%
	Extended Catchment	Total External Car Trips Entering	45,974	49,457	48,978	57,397	63,618
		External Car Trips Entering via Freeway	2,684	2,171	4,592	6,601	7,706
		Percent of External Car trips entering via Freeway	5.8%	4.4%	9.4%	11.5%	12.1%
3 km Catchment Threshold	Primary Catchment	Total External Car Trips Entering Catchment	28,778	37,472	31,384	35,454	35,399
		External Car Trips Entering via Freeway	472	1,185	2,094	3,475	2,408
		Percent of External Car trips entering via Freeway	1.6%	3.2%	6.7%	9.8%	6.8%
	Extended Catchment	Total External Car Trips Entering	42,432	46,295	46,521	52,981	56,424
		External Car Trips Entering via Freeway	2,535	2,172	4,314	5,918	7,265
		Percent of External Car trips entering via Freeway	6.0%	4.7%	9.3%	11.2%	12.9%

This clearly suggests that the Eastern Freeway, as a radial artery linking the city centre of Melbourne with the developed eastern residential suburbs, only serves to enhance the attractiveness of the city centre by directing more car traffic to it. It does not, however, have the reverse effect of augmenting the attractiveness of its catchment by pulling more car traffic into it. One reason may be that the period of analysis is relatively short (i.e., only two years after the extension) for any substantial land use changes to be perceived. In this regard, freeway development, despite its accessibility enhancing effect, has not been able to trigger any perceptible land use changes, to the extent of attracting more external car trips into its catchment, in the short run.

The Western Ring Road tells a slightly different story. While the situation with its primary catchment is similar to that observed in the Eastern Freeway Extension, its expanded catchment seems to have benefited from the opening of the Western Ring Road. Table 2b shows that the number of car trips entering into the extended catchment of the Western Ring Road has markedly risen above the pre-extension level for both the 3 km as well as 5 km thresholds. What is more significant is that the increase has not been directly attributable to the surge in traffic entering via the Western Ring Road. Furthermore, the rise in external traffic entering into the expanded catchment continued to persist after the first year, a sign of a real change is taking place.

The observations gleaned from the change in levels of external trips into the catchments of the two freeways suggest that a freeway that links some well-developed residential areas with a major activity centre, such as the Central Business District, would tend to strengthen the “pull” of activity centre, to which the traffic is directed, rather than the attractiveness of the residential districts, which the freeway serves. By contrast, a freeway designed to function as a traffic distributor to disperse car traffic away from a major activity centre could help booster the attractiveness of the catchment that it serves.

### **Freeway development and house price changes**

Studies on the relationships between freeway development and house price changes (see for example Gamble and Davinroy 1974, Palmquist 1982, Huang 1994) generally support the contention that houses adjacent to freeway development would experience price increases with the opening of new freeways. This clearly has been the case with the two freeways being examined in this study. In the case of the Eastern Freeway Extension, median house prices in both the 3 km and 5 km thresholds of the extended catchment have since been increasing at a rate that far surpassed that of the MSD median (Table 3). As price in both these extended catchments were growing at a rate below that of the MSD average the year before the extension, the substantial surge in growth rate, especially between 1998 and 1999, clearly suggests that freeway extension could be a contributory

factor. This reasoning is collaborated by the growth in price levels of residential properties in the two primary catchments (i.e., one bounded by the 3 km and the other by the 5 km threshold). Although house prices in the two primary catchments did attain an above-MSD average growth rate between 1996 and 1998, the strength of their growth did not sustain. In fact, in the case of the 5 km threshold catchment, the growth rate between 1998 and 1999 fell below the MSD average. The disparate growth rates experienced in the two primary and extended catchments before and after the freeway extension seem to confirm the speculation that the extension of the Eastern Freeway has been instrumental in prompting price hike in the extended catchments.

**Table 3      Average annual growth rate of residential properties in Eastern Freeway and Western Ring Road Catchments, 1994-1999**  
(Source: Land Victoria)

				1994-95	1995-96	1996-98*	1998-99
Eastern Freeway	5 km Catchment Threshold	Primary Catchment		-1.8%	3.1%	14.2%	7.4%
		Extended Catchment		-1.1%	1.1%	10.2%	16.0%
	3 km Catchment Threshold	Primary Catchment		-0.8%	3.2%	14.3%	9.4%
		Extended Catchment		-0.7%	0.7%	10.6%	18.0%
Western Ring Road	5 km Catchment Threshold	Primary Catchment		-3.1%	0.9%	9.9%	11.9%
		Extended Catchment		-2.4%	1.1%	11.6%	11.6%
	3 km Catchment Threshold	Primary Catchment		-2.7%	0.9%	8.6%	13.0%
		Extended Catchment		-2.3%	0.0%	11.1%	14.3%
Whole MSD				-1.9%	2.0%	9.0%	7.6%

Note: Computed based on the compound growth formulae.

Changes in house price levels in the Western Ring Road catchments also support the argument that freeway development helps to enhance property values. The two primary and two extended catchments of this traffic distributor were all growing at rates below the MSD average prior to the opening of the Western Ring Road. With the opening of this ring road, median house prices in the catchment areas have registered an increase in growth rates well above that of the MSD median since 1996 (Table 3), albeit the growth rate in the 3 km threshold catchment was slow to accelerate.

## **Conclusion**

The experience of the Eastern Freeway and Western Ring Road extensions in Melbourne has indicated that freeway development, regardless of its intended function, does not increase travel demand. There was little evidence that trip rates per capita among residents of the extended catchments of both freeways have increased as a result of the freeway extension, despite an increase in income level and a rise in car ownership rate in most instances. However, freeway development does seem to have the effect of inducing more car travel, if it is designed as a primary artery linking developed residential suburbs to a major activity centre. This is the case of the Eastern Freeway Extension. Freeways serving as a traffic distributor, dispersing traffic away from major activity centres, such as the central business district, however, do not seem to be able to induce more car travel. This is reflected in the experience of the Western Ring Road.

With regard to attracting external traffic into their catchment, the reverse seems to be the case with the two freeways. The Eastern Freeway Extension has been ineffective in attracting more car trips into the area, while the Western Ring Road, by contrast, appears to be able to draw additional car trips into its catchment.

Taking these findings together, the inference is that freeways designed to serve as radial arteries of major activity centres would help increase the accessibility of the residents living within its catchment. However, it will not be able to trigger major land use changes to the extent of attracting additional external car traffic into its catchment. For freeways designed to function as traffic distributors to disperse traffic away from city centres, the opposite seems to be the effect. These ring roads, as they are called, would tend to be able to accentuate the attractiveness of the place by drawing additional external car traffic into their catchment. But because they are not directly linked to major activity centres, they do not seem to provide much in terms of increasing the accessibility of residents to external opportunities. Since the experience of both the Eastern Freeway and the Western Ring Road confirm the long-established positive relationship between freeway development and house price changes, it may be concluded that the nature of the price enhancing effect of freeway development is different for freeways designed with different purposes.

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