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Cost impacts to motorists of discounted registration fees in the presence of distance-based charges and implications for government revenue.

By

David A. Hensher and Corinne Mulley

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TITLE: **Cost impacts to motorists of discounted registration fees in the presence of distance-based charges and implications for government revenue.**

ABSTRACT: The call for a congestion charge is getting louder and more frequent in many countries as major metropolitan areas experience increasing levels of road congestion. Although reform of road pricing is almost certain to occur at some time in the future, a key challenge is in selling the idea to the community of road users as well as a whole raft of interest groups that influence the views of society and politicians. What is required is a carefully structured demonstration of what might be done to progressively introduce adjustments in road user charges that are seen as reducing the costs to motorists while ensuring no loss of revenue to government. In this paper we show this can be achieved by the reform of registration fees in the presence of a distance-based charging regime (either for the peak or all day), that can deliver financial gains to motorists with prospects of revenue growth to the State Treasury of Sydney (Australia). The reform package assessed is predicted to result in changes to total annual kilometres of travel (especially in the peak) and flow through gains in travel time that deliver reductions in traffic congestion. We see this as an essential first stage in gaining community support for road pricing reform – proof of cost reductions associated with improvements in traffic congestion can then be used to continue the reform process.

KEY WORDS: ***Road pricing reform; political process; revenue implications; staging reform; appealing solutions; use-related registration fees; distance-based charging.***

AUTHORS: **Hensher and Mulley**

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CONTACT:

INSTITUTE of TRANSPORT and LOGISTICS STUDIES (C37)
The Australian Key Centre in Transport and Logistics Management

The University of Sydney NSW 2006 Australia

Telephone: +612 9351 0071
Facsimile: +612 9351 0088
E-mail: business.itlsinfo@sydney.edu.au
Internet: http://sydney.edu.au/business/itls

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1. Introduction

> *"A congestion tax to discourage motorists from driving at peak times could be introduced under a controversial plan flagged by the federal government's chief infrastructure adviser.* **Infrastructure Australia** *chairman Sir Rod Eddington said it was time for "mature and dispassionate" discussion over a new system of road charges to cut congestion and help pay for major transport projects." (**The Age, 8 September 2012)***

Road pricing reform is much touted by economists and others who see the current charging instruments inadequate in both delivering efficient outcomes for road use (especially in controlling levels of traffic congestion) as well as raising sufficient revenue to fund new infrastructure and much needed maintenance of existing road networks (see Verhoef *et al.* 2008 and Manville and King 2012).

The greatest challenge in reforming road user charges is how to devise a scheme which gains public acceptance, which means convincing voters that there are benefits to them, is also convincing to politicians who will be concerned about their electoral future (see Hensher and Bliemer 2012, Bliemer *et al.* 2009, Hensher *et al.* 2012) and satisfies Treasury. The public sentiment, albeit often misinformed, is well illustrated by the following summary of a recent radio conversation.

> *Setting: ABC Radio 702 Tuesday 4 Oct 2011 8.30-8.55am.*
> *Hensher discusses the merits of Road Pricing Reform (after stating clearly that it is more than a congestion tax, and to please stop using the emotive language of a congestion TAX). Calls are invited from the public.*
>
> *A plumber calls and says (paraphrase): "…I spend up to 5 hours on the roads every day between jobs and now you are telling me I have to pay a congestion tax on top of all of my existing costs for the 5 hours. What is he thinking (the Professor needs to get real)… I do not earn enough income now as it is."*
>
> *Hensher's response (paraphrased): "…I made it very clear I thought that the aim is to reform the entire set of charges (including registration fees) and to set the kilometre based charges to reflect the traffic conditions with the aim of not only enabling you to save time (which is money as well) but to give you realistic options on levels of charge and time of day to travel. It is expected that you will spend less time travelling and can convert such saved time into more productive income earning time."*

This paper promotes the belief that road pricing reform will be achieved only by a slow but progressive set of steps that must start some initiative that has an easier staged sell in respect of the "hip pocket" rather than with the explicit end objective to reduce traffic congestion. The predominant interest of car drivers when first asked about congestion charges is what it will mean financially to them (with rare reference to its value in improving travel times). This gives us the crucial clue on where to start in selling road pricing reform.

The paper is organised as follows. We begin with a discussion of how registration fees can be packaged with peak[1] distance-based charges to obtain financial gains to key stakeholders. This is followed by an explanation of the method we have adopted, together with the Sydney Household Travel Survey data (expanded to the population), to undertake scenario analysis in determining the

[1] We also investigated all day distance-based charging, and while there may be some merits for this, including the view that the perception of an all day charge might look better as it is less (3) cents per km, on balance we believe that it will be more difficult to sell this as the first step, and so we have focussed on peak period only distance-based charging.

financial and usage implications of varying registration fees and distance-based charges in the peak. We then present compelling evidence to show how road pricing reform can make both drivers and government better off financially. The conclusions summarise the main policy implications and topics requiring further research.

2. Registration-usage pricing reform

Whether any proposed reform begins with a driver-wide compulsory application or a voluntary opt in and opt out plan is secondary to establishing if there is financial merit in a scheme in terms of its impact on drivers. In addition to motorists, government, and especially Treasuries also have a keen concern for the revenue implications of road pricing reform. The approach we propose in this paper is to start with a budgetary constraint that represents the need for Treasury to be financially no worse off (and possibly better off) while establishing a charging regime that will also make drivers, on average, financially no worse off (and possibly better off).

The reform framework we adopt, as proposed in Hensher and Bliemer (2012), that has these desired attributes involves the introduction of a distance-based charging regime in return for a discount on the current annual registration fee, in full or in part. Although governments often raise the prospect of increasing the annual registration fee to raise revenue (a recent example being the release in September 2012 of the NSW Long Term Transport Master Plan draft (TfNSW 2012)), we would argue that discounting of the registration fee can be used as part of a carrot and stick initiative to move to use-related charging to relieve a cost burden on motorists, at least in the initial phase of securing buy in to road pricing reform. To be able to say that a reform strategy will not make drivers worse off financially[2] will be a major step forward in dulling the immediate critical response from motoring organisations and politicians! A resulting bonus of this reform plan, which is not available under a registration fee only regime, given the disconnection with kilometres travelled, is drivers enjoy the resulting travel time savings. The reduction in kilometres travelled, especially during peak periods, need not be radical in order to make enough of a difference in traffic congestion. The best evidence of this is the difference between peak period travel times on roads during school holidays and during normal times of the year, typically associated with up to 5 percent less traffic (or 1 in 20 vehicles) as a conservative estimate[3].

3. Sourcing data to quantify the potential cost and revenue impacts of the reform plan

The primary data on car driver trip activity and cost outlays is sourced from the Sydney Household Travel Survey (HTS), the largest and most comprehensive source of personal travel data for the

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[2] The issue of vertical equity is discussed in detail in Mulley and Hensher (2012), since some individuals may be (slightly) worse off financially even though most will be better off. Some form of a compensation package may have merit in such circumstances, with monies coming from the additional revenue gain beyond the revenue neutral outcome for Treasury.

[3] Based on data from the Sydney annual Household Travel Survey and

http://www.rta.nsw.gov.au/publicationsstatisticsforms/downloads/travelspeeds_sydney_metro_area.html

During school holidays, traffic lightens by about 7 to 10 percent outside school drop off hours, yet the influence that this has on traffic flow is immense. (See http://www.privatefleet.com.au/congestion/). The National Road and Motorists Association (NRMA) of Australia uses a rule of thumb that when traffic on congested roads falls by 5 per cent, speeds increase about 50 per cent (though this might only mean an average speed increase from 20 km/h to 30 km/h).See http://smh.drive.com.au/roads-and-traffic/how-do-you-spell-the-end-of-the-school-holidays-gridlock-20120715-224ag.html. We calculated a 4.77 percent drop in traffic volumes during school holidays in Sydney in 2005 on all the major arterial roads, freeways and tollroads (sourced from

http://www.rta.nsw.gov.au/trafficinformation/downloads/aadtdata_dl1.html.)

Sydney Greater Metropolitan Area. The HTS was first conducted in 1997/98 and has been running continuously since then. About 5,000 randomly selected households are approached each year to participate in the survey[4]. The sample of the continuous HTS is designed on a three-yearly cycle so that the pooling of three years of data gives a sample size similar to that achieved in the traditional once in 10 years metropolitan household interview survey.

We have used pooled data of residents of occupied private dwellings in the Sydney Metropolitan Area from five waves, June 2007 to October 2011, weighted to June 30 2010 population. Population weights are based on the estimated resident population as at 30 June 2010. The data is based on an average day and is scaled up to the full year. We have undertaken all of the analysis at the geographical level of the Sydney Statistical Division (SSD)5. There are 14 SSD's in Sydney; however we excluded the Statistical Division of Gosford Wyong which is unlikely to be exposed directly to road pricing reform6 (see Figure 1).

In designing a scenario-based application framework, we need to identify the 'before' or status quo financial outlays and kilometres travelled by drivers in the peak and off-peak periods. Some costs are use-related such as fuel costs (distinguishing the fuel excise from the other fuel costs passed to motorists), and tolls, while the registration fees are annual fixed charges unrelated to usage. We also need to calculate the revenue obtained by State Treasury under the status quo situation. In this study we are interested in the revenue implications for the State (of NSW) Treasury who collect registration fees only, and who will under a distance-based charging regime also collect the use-related revenue. Fuel excise is collected by the Federal government and is disbursed as they see fit, with some of the funds returning to the States in many forms. Tolls are collected by the tollroad operators and are retained as part of the public-private partnership concession arrangements and are not available to State Treasuries. The tollroad network in Sydney is extensive by the standards of most cities (see Li and Hensher 2010).

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[4] The HTS consists of a face-to-face interview survey carried out every day from July to June of each financial year. This collection method ensures high data quality and maximises response rates. A simple travel diary is used by each householder to record the details of all travel undertaken for their nominated 24-hour period. An interviewer then interviews each householder to collect the details of each trip. The interviewer records the mode of travel, trip purpose, start and end location, and time of departure and arrival. Vehicle occupancy, toll roads used and parking are recorded for private vehicle trips and fare type and cost for public transport trips. The HTS sampling method was designed for BTS by the Statistical Consultancy section of the Australian Bureau of Statistics (ABS) such that the relative standard error (RSE) decreases and the statistical reliability increases as more waves of data are pooled.

[5] We have data at the postcode level which is at a greater level of spatial disaggregation; and while it is useful for studying sources of systematic variation that influence total kilometres travelled per driver, there are sample reliability concerns for the analysis undertaken herein. We use SSDs but undertake some additional scenario analysis to assess the range of annual kilometres of drivers from each SSD.

[6] There may be implications for residents of Gosford-Wyong who commute to the other Sydney SSDs; however this can, in future analysis, be included if required.

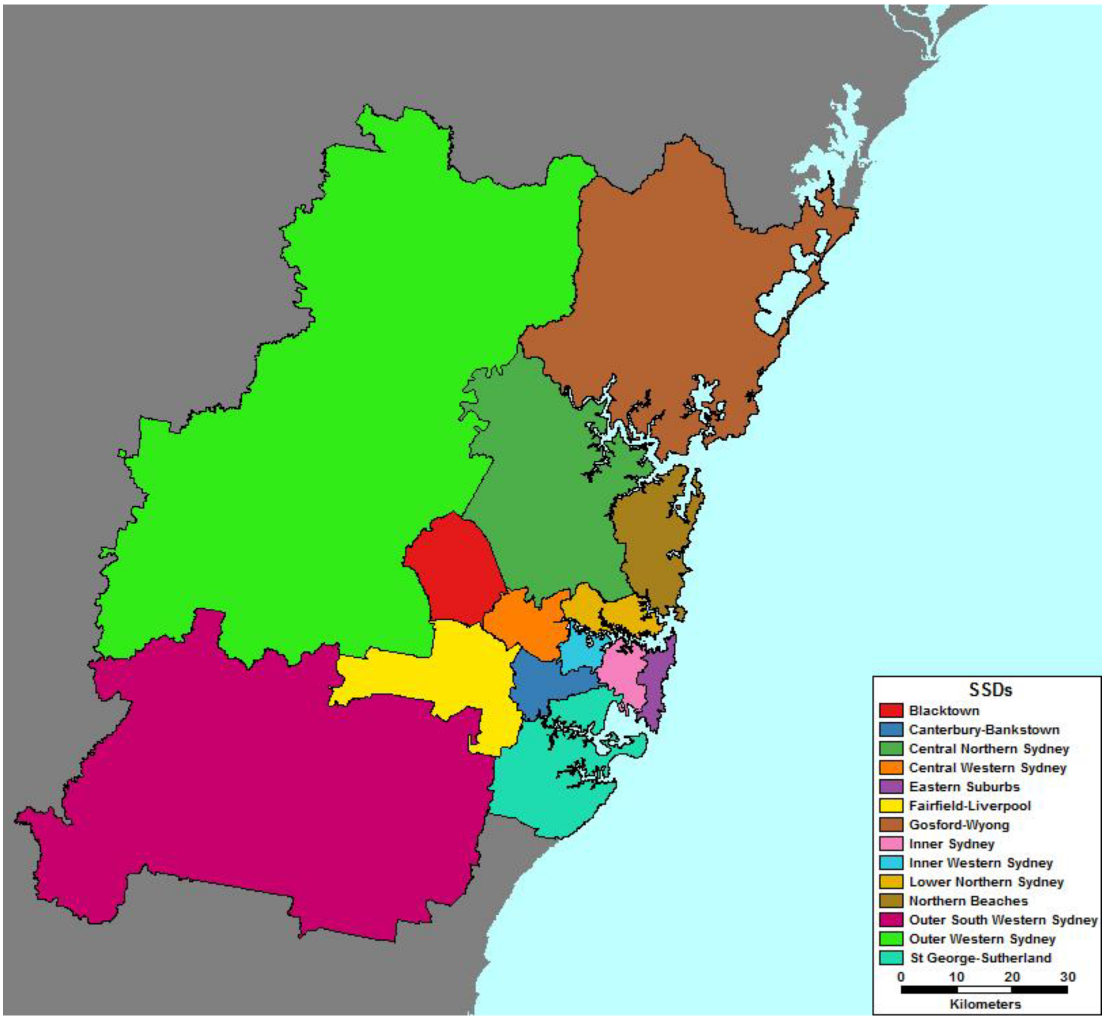

Figure 1: The location of the 14 SSD's in Sydney

To determine the behavioural response of car drivers, expressed in terms of changes in peak and off peak kilometres, to the introduction of peak period distance-based charges (DBC), we need to assume a DBC elasticity of kilometres travelled, *ceteris paribus*. Li and Hensher (2012) provides one review of the evidence, although they find that the focus of most road pricing studies that have reported elasticity estimates has not been in terms of changes in kilometres travelled. Hensher *et al.* (1992), in a longitudinal study of household demand for automobile by type and kilometres travelled in Sydney, obtained static and dynamic short run and long price elasticities for fuel and registration charges in the context of annual kilometres travelled. We have drawn on this study to select price arc elasticities of -0.25 and -0.35 respectively for peak and off-peak kilometres, which we suggest are generally in line with expert opinion. Sensitivity testing around these mean estimates enables us to determine the influence these estimates have on the change in kilometres travelled. These elasticities are applied to the fuel and toll costs[7] together with a peak period distance-based charge, assuming no change in total *status quo* kilometres. Formulae were developed to calculate the peak and off peak kilometres under a peak only DBC:

[7] In Sydney, all tolled roads and cashless with electronic tags (ETAGS). ETAGS tend to make payment seamless and change the perception of toll payments since the driver is not having to be reminded in the same way as having to find cash and stop. This tends to reduce the price sensitivity and brings it closer to the fuel cost response.

Peak Kms^{After} Elasticity Application
= PKM^{Before} *{[1-((TC^{A}|$TotalKM^{Before}$-$Regn^{After}$)-(TC^{SQ}-$Regn^{SQ}$)/ (TC^{SQ}-$Regn^{SQ}$))]*Abs Elas}Off Peak Kms^{After} Elasticity Application = Total KM^{Before}*(1-Proportion PKM),

where PKM = annual peak kilometres, Regn = annual registration fee, TC^{SQ}= total costs before (i.e., status quo) reforms, $TotalKM^{Before}$ = total annual kilometres after DBC but holding kilometres to SQ levels, and Abs Elas = the direct elasticity without sign.

Table 1 summarises the kilometre activity of motorists resident in each SSD together with the mean personal income as background to the setting where the extent of changes in annual kilometres in the peak and off peak periods change in the presence of reforms to the cost of owning and user cars is to be identified. As might be expected, the quantum of kilometres of residents of each SSD varies significantly and in large measure is due to location relative to the Sydney Central Business District, reflecting the radial-centric nature of Sydney. The data has an implied direct elasticity of daily kilometres per driver with respect to distance from the CBD of 0.21 (obtained from a linear regression model in which distance to the CBD was statistically significant with a t-value of 3.64 and in which the overall explanation of variation (adjusted R^2) is 51 percent); hence a 10 percent increase in the average distance to the CBD increases average daily kilometres per driver by 2.10 percent, *ceteris paribus*. Interestingly, when we add in personal income, retaining distance to the CBD, we find that the parameter associated with the natural logarithm of income is not statistically significant (t-value of 1.29) but with an implied mean direct elasticity of daily kilometres per driver with respect to mean personal income per SSD that is very close to unity (1.03). If distance to the CBD is removed from the model, the personal income parameter is negative (-0.85) and highly non-significant (t-value of -0.95). At the mean, therefore, there appears to be no statistically significant relationship between average daily kilometres per driver and income.

When we use equivalent data at the postcode level, the overall fit of the model is poor, (adjusted R^2 of 0.027), although both distance from the CBD and personal income as the only variables in the model, are statistically significant with respective t-values of 12.76 and 11.79. The implied direct elasticity of daily kilometres per driver with respect to distance from the CBD is 0.27, not dissimilar to the SSD level evidence of 0.21, and with respect to personal income it is 0.15.

Mulley and Hensher (2012) investigate in detail the vertical equity implications of the pricing reform evidence in this paper. In this paper we now take a closer look at the combinations of a distance-based charge and discounted registration fees that satisfy the budget neutral (or better) requirement of State Treasury, and which also deliver no financial impost on drivers overall.

Table 1: Descriptive profile of SSD level data

SSD	Mean Personal Income ($'000s)	StdDev Income	Mean Kms per day per driver	StDev KmDay perDrv
Inner Sydney	62.89	41.07	13.97	21.45
Eastern Suburbs	63.38	43.73	17.14	21.75
Inner West	56.42	40.86	16.22	22.64
Lower Nth Sydney	62.22	44.03	19.5	23.64
Central Nth Sydney	59.96	43.24	26.43	31.09
Northern Beaches	61.04	43.27	20.5	24.72
Central West Sydney	57.28	42.52	22.75	29.03
Canterbury-Bankstown	49.66	36.54	17.85	22.91
Blacktown	53.43	37.22	28.18	32.59
Fairfield-Liverpool	51.42	37.68	25.68	30.25
Outer South West	52.87	38.94	18.24	39.63
St George Sutherland	57.18	39.56	24.16	28.72
Outer West	56.65	39.23	32.86	37.82
SSD	Drivers	Total kms per day per all drivers	Population	Total Licence Holders
Inner Sydney	113,525	1,585,942	362,074	178,624
Eastern Suburbs	103,756	1,778,382	261,089	173,161
Inner West	79,607	1,291,231	195,230	127,167
Lower Nth Sydney	136,065	2,653,274	321,383	194,170
Central Nth Sydney	186,687	4,934,141	463,330	146,962
Northern Beaches	118,165	2,422,390	250,506	211,984
Central West Sydney	180,976	4,117,210	360,720	291,151
Canterbury-Bankstown	131,798	2,352,592	338,390	212,523
Blacktown	129,705	3,655,082	313,057	188,005
Fairfield-Liverpool	161,531	4,148,128	386,326	130,943
Outer South West	116,234	2,120,108	257,647	171,410
St George Sutherland	216,495	5,230,509	465,594	325,089
Outer West	161,735	5,314,614	330,454	104,697
All SSDs	1,836,280	41,603,603	4,305,800	2,455,886

4. Identifying the preferred mix of a peak period distance-based charge and discounted annual registration fee

To establish the financial implications of alternative combinations of a peak period DBC and discounted annual registration fees, we built a scenario decision support system (in excel). The key inputs, for each SSD and status quo (i.e., before) situation, are the mean annual kilometres, the proportion of kilometres in the peak periods (AM and PM)[8], the average daily cost per driver (comprising fuel and tolls, distinguished by peak and off peak periods), annual registration fees, and mean direct elasticities of peak and off peak kilometres with respect to usage costs. In addition, for the reform scenarios, we considered a DBC varying from 2c/km to 10c/km in the peak, and allowed annual registration fees to vary from 30 to 75 percent of the status quo annual fee. These ranges were determined from an initial assessment of likely adjustments that would satisfy the binding constraints to be neutral to government revenue and driver cost outlays. As part of scenario definition, given the absence of any evidence on cross elasticities of kilometre switching by time of day under a move from a fixed annual registration fee to a DBC use-related charge, we have assumed that all kilometres that have moved from the peak period do not move to the off-peak[9]. This is a limiting assumption, with an expectation that we have under-predicted the change in off-peak kilometres (Bliemer *et al.* 2009). Since the off-peak kilometres do not have a DBC cost element, the impact on State Treasury is zero; although there is a reduction in Federal fuel excise.

[8] The peak is defined as 6.31am to 9.30 am and 3.01pm to 6pm Monday to Friday.

[9] When we introduced an all day DBC, we would also get a change in off-peak kilometres but that scenario is not considered in this paper.

The decision support system calculates the status quo total costs and kilometres for all drivers and revenue to State Treasury, distinguishing outlays and receipts for the peak and off peak periods. We then introduce the range of peak-period DBCs and discounted registration fees and calculate the combination of these two cost outlays for motorists of each SSD that results in *both* a reduced mean cost outlay to motorists and no loss in revenue to State Treasury. At the SSD level, we expect to obtain different DBC levels for a given discount on the registration fee, and indeed that is what was obtained. The range is three to eight cents/km. as shown in Figure 2. Taking the lowest value would ensure net gains to each SSD motorist, but would result in the loss of neutrality (or better) to Treasury revenue. Placing different charges on motorists over the metropolitan area would raise clear concerns from many perspectives including the political ramifications.

A preferred solution is to take a system wide approach (essentially a weighted averaging of the SSD data), and to identify a single DBC, given a discounted registration fee, that achieves the required financial outcomes for drivers and State Treasury. Table 2 summarise the findings in which the selected peak period DBC is 5c/km with a discounted registration fee of $185, slightly greater than a 50 percent reduction. On average, a driver saves $9 per annum and Treasury gains $32 per driver per annum. These are extremely low amounts per driver, but they translate into sizeable financial gains to all drivers (Figure 3) and State Treasury (Figure 4 and Table 3). Figure 3 highlight the total mean differences in cost outlays for drivers resident in each of the SSDs, with eight SSDs having positive gains and five SSD's with negative gains. There is a total cost gain of $43.6m and a total cost loss of $28.8m. When converted to an additional cost outlay per driver per km the amount for the five affected SSDs is 0.34 cents/km, contrasted with 0.65 cents/km gain for the eight SSDs.

In exploring the financial implications on drivers of moving away from an SSD-specific DBC solution, Table 4 is particularly informative in that it identifies the average gains or losses in cost outlays *per driver per annum* in each SSD. The blue shaded cells represent the preferred outcome when each SSD is assessed independently; and this is contrasted with the light beige shaded cells based on the system wide 5 cents/km solution. The light green shading for SSD's 5 and 12 represents the situation where the SSD-specific and system wide DBC charge is the same. The evidence in Table 4 suggests that, on average, car drivers are better off under the system wide DBC than under the SSD-specific solution for SSDs 1-4, 6-8, and SSD 11, but Treasury is worse off; and worse off for SSDs 9 and 10, with Treasury better off. The average annual financial gains and losses per driver at 5 cents/km are relatively small, ranging from $91 for SSD1 to -$40 for SSD9. Of the SSDs located the furthest distance from the CBD (notably SSDs 9-13), drivers are better off under the 5 c/km DBC in SSD8 and SSD11, whereas in the other SSDs drivers are worse off, with annual cost outlay increases varying from a high of $84 (SSD13 - Outer West) to a low of $3 (SSD12 – St George Sutherland). These are still, however, very small financial imposts on drivers. Importantly, however, as shown above, there appears to be no evidence of an income effect as a consequence of moving from SSD-specific DBCs to a system wide DBC.

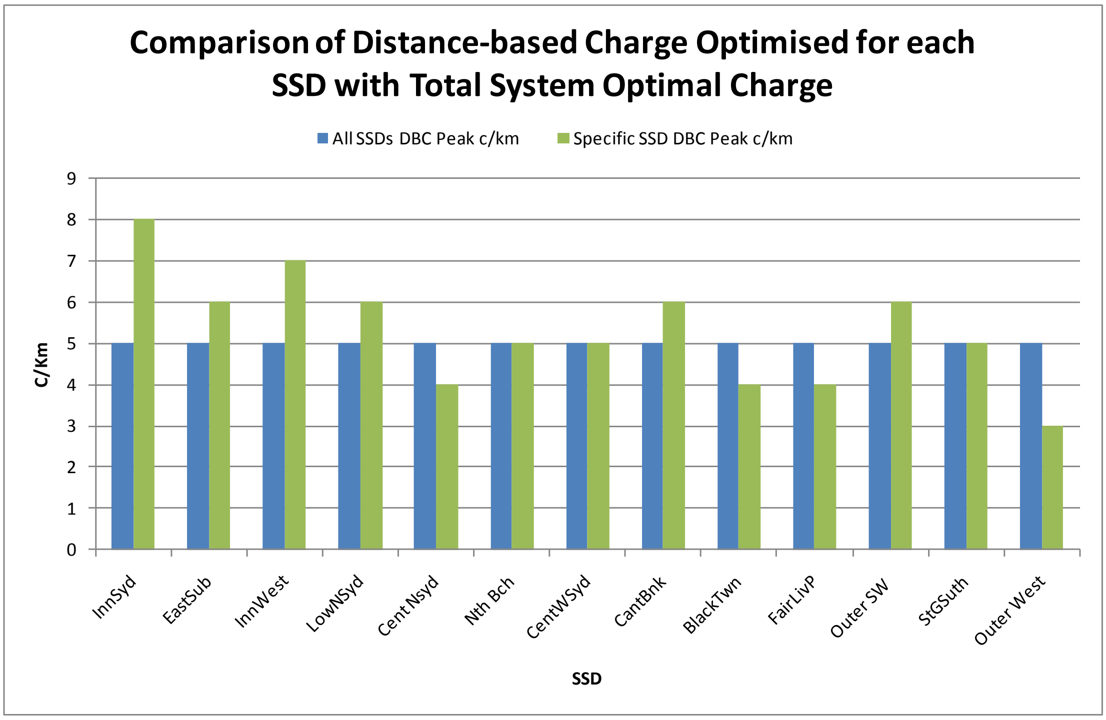

Figure 2: A comparison of the system wide DBC versus SSD specific pricing

Table 2: Identifying a DBC and discounted registration fee that makes motorists and treasury financially no worse off

		ALL SSDs		
		Positive = gain, negative = loss		
		Car driver	Treasury	change in peak km
Regn fees halved and DBC for peak kms only C/km	2	130	-113	-102
	3	88	-64	-154
	4	48	-16	-205
	5	**9**	**32**	-256
	6	-29	78	-307
	7	-66	123	-358
	8	-102	167	-409
	9	-137	210	-461
	10	-171	252	-512

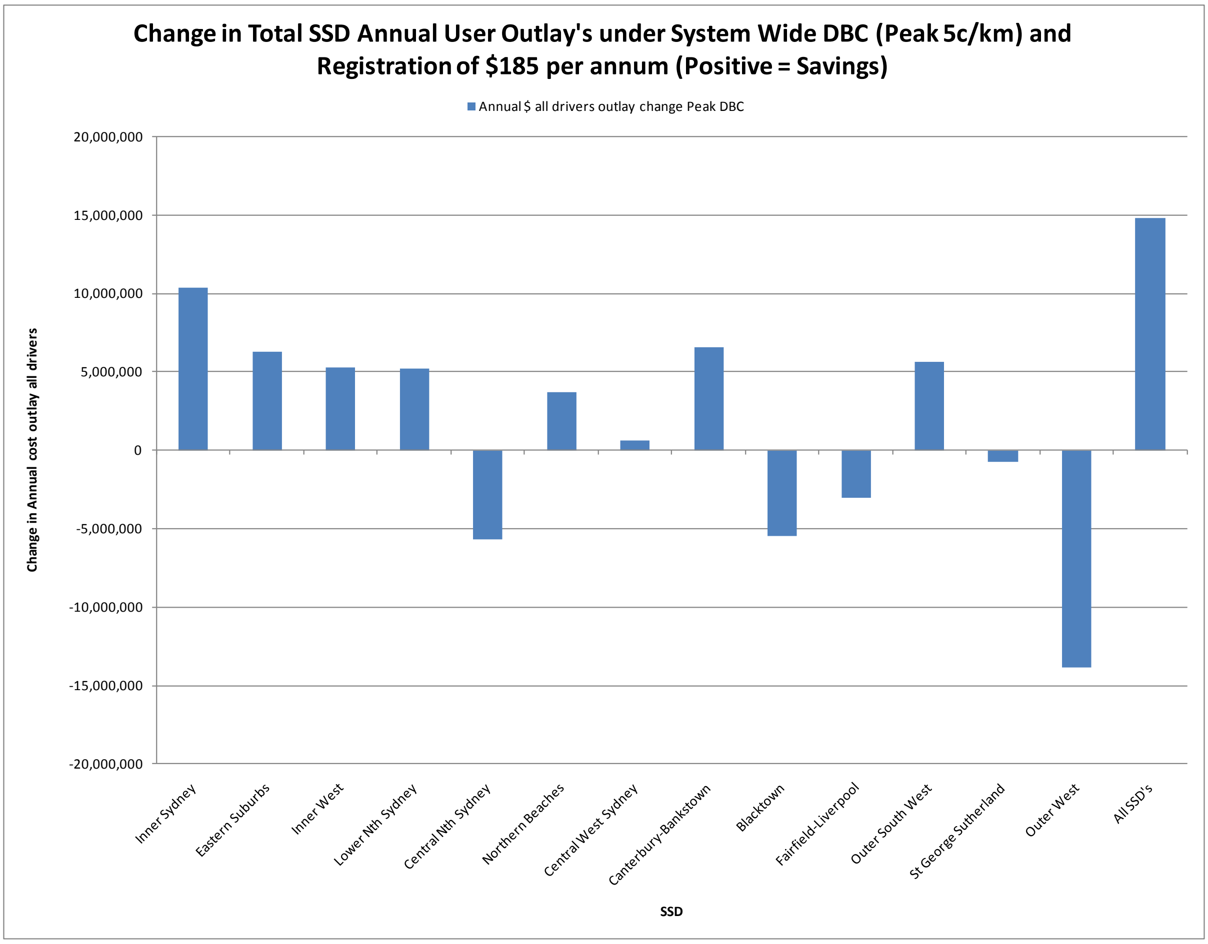

Figure 3: Impact of pricing reform on annual costs of driver per SSD

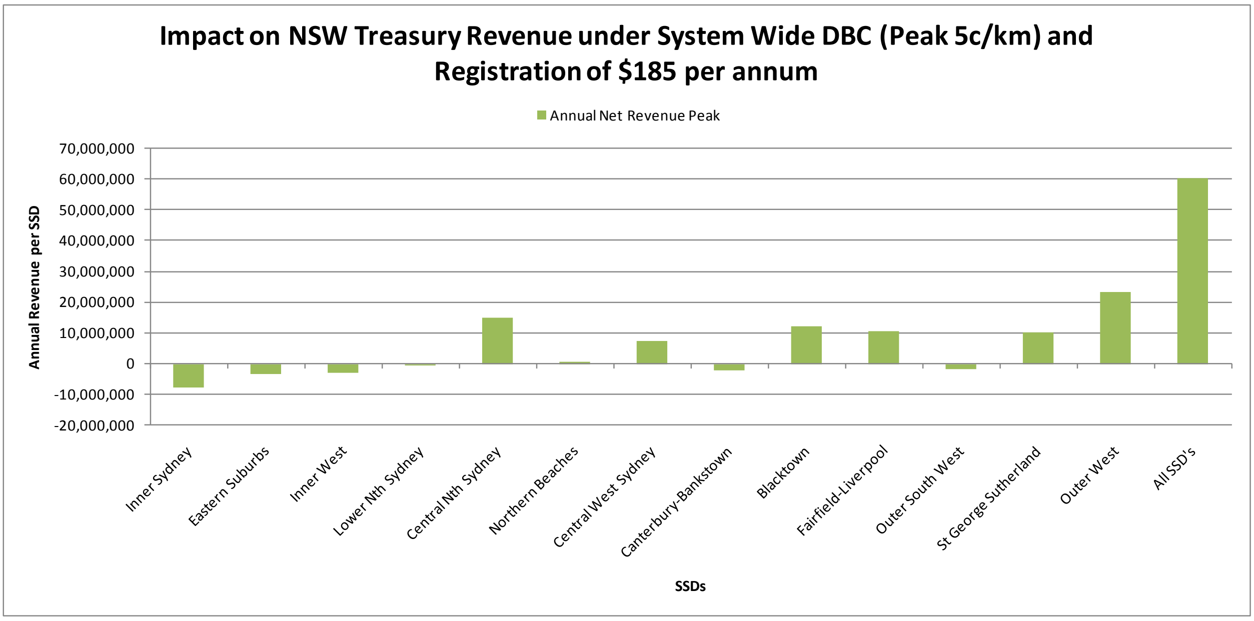

Figure 4: Impact of pricing reform on treasury revenue

Table 3: Impact of pricing reform on treasury revenue per driver and for all drivers

SSD	Treasury Impact Peak PA	Annual Net Revenue Peak
Inner Sydney	-68	-7,690,883
Eastern Suburbs	-31	-3,184,248
Inner West	-36	-2,885,496
Lower Nth Sydney	-3	-428,670
Central Nth Sydney	80	15,002,723
Northern Beaches	3	412,293
Central West Sydney	40	7,202,676
Canterbury-Bankstown	-16	-2,157,321
Blacktown	93	12,001,333
Fairfield-Liverpool	65	10,432,742
Outer South West	-16	-1,851,350
St George Sutherland	46	10,043,318
Outer West	145	23,453,308
All SSD's	**302**	**60,350,423**

Table 4: Summary of SSD-specific optimal DBC compared to the system wide 5c/km impact

	SSD1			SSD2			SSD3			SSD4		
Pos =gain, neg= loss	InnSyd			Eastern Suburbs			Inner West			Lower Nth Sydney		
DBC for peak kms only	Car driver	Treasury	change in peak km	Car driver	Treasury	change in peak km	Car driver	Treasury	change in peak km	Car driver	Treasury	change in peak km
2	164	-154	-56	151	-139	-72	153	-141	-75	141	-128	-83
3	139	-125	-84	120	-102	-108	124	-106	-113	106	-85	-125
4	115	-96	-113	90	-66	-144	95	-71	-151	71	-43	-167
5	***91***	***-68***	***-141***	***60***	***-30***	***-180***	***66***	***-36***	***-188***	***37***	***-3***	***-208***
6	68	-40	-169	**32**	**4**	**-215**	39	-3	-226	**4**	**37**	**-250**
7	45	-13	-197	3	38	-251	**12**	**30**	**-264**	-28	77	-292
8	**23**	**14**	**-225**	-24	72	-287	-14	62	-301	-59	115	-333
9	2	40	-253	-50	104	-323	-39	93	-339	-90	152	-375
10	-19	66	-281	-76	136	-359	-64	123	-377	-119	189	-416
Pos =gain, neg= loss	SSD5			SSD6			SSD7					
DBC for peak kms only	Central Nth Sydney			Northern Beaches			Central West Sydney					
2	Car driver	Treasury	change in peak km	Car driver	Treasury	change in peak km	Car driver	Treasury	change in peak km			
3	113	-93	-124	139	-125	-88	127	-110	-113			
4	64	-34	-186	103	-82	-133	85	-60	-170			
5	***17***	***23***	***-248***	***67***	***-39***	***-177***	***45***	***-10***	***-227***			
6	-30	80	-311	**32**	**3**	**-221**	**5**	**38**	**-283**			
7	-75	135	-373	-2	43	-265	-34	86	-340			
8	-119	189	-435	-35	83	-310	-71	132	-397			
9	-162	242	-497	-67	123	-354	-108	177	-453			
10	-204	293	-559	-98	161	-398	-143	221	-510			
	SSD8			SSD9			SSD10					
	Canterbury-Bankstown			Bankstown			Fairfield-Liverpool					
DBC for peak kms only	Car driver	Treasury	change in peak km	Car driver	Treasury	change in peak km	Car driver	Treasury	change in peak km			
2	147	-133	-86	109	-89	-125	118	-100	-118			
3	114	-94	-128	58	-28	-188	72	-44	-177			
4	82	-55	-171	**8**	**32**	**-251**	**26**	**10**	**-236**			
5	***51***	***-18***	***-214***	***-40***	***90***	***-313***	***-18***	***64***	***-295***			
6	**21**	**19**	**-257**	-88	148	-376	-61	116	-353			
7	-9	55	-300	-134	204	-439	-103	167	-412			
8	-37	91	-342	-179	259	-501	-143	217	-471			
9	-65	125	-385	-222	312	-564	-183	265	-530			
10	-92	158	-428	-264	365	-627	-221	313	-589			
	SSD11			SSD12			SSD13					
	Outer South West			St George Sutherland			Outer West					
DBC for peak kms only	Car driver	Treasury	change in peak km	Car driver	Treasury	change in peak km	Car driver	Treasury	change in peak km			
2	146	-133	-80	124	-107	-113	91	-67	-152			
3	113	-94	-120	81	-55	-169	**31**	**5**	**-228**			
4	81	-55	-161	38	-4	-225	-27	75	-304			
5	***49***	***-17***	***-201***	***-3***	***46***	***-281***	***-84***	***143***	***-380***			
6	**19**	**21**	**-241**	-43	95	-338	-139	211	-456			
7	-11	57	-281	-82	143	-394	-193	276	-532			
8	-41	93	-321	-120	189	-450	-245	340	-608			
9	-69	128	-361	-157	235	-507	-296	403	-684			
10	-96	162	-402	-193	279	-563	-345	464	-760			

Importantly the new reform package results in a 4.7 percent reduction in total annual peak period kilometres and a 2.96 percent reduction in all kilometres[10] (given in Table 5 and Figure 5 for each SSD and overall for all SSDs). This percentage change of close to 5 percent in the peak is in line with evidence on what it takes to get a noticeable improvement in levels of traffic congestion, which are often associated with the reduced traffic during school holidays (see footnote 2 which reports a 4.77 percent drop in traffic volumes during school holidays in Sydney in 2005). Hence if the reform package of a combination of a peak period DBC of 5c/km is combined with a discounted registration fee of $185 on average, we can expect noticeable improvements in traffic congestion without cost hit to motorists or revenue loss to State Treasury. There will however be an overall 2.96 percent loss in fuel excise to the Federal government.

Table 5: Impact of pricing reform on annual kilometres

SSD	Total Daily Peak Kms Before	Total Daily Peak Kms - Peak DBC, 50%Rego	Total Daily Off peak Kms Before	OffPk Kms - Peak DBC, 50%Rego	Total Daily Kms Before	Tot Daily Kms - Peak DBC, 50%Rego
Inner Sydney	960,137	915,997	625,805	625,805	1,585,942	1,541,802
Eastern Suburbs	1,100,758	1,047,854	677,624	677,624	1,778,382	1,725,478
Inner West	819,932	779,731	471,299	471,299	1,291,231	1,251,030
Lower Nth Sydney	1,661,215	1,579,473	992,059	992,059	2,653,274	2,571,532
Central Nth Sydney	3,175,539	3,021,395	1,758,602	1,758,602	4,934,141	4,779,997
Northern Beaches	1,480,543	1,414,676	941,847	941,847	2,422,390	2,356,523
Central West Sydney	2,653,106	2,526,716	1,464,105	1,464,105	4,117,210	3,990,821
Canterbury-Bankstown	1,502,772	1,434,478	849,820	849,820	2,352,592	2,284,298
Blacktown	2,282,529	2,185,637	1,372,553	1,372,553	3,655,082	3,558,189
Fairfield-Liverpool	2,596,794	2,474,630	1,551,333	1,551,333	4,148,128	4,025,964
Outer South West	1,327,221	1,267,888	792,886	792,886	2,120,108	2,060,774
St George Sutherland	3,263,618	3,100,803	1,966,891	1,966,891	5,230,509	5,067,694
Outer West	3,345,305	3,190,485	1,969,309	1,969,309	5,314,614	5,159,794
All SSD's	**26,169,470**	**24,939,764**	**15,434,133**	**15,434,133**	**41,603,603**	**40,373,897**
Percent Change		**-4.70%**				**-2.96%**

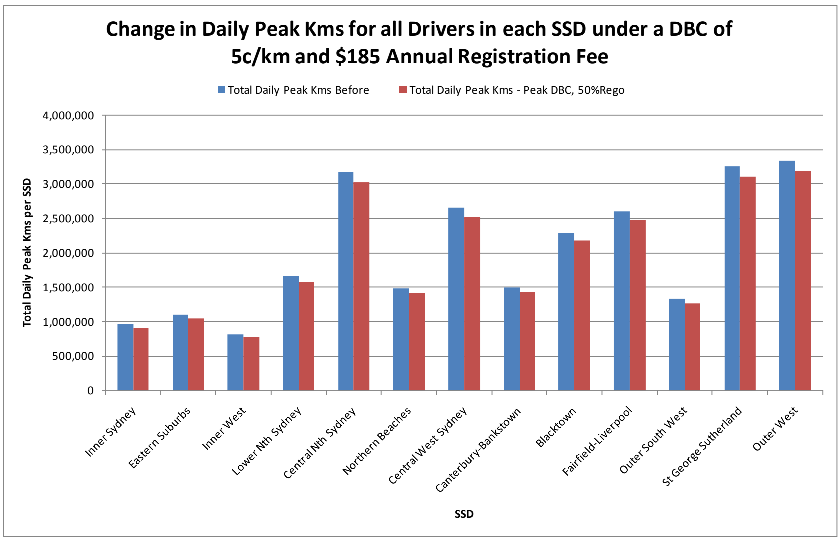

Figure 5: Impact of pricing reform on total driver kilometres per SSD

[10] We recognise that this will likely be smaller when trips moving to off-peak periods are considered.

The analysis reported so far has been based on the average driver in each SSD. To investigate the likely implications on cost outlays and revenue raised of deviations around the mean, we have taken the two extremes of all drivers in each SSD having high and low kilometres. The relevant levels for each SSD are given in Table 6 and range from a high of 75 kilometres per driver per day to a low of 8 kilometres per driver per day, both in the Outer West. Under these kilometre assumptions, we find that the peak period DBC is reduced to 2c/km for the high kilometres and increased to 10c/km for the low kilometres, given the same discounted registration fee of $185. If all drivers were at the high or low kilometre level, State Treasury is financially much better off than under the 5c/km DBC, due to either the greater number of kilometres in the peak periods, or the higher DBC. Drivers however are worse off if they all operated at the high kilometres, while substantially better off at the low kilometres. Clearly this evidence is not what will occur in reality because of a distribution of annual kilometres across all drivers. Even with a user loss of $14.076m, that is equivalent to only 2.01 cents per day per driver, hardly noticeable!

Table 6: Implications of high and low annual kilometres in each SSD

Peak period DBC =2c/km for high kms and 10c/km for low kms
annual registration fee is held at the discounted fee of $185
Positive = savings

SSD	Annual Kilometres per driver per day		Change in Driver Costs $ per annum per SSD		Change in Treasury Revenue $ per annum per SSD	
	Low	High	Low Kms	High Kms	Low Kms	High Kms
Inner Sydney	10	40	5,296,833	7,775,340	-1,500,051	-4,737,915
Eastern Suburbs	12	45	1,000,505	4,901,139	3,352,227	-1,636,590
Inner West	12	45	642,193	3,497,667	2,872,721	-861,481
Lower Nth Sydney	15	65	-5,896,785	-4,007,725	13,197,394	10,334,920
Central Nth Sydney	12	65	685,461	-6,488,833	7,781,749	15,661,644
Northern Beaches	10	55	5,420,140	1,430,670	-1,392,256	3,000,003
Central West Sydney	10	55	7,455,849	649,823	-598,481	6,893,282
Canterbury-Bankstown	10	50	5,518,786	3,174,935	-611,578	1,732,272
Blacktown	15	70	-5,537,584	-6,185,996	12,460,972	12,647,825
Fairfield-Liverpool	12	65	1,488,862	-4,737,450	5,442,874	12,246,831
Outer South West	9	50	6,902,847	3,137,157	-3,161,920	1,019,429
St George Sutherland	12	65	2,375,002	-6,199,179	6,854,364	16,197,659
Outer West	8	75	12,161,459	-11,024,484	-7,483,515	19,795,630
All SSDs	**10**	**55**	**37,513,570**	**-14,076,936**	**37,214,501**	**92,293,510**

Another way of considering variations in total peak and off peak kilometres is to stay with the DBC of 5c/km and to calculate the impost on drivers with high and low kilometres (Table 7). Although State Treasury is significantly better off under both low and high kilometres, drivers are much better off under low kilometres, but substantially worse off under high kilometres, as might be expected. It is clear that if say, 20 percent of all drivers have peak kilometres much greater than the weighted average for all SSDs, then some adjustment down in DBC will be required or a further discount of the registration fee. The ‘optimal’ DBC of 5c/km is the lowest we can obtain if State Treasury is to be no worse off (see Table 2); however if we reduce the registration fee we may be able to establish a possible ‘solution’. A zero registration fee does not work at all for Treasury; a $150 registration fee will satisfy the Treasury budget constraint at 5c/km (gaining $11 instead of $32 per driver per annum) while making drivers better off (gaining $32 compared to $9 per annum), but only at a very slightly higher kilometres than the average kilometres.

Table 7: Implications of high and low annual kilometres in each SSD

Peak period DBC =5c/km for high and low kms
Annual registration fee is held at the discounted fee of $185
Positive = savings

SSD	Annual Kilometres per driver per day		Change in Driver Costs $ per annum per SSD		Change in Treasury Revenue $ per annum per SSD	
	Low	High	Low Kms	High Kms	Low Kms	High Kms
Inner Sydney	10	40	14,307,805	-15,677,906	-12,409,414	23,271,470
Eastern Suburbs	12	45	11,036,737	-19,611,823	-8,860,372	27,773,194
Inner West	12	45	8,340,664	-15,609,974	-6,583,207	22,200,438
Lower Nth Sydney	15	65	10,631,043	-50,773,151	-6,980,738	66,591,138
Central Nth Sydney	12	65	19,235,148	-71,886,155	-15,001,543	94,818,182
Northern Beaches	10	55	14,825,949	-32,313,832	-12,812,007	43,390,513
Central West Sydney	10	55	22,119,151	-52,916,193	-18,690,467	71,773,956
Canterbury-Bankstown	10	50	16,176,667	-32,091,947	-13,723,064	44,359,965
Blacktown	15	70	10,174,725	-54,085,857	-6,713,031	70,240,430
Fairfield-Liverpool	12	65	17,079,316	-60,165,202	-13,613,448	78,938,656
Outer South West	9	50	15,427,902	-27,582,892	-13,557,438	37,974,358
St George Sutherland	12	65	23,019,199	-80,243,178	-18,404,516	105,239,380
Outer West	8	75	22,857,881	-75,335,331	-20,518,909	97,263,195
All SSDs	**10**	**55**	**205,232,187**	**-588,293,441**	**-167,868,152**	**783,834,875**

What is emerging from this analysis is that if we can increase the net revenue to Treasury substantially, while not making users worse off on average, then we can use the net Treasury gains to compensate drivers who have kilometres in excess of the average, possibly limiting this to 25 percent or more above the average. As the annual savings are very small per driver for users and Treasury (shown in Table 3), an increase in cost, say of $100 per year, amounts to a minimal amount per trip. For example, in Table 2, if we had a peak DBC of 10c/km, the average cost increase per driver per day would be 46 cents on average or 2 cents per kilometre over all kilometres. The resulting increase in net revenue to State Treasury can then be available to compensate high peak kilometre drivers[11], and based on the evidence in Tables 2 and 3 this could amount to over $60m per annum available for disbursement. A user loss of $588.29m is equivalent to 89 cents per day per driver (or $324 per annum), or 3.8 cents per kilometre, which again is very small! We might suggest, given these very small numbers, that a case can be made for a higher DBC above 5c/km as a way of ensuring sufficient additional funds to compensate high peak kilometre drivers.

Conclusions

The road pricing reform proposal developed in this paper is designed to provide a pathway to gaining buy in from the community that is essential to securing the support of the political process. With demonstrated evidence in the initial phase of reform that the majority of drivers and the State government will not be worse off financially, it is easier to obtain buy in, regardless of the implications for reduced traffic congestion and faster trips. The real bonus and effective selling point will occur when drivers see real time savings and motoring associations finally are convinced that their members do gain from such pricing reform. We see no reason to suggest that the results for Sydney do not translate to other cities and countries.

This is the first study that we are aware of that has systematically investigated a reform package that can appeal to key stakeholders and that places quantitative evidence on the table for an entire Metropolitan area. The great majority of well articulated academic and consultancy research has failed in this endeavour. Indeed a recent comment by Poole (2012) best summarises this position:

[11] This will need very careful consideration. It should be fair as well. If high peak km drivers get a lot of compensation, they pay much less per km than people that drive below average kms. So this would more or less mean that the first kms are charged at a higher rate, while the rate diminishes. Does this have the desired effect? In the end, high peak km drivers may have less and less incentive to decrease their kilometres driven.

"I'm struck by what seems to be a huge disconnect between the systems being modeled by academic economists and the proposals emerging from field tests and demonstrations involving actual motorists." (Poole 2012).

This road pricing reform plan would require drivers to purchase an on-board unit (OBU) (approximately $50 once off cost[12]) that will record the kilometres by time of day. The off peak kilometres are not charged, but peak kilometres will be charged at the agreed cents/km. This scenario implies that if an OBU is not installed, all kilometres will be charged as peak kilometres, giving an incentive to install a meter (with the expectation that all motorists will do so), just like households have had with off peak electricity meters or with water meters when they were first introduced.

In ongoing research using the same data and analysis framework, Mulley and Hensher (2012) investigate the vertical equity implications of the road pricing reform scheme proposed in the current paper. Vertical equity requires that revenues benefit low-income drivers as a class at least as much as the costs they bear, and that disadvantaged residents (including non-drivers) benefit overall. A popular view is that revenues must be dedicated to transport improvements to be politically feasible, but some analyses indicate that alternative distributions that include broad tax reductions or financial rebates benefit the largest number of citizens and therefore may be more politically popular (Littman 1996, Hensher and Li 2012).

In the current paper we have focussed on a peak DBC; however we have also considered the possibility of an all day DBC, which will be lower than the 5c/km peak charge, optimised at 3c/km. There are arguments for and against peak versus all day charging. For example, charging only in the peak may make some people worse off, especially those that cannot avoid the peak period because of fixed working hours in comparison to others that have flexible working hours, although the higher DBC in the peak with a no off peak charge may result in them being no worse off given the percentage of all kilometres that are in the peak. Clearly this effect may be increased, subject to the relativity of a peak only and an all day DBC, because all revenues need to come from peak hours, such that the peak rate needs to be higher, but for Sydney the difference is only 2c/km. As part of the paper on vertical equity (Mulley and Hensher 2012) we are exploring the possibility that, although on average, drivers are no worse off financially under a peak DBC, a peak rate only scheme might lead to large differences, where many will be much worse off, and many will be much better off. Having an off-peak rate might spread the financial impact much more, and hence does not create such huge equity issues.

Finally, this paper has focussed on motorists resident in Sydney and is designed to move to a more efficient use of roads by using the price signal to underpin motorist's travel behaviour. However, there is a good case to extend the reform package to all vehicles, freight and passenger, as well as all jurisdictions under the control of a single government (in our case it would be New South Wales). In doing this, vehicles would be more closely paying for the damage done to roads. However, a charge related to damage is likely to be a lower all day DBC than is suggested by this paper and would be similarly replacing an element of registration charge when implementing the scheme outside of capital cities where traffic congestion is not an issue. When initial reform is bedded down and accepted, a case for increasing the DBC may be considered, as a way of raising much need funding for future investment in public transport and roads as a consequence of the diminishing revenue base from traditional and more inefficient sources.

[12] Based on the expected volume of installations.

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