

Parking Price Policies – A review of the Melbourne congestion levy

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Abstract

In January 2006, the Victorian Government introduced a levy on public and private car parking spaces within the Melbourne CBD and adjacent inner city areas. In 2009, preliminary findings on the travel demand impacts of the levy were reported to the 32nd Australasian Transport Research Forum. This paper builds upon the earlier research by examining how the price of parking has changed in response to the introduction of the levy, and uses this information to consider the parking supply and travel demand impacts of the levy.

Results of this research demonstrate that the introduction of the levy coincided with an increase in the price of long-stay parking. However, in public off-street parking facilities, short-stay parking charges also increased, despite the fact that the levy is only charged on long-stay parking; in private off-street parking facilities, some increases in long-stay parking charges occurred at the expense of annual rental increase. The way in which the levy has been passed on to different users has resulted in only minimal changes to the supply of short-stay and long-stay parking within the inner city. Similarly, while the last decade has seen significant modal shifts away from the car for trips to the inner city, only a very small proportion of this shift can be attributed to the introduction of the levy itself. These findings highlight the importance of passing on the full cost of the congestion levy to the motorist, if the levy's supply and travel demand impacts are to be maximised.

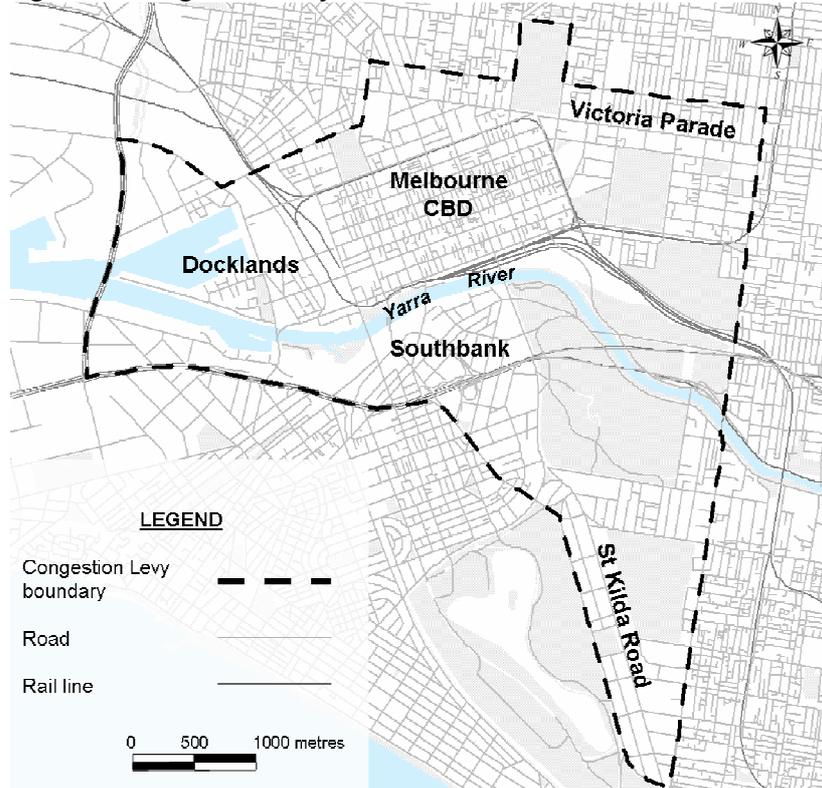
1 Introduction

Parking pricing schemes have been implemented in many cities across the world as an efficient means of managing car travel demand (Albert & Mahalel 2006; Valleley 1997). Such schemes are often preferred to more direct road pricing initiatives as restrictive and priced parking already exists in many centres, reducing the potential political impacts of implementation (Verhoef, Nijkamp & Rietveld 1995). In Australia, area wide parking pricing schemes have operated in the business districts of Sydney, North Sydney and Perth since the 1990s (Brown et al. 1999; Hidas & Cuthbert 1998) and in other suburban business districts of Sydney since 2000 (Enoch 2001). In Melbourne, a levy of \$400 per annum on long-stay parking spaces within the inner city (Figure 1) was introduced in January 2006, rising to \$800 per annum in January 2007, and indexed by inflation each year thereafter. The aims of the levy (as stated in the Explanatory Memorandum of the *Congestion Levy Bill 2005*) are to reduce traffic congestion in Melbourne's inner city, encourage the use of public transport by commuters and provide more options for shoppers and visitors.

A paper presented at the 32nd Australasian Transport Research Forum (Hamer, Currie & Young 2009) reported on the trends in travel behaviour to the Melbourne central business district (CBD) before and after the introduction of the levy, based on an analysis of data from

the *Victorian Activity and Travel Survey* (VATS 94-99) (Transport Research Centre 1994-99) and the *Victorian Integrated Survey of Travel and Activity* (VISTA 07) (Victoria: Department of Transport (DOT) 2007-08). That paper found that the levy represented a 30% premium on the average pre-levy cost of 'early-bird' parking and, based on previous studies (Chambers & Ker 1990; Pickrell & Shoup 1980; Transport Co-operative Research Program (TCRP) 2005; Willson & Shoup 1990), a short-run elasticity of -0.3 might be expected; this equated to a theoretical 9% reduction in car travel demand.

Figure 1: Congestion levy area



The initial paper assumed that, where the levy was passed on to users, it was charged at its full rate (i.e. \$400/\$800 per annum). However, the congestion levy legislation does not mandate the process for passing on the costs of the levy, with the legislation framed to provide maximum flexibility to car park owners and operators (Victoria: State Revenue Office 2007). While lowering its administrative costs, the flexibility of the levy potentially compromises its effectiveness. In particular, parking measures may be undermined by parking operators, through the absorption of parking charges (particularly in the short term) or compliance with the relevant regulations without discouraging long-stay parking, eg. increasing fees across all parking bays to recoup the additional cost.

The current paper considers how the price of parking has varied since the introduction of the levy, and reviews the consequential impacts on parking supply and travel demand. The paper begins with a brief description of the methodology used to analyse the price of parking before outlining how the price of municipal, commercial and private non-residential parking has varied since the introduction of the levy in 2006. The paper continues with a consideration of the parking supply impacts of the levy, and a review of the earlier travel demand results in light of the additional parking price data. The paper then draws some conclusions from the findings and makes some general observations about the implications for similar market-based travel demand measures.

2 Methodology

The methodology for data collection and analysis varied for each of the three types of off-street parking on which the levy applies: municipal parking; commercial parking; and private, non-residential parking.

Municipal parking refers to car parking provided by the local municipality for use by the general public. Parking price and supply data for municipal car parks was provided by the Melbourne City Council (MCC), with reference also made to recent publications relating to council's parking policy (MCC 2008a). These investigations revealed the number of council-owned car parking spaces within the levy area, and the pricing structure which applied to these spaces.

Commercial parking refers to all other car parking provided for use by the general public. Commercial parking can be distinguished from municipal parking not only by its ownership, but also by the fact that it is offered to customers on a purely commercial basis, rather than in accordance with the parking policy of the local municipality. The pricing structure offered in commercial car parks within the levy area was determined by reference to the *Inner Melbourne Car Park Study: Car Park Levy Price Impact Assessment* (MCC 2008c), the *Car Parking Price Policy of Melbourne CBD* (McGuigan 2009) study, as well as personal observation. The *Inner Melbourne Car Park Study: Car Park Levy Price Impact Assessment* (MCC 2008c) provided parking cost data for early-bird parking at public off street car parks from 2005 (i.e. before the introduction of the levy) until 2008 (i.e. after the introduction of the full \$800 levy). The *Car Parking Price Policy of Melbourne CBD* (McGuigan 2009) study identified the range of pricing options that are used in selected CBD public off-street car parks, and demonstrated how parking price (and pricing options) varied with location.

Private, non-residential parking refers to non-residential, off-street parking spaces that are not available for use by the public. Private, non-residential parking includes owner-occupied parking, and parking leased to a commercial (i.e. non-residential) tenant. Typically, the owner or tenant provides these parking spaces for use by their employees. To understand how owners of private, non-residential car parks responded to the levy, semi-structured interviews were held with property managers (representing car park owners). A short web-based questionnaire (*Inner Melbourne Employer Survey - Car Park Levy*) was also developed for completion by employers (representing both owners and tenants) located within the levy area.

An assessment of the levy's parking supply impacts was based on data collected for the *Census of Land Use and Employment* ('CLUE') (MCC 2004; MCC 2006; MCC 2008b). The CLUE data provided information on the spatial distribution of public and private, non-residential off-street parking spaces within the inner city before, during and after the implementation of the levy. This data was supplemented with records provided by car park operators to the State Revenue Office (Victoria: Department of Treasury and Finance (DTF) 2010) as to the number of leviable and non-leviable parking spaces on each car park site.

Analysis of travel demand impacts sought to use results from the *Victorian Activity and Travel Survey 1994-1999* ('VATS 94-99') (TRC 1994-99) and the *Victorian Integrated Survey of Travel and Activity 2007-2008* ('VISTA 07') (DOT 2007-08). VATS 94-99 and VISTA 07 used a self-completion questionnaire to record details of all travel and activity undertaken by members of a selected household on one randomly assigned travel day. In addition to household and trip details, the VATS 94-99 and VISTA 07 surveys recorded the car parking details (i.e. location; time of entry) for each car trip made by a household member. The VISTA 07 survey also collected information on the type of parking fee paid (casual; daily; periodic).

In both VATS 94-99 and VISTA 07, the use of a random sampling methodology enabled the data to provide an estimate of the 'true' population statistic for a particular travel parameter (e.g. number of car trips to the levy area). However, prior to any analysis, expansion factors needed to be applied to the raw data that accounted for the disproportionate number of responses obtained from each sampling region, relative to their share of the total population within the survey area. Expansion factors were derived by factoring up the survey data to reflect output from the relevant *Census of Population of Housing* ('Census'). Despite the use of a random sampling methodology some travel demand impacts that are tested and presented in this paper rely on a relatively small absolute sample size (< 100). Results drawn from such samples (equating to estimates less than 15,000) should be treated with some caution and any trends considered indicative only. Where statistically significant (at 95%) changes have been observed, these are noted in the text.

3 Parking pricing within the levy area

3.1 Municipal Parking

The City of Melbourne (2009) provides municipal parking at two sites within the levy area, both of which are located in close proximity to the CBD's retail core. Parking prices at both facilities are set in order to encourage shopping and visitor trips; discourage commuter car trips; and discourage drivers from searching for cheaper on-street car parking (MCC 2008a). Accordingly, for stays less than two hours, the municipality offers off-street parking at on-street parking rates (\$1.75 per half-hour); for stays in excess of two hours, parking charges escalate rapidly with a fee of \$30 (i.e. more than four times the two hour parking fee) charged for a four hour stay (MCC 2009). The Council has instructed its parking operator to only recoup the levy from users who park for a period in excess of four hours (MCC 2005).

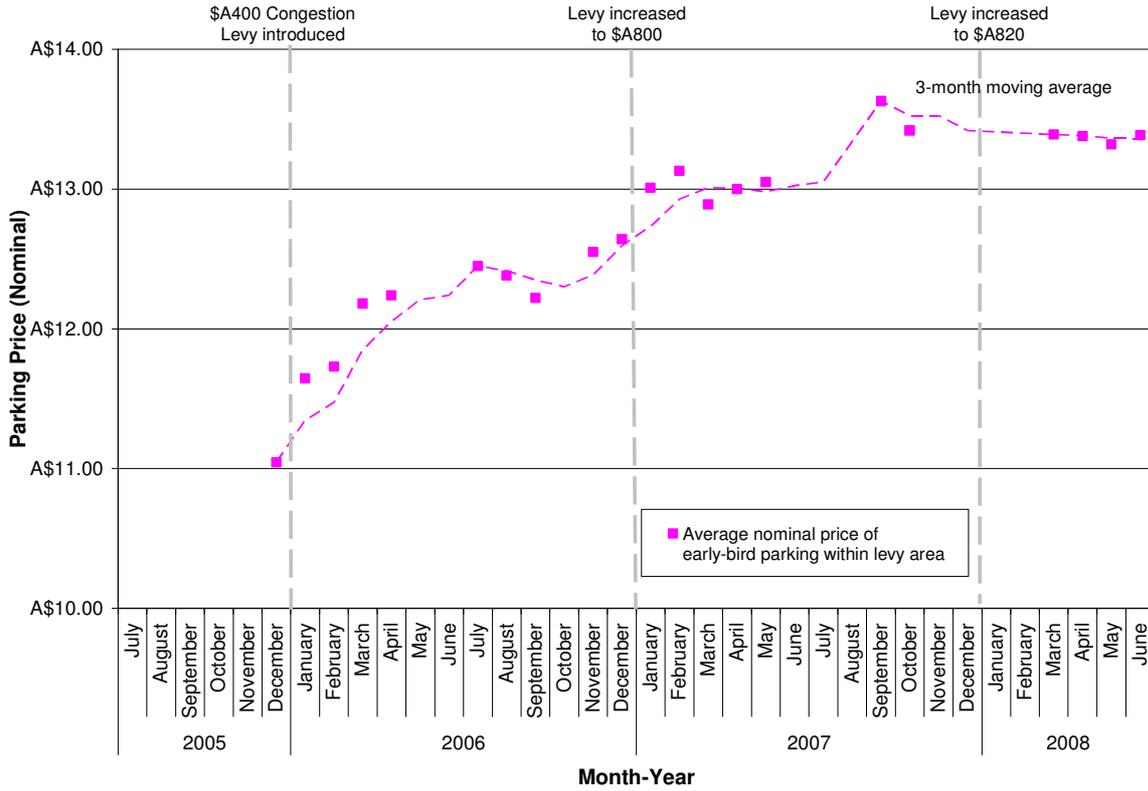
3.2 Pricing of commercial parking

Commercial parking operators offer drivers a range of parking products, including periodic parking; 'early-bird' parking; weekday flat-fee parking; weekday casual parking; and off-peak parking. Many commercial car parks in Melbourne offer early-bird parking, a discounted daily fee for users who arrive before a pre-determined time (e.g. 9.30 am) and stay for a minimum period. In 2009, forty-seven (of seventy-three) commercial car parks in the CBD offered early-bird parking (McGuigan 2009). Outside the CBD, but within the levy area, thirty-two (of sixty-three) commercial car parks offered early-bird parking.¹

Figure 2 shows the nominal early-bird parking charges within the levy area for the period December 2005 through to June 2008, based on the results of the *Inner Melbourne Car Park Study*. To smooth out short-term fluctuations in the data, a three-month moving average is also shown. The average nominal price of early-bird parking within the levy area increased from \$11.05 in December 2005 to a peak of \$13.63 in September 2007. From September 2007 to June 2008, early-bird parking charges fell slightly to \$13.39. The increase in parking charges shown in Figure 2 do not account for any increase in inflation that occurred during the study period. By indexing December 2005 parking prices to 100 and adjusting for inflation, the relative changes in real early-bird parking charges within the levy area can also be shown (Figure 3).

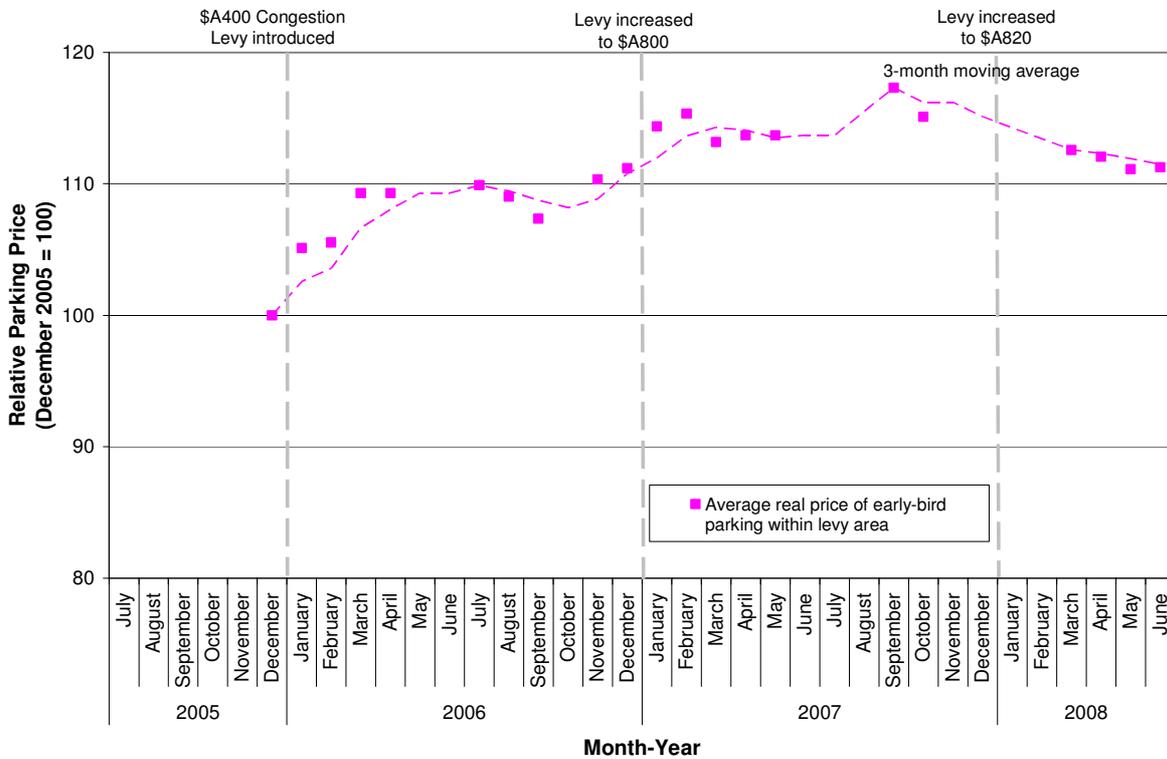
¹ Excludes commercial car parks outside the City of Melbourne.

Figure 2: Nominal early-bird parking charges within the levy area



Source: MCC (2008c)

Figure 3: Changes in real early-bird parking charges within the levy area



Sources: ABS (2009); MCC (2008c)

Figure 3 shows that the average real price of early-bird parking within the levy area increased in the first few months of 2006, and again in the first few months of 2007. The timing of these increases corresponds with the introduction of the levy in January 2006, and its doubling in January 2007. The scale of the increases shown in Figure 3 suggests that not all commercial car park operators have been passing the levy on to users of early-bird parking in full. For example, between December 2005 and September 2007 the average real price of early-bird parking increased by 17%. However, the A\$800 per annum levy that applied in September 2007 represents a 28% premium on the average real price of early-bird parking in December 2005. The subsequent decline in real early-bird parking charges means that, across the entire survey period (December 2005 to June 2008), real early-bird parking charges only increased by 11%.

Early-bird parking charges for commercial car parks located within the levy area were also recorded in April 2009. Analysis of the data shows an average nominal price of early-bird parking within the levy area of \$13.15. Assuming data from the *Inner Melbourne Car Park Study* and the April 2009 studies are comparable, the April 2009 price represents just an 8% increase in real early-bird parking charges above pre-levy (December 2005) prices.

The changes in the price of early-bird parking can also be compared to changes in weekday casual parking. Weekday casual parking includes all weekday (daytime) parking where a fee is paid based on the parking duration. Weekday casual parking can be distinguished from early-bird parking as it requires a fee to be paid based on the length of stay (typically in half-hourly or hourly intervals), whereas early-bird parking offers parking at a fixed daily fee. In 2009, all but two (of seventy-three) commercial car parks in the CBD offered weekday casual parking (McGuigan 2009). Outside the CBD, but within the levy area, forty-four (of sixty-three) commercial car parks offered weekday casual parking.²

Figure 4 compares nominal weekday casual (one-hour) parking charges within the levy area to nominal early-bird parking charges within the levy area. The relative changes in these parking charges are also compared in real terms (Figure 5). The price of both weekday casual and early-bird parking within the levy area increased by approximately 11% over the study period, suggesting that parking operators may be recouping some of the levy from users of weekday casual parking. Figure 4 also shows that, for stays of up to one hour, nominal weekday casual parking charges are consistently less than early-bird parking charges. For longer stays, the parking price depends on the length of the stay. Table 1 shows how nominal weekday casual parking charges within the levy area vary according to the parking duration. For comparison, early-bird parking charges are also shown. While weekday casual parking charges are cheaper than early-bird parking charges for stays up to one hour, weekday casual parking charges are almost three times greater than early-bird parking charges for stays in excess of three hours.

Table 1: Nominal weekday casual parking charges within the levy area

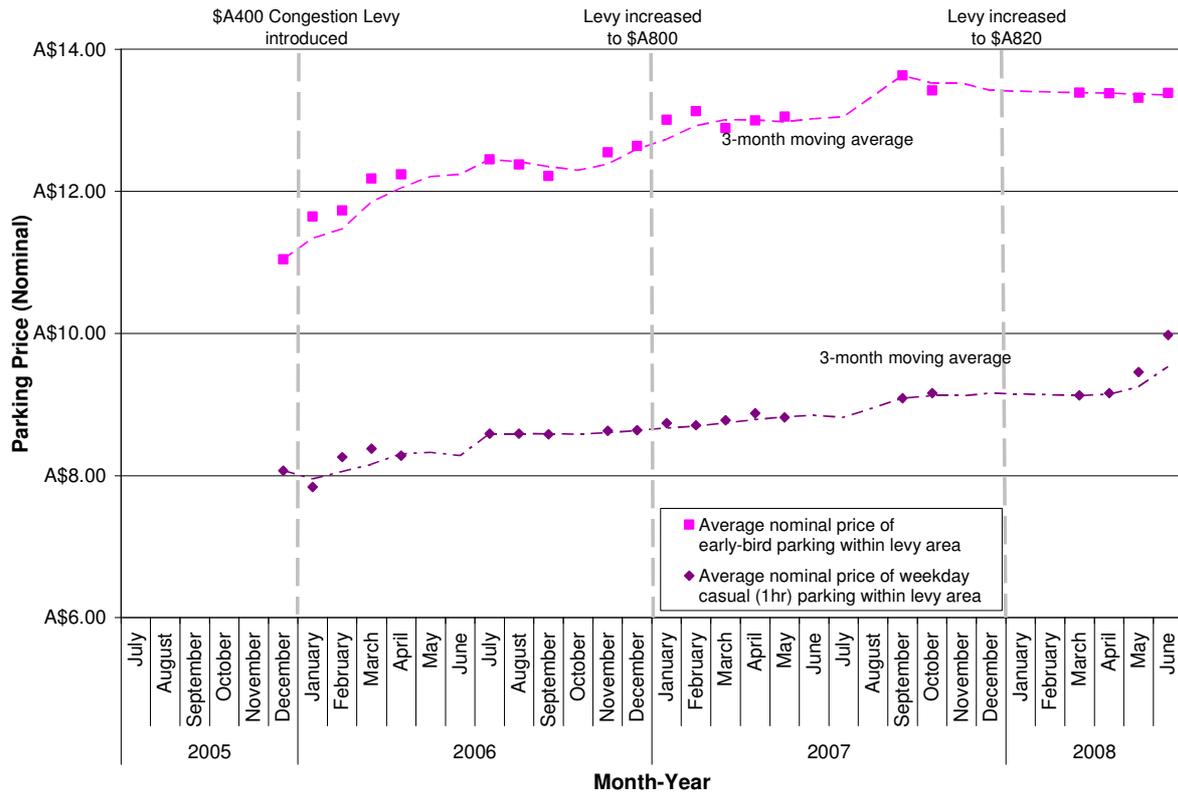
Parking Fee Type	Parking Duration (min)						
	0 - 30	30 - 60	60 - 90	90 - 120	120 - 150	150 - 180	180+
Weekday casual	A\$5.58	A\$10.56	A\$21.77	A\$22.26	A\$31.23	A\$31.25	A\$35.76
Early-bird	A\$13.15	A\$13.15	A\$13.15	A\$13.15	A\$13.15	A\$13.15	A\$13.15

Source: McGuigan (2009) plus additional primary sources

Assuming data from the *Inner Melbourne Car Park Study* (MCC 2008c) and the April 2009 studies are comparable, the results shown in Table 1 also suggest that nominal weekday casual (one hour) parking charges increased by A\$0.58 between June 2008 and April 2009, or a 4.8% increase in real terms. This compares to a nominal and real reduction in the price of early-bird parking over the same period.

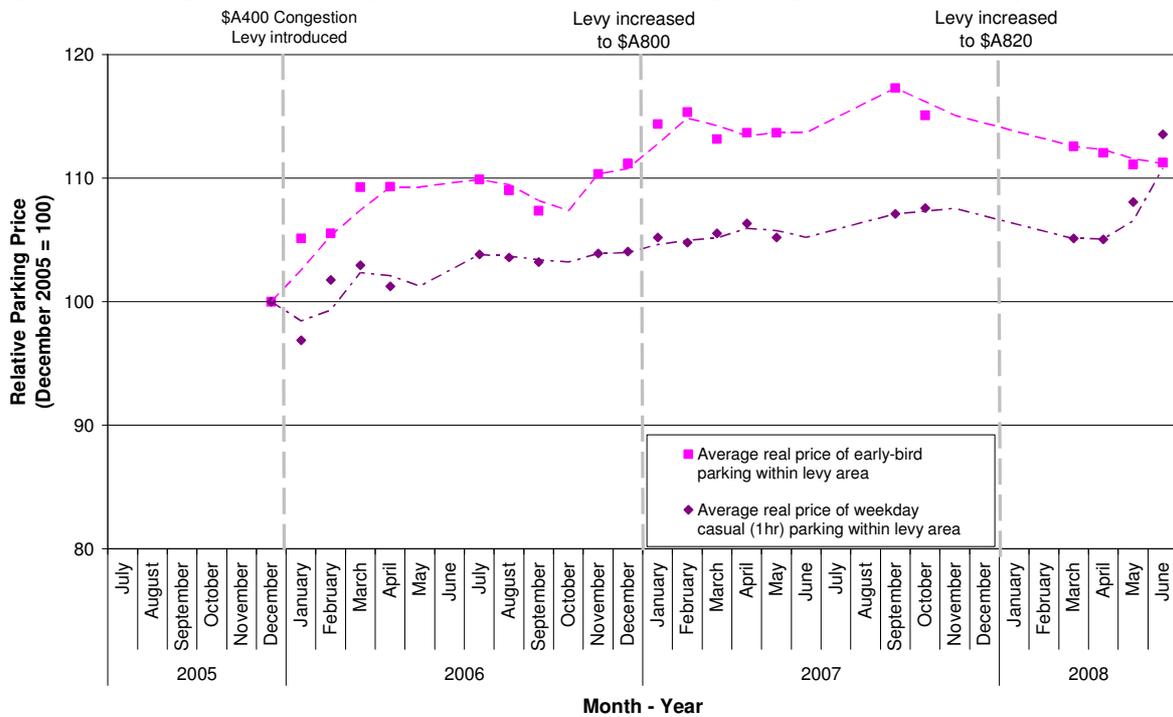
² Excludes commercial car parks outside the City of Melbourne.

Figure 4: Nominal early-bird v casual (1hr) parking charges within the levy area



Source: MCC (2008c)

Figure 5: Changes in real early-bird v casual (1hr) parking charges within the levy area



Source: ABS (2009); MCC (2008c)

In summary, a review of parking charges in commercial, off-street car parks suggests that while the levy may have precipitated a small increase in early-bird parking charges within the levy area, a significant portion of the levy is being recovered from other (short-stay) users. Some of the levy may also be being absorbed by the parking operators themselves, with one commercial parking operator suggesting that the reduction in early-bird parking charges that occurred after September 2007 (and between June 2006 and October 2006) was a commercial response to changing market demand for inner city parking (S Rush [Wilson Parking] 2008, pers. comm., 15 July).

3.3 Pricing of private non-residential parking

In 2008, the average monthly rent for a car park within the Melbourne CBD was estimated to be \$450 (M Haddon [CB Richard Ellis] 2008, pers. comm., 5 November). In city fringe areas, such as the St Kilda Road (refer Figure 1), the average monthly rent for a car park was estimated to be \$275 (M Haddon [CB Richard Ellis] 2008, pers. comm., 5 November). While rents are higher in the CBD than in city fringe areas, parking location within the CBD does not appear to be a strong determinant of price, with considerable differences observed even where car parks are in close proximity to each other (D Whitelegg [Colliers International] 2008, pers. comm., 12 November).

While the owner can theoretically absorb the levy, in most cases the levy is passed on entirely to tenants in addition to any increase in rent (M Haddon [CB Richard Ellis] 2008, pers. comm., 5 November). However, in 2006 (i.e. when the levy was introduced at \$400 per annum) and 2007 (i.e. when the levy increased to \$800 per annum), some property owners agreed to pass the levy on to their tenants in lieu of any rental increase (M Nunan [Knight Frank] 2008, pers. comm., 14 October). This arrangement meant that while the tenant appeared to be paying the levy, the owner was actually subsidising the tenant for part of this payment by not increasing the rental payments due under the base lease.

The *Inner Melbourne Employer Survey - Car Park Levy* sought information from owners and tenants as to how parking costs (including the levy) are recovered from employees. The small number of responses (15) makes it difficult to draw generalised conclusions. However, it is assumed that the proportion of drivers who park in a private, non-residential car park and knowingly pay for the parking levy is relatively small given that in seven of the organisations that completed the survey parking is offered 'free of charge', i.e. where the parking space is provided as part of the employee's contract and cannot be exchanged for a higher base salary. Where parking is not offered free of charge, it is offered to users at or below market rates through salary sacrifice. These salary packaging arrangements mean that the employee is somewhat removed from the payment of the parking fee, and may not be aware of any additional parking costs (e.g. a levy) that are passed on.

4 Parking supply impacts of the levy

Parking price is known to influence parking supply (Litman 2006; Shoup 2005) and therefore, prior to any analysis of the levy's travel demand impacts, it is important to understand the levy's parking supply impacts. Changes in the supply of off-street parking may also magnify the travel behaviour impacts occurring as a result of an increase in parking price (Shoup 2005; TCRP 2003), although this interrelationship is beyond the scope of the present paper.

Table 2 summarises how the supply of commercial and private non-residential parking within the levy area varied between 2004 and 2008. Following the introduction of the levy in 2006, the supply of public off-street car parking decreased slightly, reversing the trends from earlier survey periods. By contrast, the supply of private, non-residential off-street car parking has increased slightly over the same period, although the growth in the number of car parking

spaces is far slower than it was between 2004 and 2006. In all, total off-street parking supply grew by more than 12% in the two years leading up to the levy, but largely remained steady in the two years following the its implementation. In addition to the number of parking spaces shown in Table 2, a further 499 car parking spaces were provided by the City of Melbourne (MCC 2009); this level of supply which has remained unchanged since 2004 (MCC 2004).

Table 2: Summary of off-street parking supply in the levy area (MCC area only)

Measure	CLUE 2004	CLUE 2006	CLUE 2008	Change (2004 – 2006)		Change (2006 – 2008)	
				No.	%	No.	%
Number of commercial spaces	49,609	55,403	53,520	5,794	11.7%	-1,883	-3.4%
Number of private spaces	35,134	40,147	42,439	5,013	14.3%	2,292	5.7%
Total number of spaces	84,743	95,550	95,959	10,807	12.8%	409	0.4%

Source: CLUE (MCC 2004; MCC 2006; MCC 2008b)

Note: Excludes car parks outside of the City of Melbourne.

While the overall reduction in the supply of commercial parking that has occurred since 2006 (Table 2) appears to support sustainable transport objectives, the data cannot reveal whether this reduction has been accompanied by a similar (or greater) reduction in the number of commercial long-stay parking spaces. Some evidence of how the mix of parking types has changed since the introduction of the levy comes from the *Inner Melbourne Car Park Price Study* (MCC 2008c), which revealed that, over the two and a half year survey period, five (of fifty) car park sites ceased offering discounted daily parking rates.

Annual returns provided by car park operators to the State Revenue Office (DTF 2010) provide a further indication of the shift in the parking mix. Table 3 compares the number of leviable parking spaces to non-leviable parking spaces within the levy area. Leviable parking spaces include all non-exempt parking spaces in private, non-residential car parks; all non-exempt parking spaces in commercial car parks provided for periodic parking; and all non-exempt parking spaces in a municipal or commercial car park that satisfy the levy's entry time and duration criteria (Congestion Levy Act, s. 4). Non-leviable parking spaces include all other non-exempt parking spaces and primarily service the needs of weekday casual users and daily users arriving after 9.30 am. Between 2005 and 2007, the number of leviable parking spaces within the levy area fell by 2.1% (or about 1,000 spaces), but remained relatively steady thereafter. The number of non-leviable parking spaces dropped sharply in the year immediately following the introduction of the levy (2006), but more than recovered in 2007, to the point where there was a 25% increase in non-leviable parking spaces between 2005 and 2007. The number of non-leviable parking spaces has remained relatively steady since 2007. Thus, while the small reduction in the number of leviable parking spaces recorded in 2006 may be (in part) attributable to the levy, there has been no subsequent reduction in long-stay parking supply despite the continued increase in the levy. This makes it difficult to draw any causal link between the introduction of the levy and the changes in parking supply.

Table 3: Supply of leviable and non-leviable spaces in the levy area

Measure	2005	2006	2007	2008	2009
Number of leviable parking spaces	54,000	52,000	53,000	52,400	52,600
Number of non-leviable parking spaces	18,000	14,000	22,500	21,900	22,600

Source: DTF (2010)

Note: Excludes parking spaces within Docklands.

5 Travel demand impacts of the levy

The effectiveness of the levy as a travel demand measure depends on the price signal that is sent to the driver (TCRP 2005). Therefore, even if the levy has resulted in an increase in parking charges, the impacts of any increase are limited by the extent to which these charges are passed on to motorists. VISTA 07 recorded information on the type of parking fee paid and the entity responsible for paying the fee (i.e. employer, driver, other) for each car (driver and passenger) trip made by a survey respondent. By ignoring duplicate trips (e.g. where a driver and passenger from the one household make a trip in the one vehicle), this trip information can be converted into car (vehicle) trips terminating at off-street car parks within the levy area (Table 4).

Table 4: Average weekday car (vehicle) trips to the levy area

Parking fee type	Who pays?				Total
	Employer	Driver	Other	N/A	
Periodic	18,800 (16%)	8,600 (7%)	600 (1%)		28,000 (24%)
Daily ('early-bird' and flat-fee parking)	5,600 (5%)	18,700 (16%)	1,500 (1%)		25,800 (22%)
Weekday casual (Daytime; < 5 pm)	2,700 (2%)	5,100 (4%)	600 (1%)		8,400 (7%)
Weekday off-peak (Evening; > 5 pm)		4,800 (4%)	1,400 (1%)		6,200 (5%)
No fee paid				48,000 (41%)	48,000 (41%)
Total	27,100 (23%)	37,200 (32%)	4,000 (4%)	48,000 (41%)	116,400 (100%)

Source: VISTA 07 (Victoria: Department of Transport (DOT) 2007-08)

Notes: Percentages do not total due to rounding errors.

Sampling error (at 95% level of confidence) equals $\pm 5,000$ for no fee paid; $\pm 3,800$ for periodic parking; $\pm 3,600$ for daily parking; $\pm 2,100$ for weekday casual parking; and $\pm 1,800$ for weekday off-peak parking.

Table 4 demonstrates that of the 116,400 ($\pm 7,700$) weekday car trips to off-street car parks,³ the driver pays for parking just 32% ($\pm 3.7\%$) of the time. Therefore, even if car park operators pass on the full cost of the levy to their customers, in approximately two-thirds of all cases, the end user (i.e. the driver) is not affected by the additional charge.

5.1 Impact on peak hour car travel demand

One of the key objectives of the congestion levy is to influence commuter travel behaviour by reducing peak hour car travel demand and increasing peak hour public transport use. Previous studies (Halcrow Fox 1995; Kulash 1974; Pickrell & Shoup 1980; TCRP 2005) have reviewed the impact that parking prices have on car travel demand. Typical short run elasticities ranged between -0.1 and -0.6, with an average of -0.3 (Chambers & Ker 1990; Pickrell & Shoup 1980; Transport Co-operative Research Program (TCRP) 2005; Willson & Shoup 1990). In June 2008 (i.e. month in which both the VISTA 07 survey and the *Inner Melbourne Car Park Study* were completed), the full cost of the parking levy represented a 28% premium on the real price of discounted daily parking prior to the introduction of the levy, and a 16% premium on the price of periodic parking (\$415 per month). Accordingly, had the full levy been passed on to users of early-bird and periodic parking, the expected reduction in car travel demand would be approximately 8.4% for daily parking users, and 4.8% for periodic parking users.

In 2007-08, an estimated 116,400 ($\pm 7,700$) car trips were made to an off-street car park (Table 4). However, further analysis of the VISTA 07 database shows that, of these trips,

³ The paper presented at ATRF 09 estimated that 122,300 car trips are made to an off-street car park within the levy area each weekday (Hamer, Currie and Young, p 8). These trip numbers include all car trips made as either driver or passenger, and thus 'double-count' trips made by a driver and passenger from the one household.

only 68,700 ($\pm 5,900$; or $59\% \pm 5.1\%$) trips are made during the peak period, i.e. arrive before 9.30 am (Table 5). Assuming that the proportion of car trips which are paid for by the driver ($32\% \pm 3.7\%$) are evenly distributed throughout the day, just 22,000 ($\pm 3,400$) of these trips are paid for by the driver.

Moreover, the levy is not being passed on in full, with the real price of early-bird parking only increasing by 11% between December 2005 and June 2008 (Figure 3). Assuming the price of periodic parking also only increased by 11% in real terms, the predicted reduction in car travel demand, based on an elasticity of -0.3, would be only 730 trips:

$$N = 22,000 \times \Delta \times \varepsilon, \text{ where } \Delta = \text{the change in price; } \varepsilon = \text{elasticity}$$

$$N = 22,000 \times 0.11 \times -0.3$$

$$N \sim - 730 \text{ trips}$$

Therefore, each weekday an estimated 730 peak-hour car trips have been prevented as a result of the introduction of the levy. This represents less than 8% of the estimated 9,700 car trips that are no longer being made to an off-street car park, and just 2% of the 31,900 reduction in weekday car trips to the levy area (Table 5). Table 5 suggests that the congestion levy may account for most (if not all) of the reduction in peak hour car trips to off-street car parks within the levy area. However, this is difficult to substantiate given that the recorded change falls within the standard error margin of both samples.

Table 5: Summary of car trips to the levy area

Measure	Source	Pre-levy	Post-levy	Change
Number of weekday, driver-paid car trips to levy area, where car is parked off street (arriving before 9.30am)	Estimate	22,730	22,000	-730
Number of weekday car trips to levy area, where car is parked off street (arriving before 9.30 am)	VATS 94-99; VISTA 07	69,300	68,700	-600
Number of weekday car trips to levy area, where car is parked off street	VATS 94-99; VISTA 07	126,100	116,400	-9,700
Number of weekday car trips to levy area	VATS 94-99; VISTA 07	239,000	207,100	-31,900*

* significant at 95%

To illustrate the effect that employer-paid parking and operator-subsidised parking is having on the decision to drive, the above analysis can be compared to a scenario in which all long-stay parking (daily, periodic and private non-residential parking) is paid for by the driver, and includes the full cost of the levy. Using the trip numbers from Table 4, the estimated reduction in car travel demand then becomes:

$$N_{\text{periodic}} = 28,000 \times \Delta \times \varepsilon, \text{ where } \Delta = \text{the change in price; } \varepsilon = \text{elasticity}$$

$$N_{\text{periodic}} = 28,000 \times 0.16 \times -0.3$$

$$N_{\text{periodic}} \sim - 1,300 \text{ trips}$$

$$N_{\text{daily}} = 25,800 \times \Delta \times \varepsilon, \text{ where } \Delta = \text{the change in price; } \varepsilon = \text{elasticity}$$

$$N_{\text{daily}} = 25,800 \times 0.28 \times -0.3$$

$$N_{\text{daily}} \sim - 2,200 \text{ trips}$$

Assuming that no fee is 'paid' for private, non-residential parking, and an average price of \$350 per month, the full levy represents a 20% premium on the price of 48,000 private, non-residential parking spaces:

$$N_{\text{private}} = 48,000 \times \Delta \times \varepsilon, \text{ where } \Delta = \text{the change in price; } \varepsilon = \text{elasticity}$$

$$N_{\text{private}} = 48,000 \times 0.2 \times -0.3$$

$$N_{\text{private}} \sim - 2,900 \text{ trips}$$

$$\begin{aligned}
 \text{Therefore, total (potential) travel demand reduction} &= N_{\text{periodic}} + N_{\text{daily}} + N_{\text{private}} \\
 &= -1,300 - 2,200 - 2,900 \\
 &= -6,400 \text{ car trips}
 \end{aligned}$$

Instead of a potential diversion of up to 6,400 car trips, only 730 trips (or approximately 11%) are estimated to have been diverted as a result of the congestion levy. Previous studies (Halcrow Fox 1995) have also suggested a 50%-75% diversion rate to public transport for those trips no longer being made by car. Based on a reduction in peak hour car travel demand of 730, approximately 450 additional trips would be made by public transport to the levy area. Between 1994-99 and 2007-08, the number of public transport journey to work trips increased by 75,200 (Table 6). Even if all diverted trips were journey to work trips, the congestion levy would still only be responsible for less than 1% of the total increase.

Table 6: Summary of public transport trips to the levy area

Measure	Source	Pre-levy	Post-levy	Change
Number of weekday, driver-paid car trips to levy area diverted to public transport	Estimate	-	-	450
Number of JTW public transport trips to levy area	VATS 94-99; VISTA 07	98,400	173,600	75,200*

* significant at 95%

5.2 Impact on non-commuter car travel demand

A secondary objective of the congestion levy was to encourage shoppers and visitors to the city by only targeting long-stay car parking spaces. However, an analysis of weekday casual parking prices within the levy area (Figure 5) shows that between December 2005 and June 2008, the price of one hour parking increased by approximately 11% in real terms. This suggests that parking operators were recovering some of the costs of the levy from short-stay users, many of whom are likely to be parking for non-work purposes.

Hensher and King (2001) have previously determined implied price elasticities for drivers' responsiveness to an increase in hourly parking rates of between -0.48 and -1.02, depending on the drivers' destination. Applying these elasticities to the real increase in short-stay parking prices suggests that a 5% - 11% reduction in non-commuter (short-stay) car travel demand might be expected to occur as a result of the levy. Based on an estimated 10,800 (\pm 2,400) shopping and social trips made to an off-street car park within the levy area (Table 7), this reduction equates to an estimated 600 - 1200 fewer trips each day.

However, the analysis shows that the number of shopping and social trips made to the levy area by car (where the car is parked off street) has remained relatively stable over the last decade (Table 7). Significantly, this has occurred in the context of a slight downward trend in the number of trips made to off-street car parks, and a more significant reduction in the overall number of car trips to the levy area (Table 7).

Table 7: Summary of shopping and social trips to the levy area

Measure	Source	Pre-levy	Post-levy	Change
Total number of weekday shopping or social car trips to levy area, where car is parked off street	VATS 94-99; VISTA 07	10,900	10,800	-100
Number of weekday shopping trips made to levy area by car, where car is parked off street	VATS 94-99; VISTA 07	4,200	2,300 [#]	-1,900*
Number of weekday social trips made to levy area by car, where car is parked off street	VATS 94-99; VISTA 07	6,700	8,500	1,800
Number of weekday car trips to levy area, where car is parked off street	VATS 94-99; VISTA 07	126,100	116,400	-9,700
Total number of weekday shopping or social car trips to levy area	VATS 94-99; VISTA 07	26,000	23,100	-2,900
Number of weekday shopping trips made to levy area by car	VATS 94-99; VISTA 07	10,500	6,600	-3,900*
Number of weekday social trips made to levy area by car	VATS 94-99; VISTA 07	15,500	16,500	1,000
Number of weekday car trips to levy area	VATS 94-99; VISTA 07	239,000	207,100	-21,900*

* significant at 95%

RSE is between 25% and 50%; results should be used with caution

While the levy sought to create more parking options for 'shoppers and visitors' as a group, disaggregation of travel demand by trip purpose shows that shopping trips and trips made for a social purpose are quite distinct. In particular, the total number of weekday shopping trips made to the levy area by car fell by a statistically significant amount between 1994-99 and 2007-08. By contrast, the number of weekday car trips made for a social purpose remained relatively steady, despite a statistically significant decline in the total number of weekday car trips made to the levy area. A similar pattern is observed for car trips terminating in off-street car parks within the levy area. These results suggest two distinct patterns of behaviour for shopping and social trips.

Shopping trips appear to be in decline across the levy area. This response is consistent with what would be expected to occur as a result of an increase in parking prices, caused at least in part by the levy. Another possible explanation could be the ongoing expansion of suburban shopping centres, which typically offer free (though sometimes time-restricted) parking to all customers. The rise in social trips to the levy area appears to be counteracting the decline in shopping trips. A closer analysis of the data reveals that 60% of social trips arrive in the levy area after 5:00 pm, with an increasing number of social trips being made during traditional working hours.

6 Conclusions

In January 2006, the Victorian Government introduced a levy on public and private car parking spaces within the Melbourne CBD and adjacent inner city areas. The levy was introduced to reduce traffic congestion by encouraging commuters to switch to public transport for travel into the city, and to create more parking options for shoppers and visitors. This paper has reviewed the price of parking within the levy area, and observed how car park owners and operators have responded to the introduction of the levy.

Since the introduction of the levy in January 2006 and its doubling in January 2007, there has been a clear trend towards a framework that supports more sustainable travel to access the inner city area of Melbourne. The increase in long-stay parking prices, the reduction in long-stay parking supply, and the increase in short-stay parking supply all align with the policy direction of the legislation and, for the most part, arguably support more sustainable transport patterns. Concurrently, there have been significant increases in the number of

people coming to the city by public transport or other sustainable means, and a significant reduction in the number of people travelling to the city by car.

However, the continued increase in early-bird parking prices since 2006 has not corresponded with any further reduction in long-stay parking supply. Moreover, analysis of the travel and parking demand impacts of the levy suggests that because the levy is largely not being borne by the drivers themselves, its effectiveness has been greatly reduced – it is estimated that following the introduction of the levy only 11% of the theoretical reduction in car travel demand has actually been achieved. Thus, the extent to which the levy is not being passed on by parking providers is undermining the stated purpose of the levy, and is limiting its effectiveness as a travel demand management tool. The limited effectiveness of the levy may also be encouraging parking providers to maintain their existing supply of long-stay parking. These findings suggest that the actual price increase, as experienced by users, is a critical determinant of the extent to which the supply of long-stay may be reduced and travel behaviour may be modified. Although some of the final results have relied on relatively small sample sizes (and must therefore be treated with a degree of caution), the results nevertheless highlight the importance of passing on the full cost of the congestion levy to the motorist, if the levy's supply and travel demand impacts are to be maximised.

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