What Type of Road Pricing Scheme might appeal to Politicians?

Viewpoints on the Challenge in gaining the citizen and public servant vote by staging reform

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Abstract

The greatest hurdle facing road pricing reform is political commitment. With rare exception, efforts to introduce significant reform in road pricing, aimed at raising sufficient revenue to ensure that road investment and ongoing maintenance is secured, without an additional impost to users above current outlays, while at the same time reducing traffic congestion, has fallen largely on politically non-supportive ears. The big challenge is to convince politicians (and their advisers) that it is possible to reform road pricing so that users are made better off (at least the great majority) in terms of time spent travelling and monies outlaid, and that government secures growing levels of revenue, but with at least some funds being used to improve public transport and the existing road network. This paper identifies the major issues that make much of the academic research into road pricing somewhat limited in terms of achieving real change. Staging reform is an appealing way forward, but ensuring the order and timing of events to secure progress is the big challenge. We offer some suggestions, including some ideas on new language designed to increase the level of buy in, and recognise that progress through action will require compromises in respect of an 'ideal' economically efficient pricing reform agenda.

Key words: road pricing reform, political process, revenue implications, staging reform, simple solutions, use-related registration fees, time reduction benefit charge, non-choice pricing, choice pricing

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Introduction

> *"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)

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). It is estimated, for example, that traffic congestion in Australia resulted in AU$9.4 billion of avoidable social costs in 2005, increasing to AU$20.4 billion by 2020 (BTRE 2007). In the USA, the congestion costs (in constant 2009 dollars) continue to rise from US$24 billion in 1982 to $115 billion in 2009; this is associated with 3.9 billion gallons of wasted fuel (equivalent to 130 days of flow in the Alaska pipeline), and a $US808 cost impost per average commuter in 2009 (Texas Transportation Institute 2011). This results in a predictable 'tragedy of the commons'.

Despite these well known statistics, politicians in the main are not supportive of road pricing reform. An example that is typical of political responses is:

> *"We will not introduce a congestion tax for motorists … due to the lacklustre standard of the state's public transport system. …The Minister … has ruled out imposing a tax on motorists entering the CBD similar to a system used in London. There cannot be a congestion toll if there is no public transport, and the one thing that [we] … have not got is proper public transport," he says. "It would be so unfair to put a congestion tax on people that have no alternative to using their car."*[1]

The greatest challenge is how to gain acceptance from the general public and senior public servants (especially Treasury officials)[2] that is also convincing to politicians. We are of the belief that road pricing reform will entail a slow but progressive set of steps that must comply with the adage "keep it simple and singularly focussed" but do not start with the ultimate

[1] It is often the case that when politicians refer to public transport they are assuming rail-based solutions, which are not only very expensive, but in the context of road pricing take many years to deliver, making the case for road pricing reform simultaneously accompanied by public transport vexed. If, however, like London, we consider improving public transport by introducing a large increase in the number of buses (designed not to create more havoc on the roads in mixed traffic but to support switching away from the car), then road pricing reform can *simultaneously* be achieved in terms of a timeline with improvement in public transport. A large increase in buses to support greater connectivity and frequency (something not so feasible with single corridor rail projects) can readily be facilitated given the availability of buses of high quality manufactured in countries such as China.

[2] The experience below typifies public sentiment, albeit misinformed. 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). Conversation proceeds and calls are invited. A plumber calls in. He 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 is the buy in challenge – how to convince voters that there are benefits to them.

journey end pricing solution to reduce traffic congestion, but with some initiative that has an easier staged sell. Crucially the focus of the reform process must be on asking 'are travellers paying for the right things' and not 'are they already paying enough'? This also translates into a request to stop being obsessed with the question of how much car users pay *on average*, for congestion is not caused by "…the fact that the tax on a car trip is 50p on average: it is caused by the fact that *the next trip is always [perceived as] free*." (Harford 2006).

Policy Objectives that Require Addressing

Introducing road pricing is a delicate task as there are many and diverse interests at stake. In general, travellers would like to have a fair system and typically do not like paying more than they currently do. Public acceptability is often regarded as a prerequisite for introducing road pricing. If the public acceptability is not there, politicians typically find the topic too controversial. On the other hand, governments face the issue of raising sufficient revenues for building new roads and maintaining existing roads, while at the same time they are held responsible for solving any congestion problems. What is often not realised by the general public is that building new infrastructure is extremely expensive and will generally not 'solve' congestion problems. Congestion mainly appears during the morning and evening peaks, typically about five to seven hours a day[3]. At other times there is an oversupply of infrastructure and the roads are under-utilised. Many, but by no means not all, people may have already adapted their departure times to avoid some or most of the delays in travel time by leaving earlier or later to work[4]. Building extra roads under the current pricing regime would mean that some travellers would shift back to their preferred departure time, and that others will change their mode to car use, with the likely result that congestion would again appear and may even become worse than prior to the road improvement. Hence, in the best of cases, it may provide comfort to car drivers not to get up so early, but would not decrease their travel time much, and it would come at a large expense in infrastructure investment.

The main question is: is it possible to find a road pricing strategy that (i) is acceptable and well-understood by the general public, (ii) raises sufficient revenue for infrastructure investment and maintenance, (iii) is revenue neutral or better to satisfy Treasury, (iv) would alleviate congestion, (v) would be technically simple (meaning less risk) and inexpensive, and (vi) addresses adequately the vertical equity concerns? As an added bonus in promoting the congestion-related benefits of road pricing reform, such reform can also reduce parking congestion, improve traffic safety, energy conservation and emissions reductions, and reduced sprawl. These additional benefits enhance the justifications for road pricing and build a larger coalition of support, including public health officials, environmentalists, and even farmers concerned with urban expansion.

[3] There is a view amongst specialists in traffic management that it only takes about a six percent reduction in the number of trips in the peak period to reduce the worst of the congestion.

[4] The March 2013 Transport Opinion Survey (TOPS) undertaken quarterly throughout Australia by ITLS found that at least one in three drivers who commute to work during peak periods in most major cities do not need to do so and could significantly reduce traffic congestion by simply choosing a different time to travel.

If all six points are ticked, it would be a big sell for road pricing. However, this is not trivial, as some of the objectives are not in line with each other (Joksimovic *et al*. 2006). For example, for raising revenues, the optimal strategy would be to price everyone and not offer any alternatives. A fixed annual fee is an example of this strategy, where the only alternative to not paying is to sell the car. In contrast, for the objective of alleviating congestion, the optimal strategy is to offer many alternatives (i.e., offer plenty of relevant choices) such that there may be fewer car trips, and the remaining trips would be distributed better over time and space. A space and time dependent kilometre charge is an example of this strategy, where the road pricing fee can be avoided by not driving, driving at a different time period, driving on another route, or switching to another mode. There is a large and growing literature promoting the virtues of use-related charges (e.g., Barter 2005, Goodin et al. 2009, Litman 1997, Hensher and Mulley 2013). A fixed annual fee is a much simpler strategy to implement, while a space and time dependent kilometre charging strategy will most likely rely on installing GPS devices in vehicles. Privacy issues are often mentioned when using GPS devices, but these issues can be and have been largely resolved[5].

We argue that offering travellers alternatives that would avoid paying tolls, and lower taxes, or prices would be of interest to the traveller, and therefore can provide a means to increase acceptance. We suggest that offering such choices is relevant in pricing strategies, and we come back to this point later. Furthermore, total revenues can be kept the same (revenue neutral for Treasury), but rather have frequent car drivers who travel many kilometres each year, especially in the peak periods, pay more than less frequent drivers, which would be fair.

The next sections describe a number of ways that road pricing can be sold and how a transition could take place from the current status quo.

A Starting Position: What do Voters think about Reform Options?

In recent research by Hensher *et al.* (2013), using ideas promoted in the literature by many authors (for example, Parry and Bento 2001, Small 1992, Nie and Liu 2010, Kockelman and Kalmanje 2005), a model of voting choice between the current situation and a number of reform packages, suggested, *ex ante*, that over 62 per cent of participants would vote for a cordon-based payment of $8 to enter the Sydney CBD in peak periods and $3 outside of peak periods, and respondents would also be prepared to pay the charge on top of existing annual registration fees (ARFs) and fuel costs so long as 100 percent of the revenue was used to improve public transport. Distance-based charging is less popular if there is no reduction of the ARF and no hypothecation of revenue to uses supported by voters, with the highest percentage voting for a scheme, where the charge is 3c/km in the peak only, being 32.2 per cent. A particularly important finding is that when the revenue allocation is recognised in conjunction with distance-based charging, the support increases from 17.6 percent (under

[5] Instead of letting the GPS device send the complete GPS trail of locations of an individual car driver, the information can be transformed or aggregated in such a way that, for example, only the charge to be paid is sent, or only the distance travelled in certain areas or certain road types at certain time intervals, etc. As a result, the exact locations of each driver cannot be traced.

5c/km) to between 25.5 and 27.12 percent (depending on the revenue allocation plan). If however, we eliminated the annual registration fee in the presence of a peak charge of 3c/km, and hypothecated all the revenue to public transport improvements, over 51 percent would vote for the scheme, enough to ensure a positive outcome. The evidence reinforces the view in the growing literature that how the revenue is allocated is critical to obtaining buy in to road pricing proposals (see Hensher and Li 2013 for a review and also Parry and Bento 2001)[6].

Despite the *ex ante* evidence suggesting a winning vote for a cordon-based charging scheme in the Sydney CBD, a cordon-based charging scheme in a specific location such as the CBD may be a good starting scheme as long as it can assure real time benefits[7]; however this is something that is by no means clear in many cities (and hence a real risk of failure – see Appendix A for Melbourne for some evidence). If it fails to deliver the expected user benefits then it may set back the support for systemwide reforms. Ideally, if such a scheme is introduced, the Stockholm approach offers the best evidence of the way forward, promoting a pilot scheme that is then subject to a referendum, so that it is carried forward with community support, in contrast to a government imposed scheme. It is not however a 'solution' to improving the efficiency of the entire network in a metropolitan area, recognising that much of the traffic congestion is often on roads far away from a CBD. The challenge then is to find a way of beginning the pricing reform journey that can deliver widespread benefits to the entire transport network. The remaining sections of the paper focus on this agenda, but we start with a suggested new language to assist the debate on road pricing reform.

Language Support: Switch from No-Choice Pricing to Choice Pricing

ARFs and fuel excise are unrelated to *specific* kilometres travelled and *specific* travel time outlaid in terms of a charging mechanism that can be used to discriminate between travel at specific locations and times of day. To emphasise the need for alternatives, and to give users more choices in a use-related pricing reform scheme, a critical (albeit intuitively useful) distinction in the selling of road pricing reform is a language that is close to the intent of reform that is more reflective of the context in which individuals would like to appraise options and hence can be better appreciated by the population of travellers affected by pricing reform. Given that many individuals when commenting on road pricing (predominantly congestion taxes) often refer to the need to be able to make a choice to avoid the impost, the distinction between *no choice pricing* and *choice pricing* may have merit. This distinction, designed to suggest some flexibility in the amount a person pays to travel, can be explained by a phrase such as 'converting from fixed to variable charges offers consumers a new opportunity to save money, which tends to be particularly beneficial to lower-income people, who tend to drive less and value financial savings'.

[6] If a pilot program was introduced that showed real time benefits, as in Stockholm, then the requirement to ensure revenue hypothecation might be less relevant.
[7] There will be some spill-over benefits from a CBD treatment, but they unlikely to be sufficient to make a big difference to the performance of the network as a whole.

No choice pricing (NCP) is what we have currently with ARFs (for a given class of vehicle) and fuel excise charges (which are same for each and every kilometre travelled). For a given class of vehicle, there is a fixed non-negotiable annual fee which is not linked to use of the road network; and a fuel excise which is a sum per litre of fuel that is essentially independent[8] of the *specific* kilometres of travel. The idea of *specific* kilometres (and its link to locations and times of the day) is critical to the distinction between NCP and choice pricing, and is focussed on relating travel to sources and magnitudes of externalities such as traffic congestion and emissions. NCP instruments are essentially invisible charges at the time of *specific* trip activity, and are unrelated to the prices of alternatives.

In contrast, choice pricing (CP) offers individuals a very visible choice to pay to use a particular road at a particular location and time of day, with different prices charged according to location and time of day, so that individuals have a real choice of paying or avoiding to pay a specific sum for specific kilometres. If the choice pricing instruments can offer the opportunity to both save travel time and reduce the overall cost of motoring, while giving motorists the choice to avoid such a charge by switching out of the peak (by undertaking off peak car travel) or use public transport, then it can be argued that this is likely to be a reform that garneres general public support.

Beginning the Sell: Registration-Usage Reform

Focus on Cost Reductions

Let us begin with what is in place at present and see how this can be modified in line with a longer term objective. While we may wish, in time, to have a true distance-based or travel time related charging regime in which the charge varies by time of day and road type, it may be sensible for community buy in to see if we can modify the current mix of registration and fuel excise charges to signal real opportunities for individuals to reduce their road use cost outlays, even if the resulting level of traffic congestion does not deliver improvements in travel time (although such gains would be a real bonus). This focuses on what is seen by many, informed or otherwise, as the first blockage in gaining public acceptance. It is astounding how few individuals, when exposed to the idea of a congestion charge, relate it to time savings; the overwhelming response is: ‘why are we being slugged again given how bad the traffic is?” (see footnote 2). This disconnect is frightening, but may be the fault of those promoting the debate on road pricing reform via a reference to reducing congestion. Typically, it is not long after that the media pronounces that a congestion ‘tax’ is being proposed.

The reform must emphasise a package of pricing reforms, which include current fees. Let us consider ARFs. These are typically imposed and collected by State governments (at least in the USA and Australia, for example) and vary in most cases by the class of vehicle, and

[8] Although we acknowledge that there is a link between variations in fuel consumed per kilometre and specific kilometres.

certainly not by the amount of usage. Usage has historically been covered by fuel excise, which has been argued to be an inappropriate way of charging for usage in *specific* traffic settings that may result in a change in the time of kilometre consumption. But what if we redefine a transitional role for the ARF? In particular, why not introduce a baseline (or flag fall) fixed fee (which is significantly less than the current ARF) defined to support a minimum amount of annual usage, regardless of whether they are peak or off peak kilometres, with this minimum based on a percentage (say 75 percent) of an estimate of the previous two years of kilometres driven, much like what the taxation office does in a number of countries (e.g., Australia) with a "pay as you go" (PAYG) quarterly or annual up front estimate of tax obligations. The sum tailored to the recent historical evidence of each vehicle can be promoted as a use-related ARF designed to have individuals '*paying for what you do and not what you own'*.

This can be also calculated in accordance with the overall amount of revenue currently raised from this source (in the previous two years) to ensure that government (Treasury in particular) is no worse off. This is a very simple way of beginning the usage journey to achieving "those who benefit also pay", even if we are not yet ready to have different charges by time of day and location. An adjustment would be made at the end of the year at an annual vehicle inspection (or other check point) as a refund or additional charge, depending on usage relative to the agreed baseline as proposed above[9]. People like refunds, so if the levels can encourage this, then it is a psychological win[10]. This then defines the baseline charge for the next period. The level can also be calculated so that there is a reduction in fuel excise[11] (or any cost component that can reasonably be adjusted[12]) which will send another positive message about reforms that can appeal to the public, although this requirement is not critical.

If this stage one initiative ensures that Treasury is no worse off (and it can be adjusted to ensure this), and the public is happy with this reform, since it offers an incentive to reduce costs, then this is real progress. What we would have achieved is the beginning of a greater commitment to the notion of 'user pays' but without any additional financial impost on users or government. One test of acceptance would be a population-level poll on whether people think this is fair.

The baseline fixed fee can be further reduced each year, while increasing the avoidable kilometre-linked cost component. Keeping the average costs of car users the same, this will be revenue neutral to Treasury, but at the same time provide scope for more discounts to car users that choose to drive less than the average annual number of kilometres (over all car

[9] This reformed registration two-tier charge has a sunk cost component and an avoidable cost component, the latter referring to the kilometre-linked charge that could be avoided.

[10] It is well known that if you start with a somewhat undesirable proposition and then offer something that you really want that is indeed 'better', then the chances of support increase.

[11] The reduction in fuel excise would not occur independently of the introduction of a distance-based charge (either in the peak or for all kilometres travelled). Importantly, if the net impact is a reduction in traffic congestion then traffic flow will be improved and there will be a reduction in local air pollution (such as smog) which is influenced by the traffic conditions (unlike greenhouse gas emissions which are much more defined by kilometres and vehicle fuel efficiency).

[12] In Australia, there is a problem in reducing fuel excise since it is collected by the Federal government and not the States; however a road pricing use-related charge would most likely be collected by the State government. Possible fees that could be adjusted (apart from annual vehicle registration) that are State related are driver licences, stamp duty of vehicle registration and fuel franchise taxes and/or fees.

users). In general, even assuming that no one would change their driving behaviour, the majority of the car drivers will be better off and pay less, while a smaller proportion of the population will pay more. This results from the fact that a small number of car users is responsible for a significant proportion of the total number of travelled kilometres, while many car drivers use their car relatively little. From percentiles of total kilometres travelled obtained from the Australian Bureau of Statistics (ABS 2010b), for example, approximately 62 per cent of the car drivers in the state of New South Wales (NSW) would receive discounts on their current ARFs.

Another way to start offering car drivers the option to save on their costs is *voluntary* participation in an ARF discount plan, in which they will be guaranteed to never pay more than their current annual fee. If they drive less than the average annual number of kilometres (in NSW about 14,250 kilometres per year, ABS 2010b), they receive a proportional discount on their ARF. Again, the majority of the car drivers would benefit by entering such a plan. In order to keep it revenue neutral to Treasury, car drivers who do not participate will have to pay a fixed ARF that is determined yearly by the average annual kilometres driven by non-participants. In particular, car drivers who drive significantly less than average would choose to participate and save money. As more car drivers participate, the ARFs of non-participants will slowly increase, reflecting their higher average usage of the infrastructure. Such a scheme can be easily communicated as the choice between (i) a fixed ARF that gradually increases over the years, and (ii) participating in an ARF discount plan in which you will never pay more than the fixed ARF. This interesting voluntary discounted ARF concept, which we call 'saving per automatically registered kilometre' (SPARK), would likely be acceptable by the public (as it is opt-in and the majority saves money), can remain revenue neutral to Treasury, and does not require expensive technology besides periodically (e.g., annually) monitoring the already automatically registered kilometres as shown in any car.

Targeting specific kilometres

There may be other, possibly more attractive, registration-usage reform scenarios worth considering which start targeting the *specific* peak vs. off peak kilometres (see Hensher and Mulley 2013 and a later section for further details). For example, we can begin by assuming that all annual kilometres are peak kilometres. If the driver wants to have a subset of kilometres recognised as off peak (including peak shoulder) kilometres, they must purchase a small on-board unit (OBU) (approximately $Aud100 once off cost) that will record the kilometres by time of day. The off peak kilometres are not charged, but peak kilometres will be charged at either an agreed cents/km[13] or a fixed peak surcharge for bands of annual peak kilometres (the choice of charging regime must be cognizant of which will offer the least resistance in the initial phase of reform). Note that if an OBU is not installed, all kilometres will be charged as peak kilometres, giving an incentive to install a meter, just like households have had with off peak electricity meters or with water meters when they were first introduced.

[13] There can be a graduated set of peak charges to reflect the degree of peakiness in the traffic throughout the declared peak hours.

This regime can, and ideally should, be related to the ARF, with the idea that the latter is adjusted from the full amount to close to zero[14] depending on the amount of kilometres travelled per annum in the peak, and the number of kilometres that have switched out of the peak in the previous year[15] (regardless of whether the reduced peak kilometres are now converted to off-peak kilometres, public transport trips, or eliminated travel). Although we recognise the possibility of complaints of unfairness (and political concerns) from those who claim they cannot switch some amount of kilometres out of the peak, we counter this by the argument that maintained peak kilometres are a contribution to peak congestion and are not currently being fully paid for; and that a significant number of road users (enough to make a difference to peak traffic congestion) do actually have a choice of time of day to travel[16]. Car drivers that cannot switch, however, are likely rewarded with lower travel times due to fewer travellers in the peak period. We propose to reward the amount of switching out of the peak through a noticeable discount on the ARF, calculated in such a way that the revenue raised for the Treasury is not disadvantaged. The charge per peak kilometre or new peak annual surcharge is one way of securing revenue neutrality (even in the absence of politically problematic c/km peak usage charge), which is likely to be necessary to incentivise some amount of temporal switching if the ARF is too price inelastic to have any significant effect.

The challenge is to identify an appropriate adjustment quantum in the ARF. It can be calculated on the basis of the reduction in the amount of annual peak kilometres. Herein lies the (perceived) vertical equity debate[17] about fairness, which can work against both high and low annual peak kilometres if not carefully defined. One way forward is to adopt a simple discount rule which amounts to a flat reduction in the ARF linked to the acquisition of the OBU, even if a differential amount for further reductions is offered. Given the problems with absolute and percentage reductions in peak kilometres as the entitlement for an ARF adjustment, we suggest an incentive based on free peak kilometres for 50 per cent of peak kilometres if an OBU is purchased, and a charge per additional peak kilometre or an annual peak surcharge linked to bands of additional peak kilometres for the balance of peak kilometres[18], which begins the move to a distance-based charge, *together with* a 50 percent reduction in the ARF.

An Illustrative example

[14] Zero registration would not work because registration is the process where documentation is checked and so there should always be a minimum fee e.g., $50 to both cover the administrative fee and to maintain the process where insurance and roadworthiness is checked.

[15] For newly acquired cars which have no previous year kilometre history we would have to assume the kilometres of the previous vehicle which should be recorded by the regulatory inspection organisation. Individuals who have just received a driver's licence will be ineligible for ant registration exemptions for one year until they have a baseline annual kilometres. If a household tries to evade the system by selling their cars to another member of the household every year to avoid any history of use, we would have to impose an estimate associated with the average annual kilometres for a vehicle in a particular geographic jurisdiction. Such data is readily available in cities in Australia.

[16] We recommend a research study to establish the ability to time of day switch, although see footnote 4.

[17] If one believes equity balance is appropriate, in the sense of being equitable for people who have made a location decision which is difficult to reverse, and in that sense is politically sensitive.

[18] In this regime you could ignore new cars and new ownership by saying that X,000 km (worked on the average of the previous year national or local statistics of usage) is the allocation of peak kilometres. This is the most appealing pricing regime if it can be linked to reducing peak kilometres.

Let us begin by assuming that total annual kilometres are 15,000, all initially assumed to be peak kilometres. A motorist purchases an OBU, which means that only peak kilometres are then subject to a new charge, which we define as a surcharge based on kilometre bands (in contrast to a cost per kilometre). We have arbitrarily defined five charge bands: <2,500 km; 2,500-5,000 km; 5,000-7,500 km; 7,500-10,000 km, and >10,000 km per annum. A charge of $100 applies for band 1, with $100 increments as the band increases.

If peak kilometres are switched to off peak kilometres, the proposal is to reduce the ARF, which we assume is currently $500. The reduction in fee will be $100 per move to a lower adjacent band plus a 25 per cent reduction in the ARF. The surcharge for remaining peak kilometres will be imposed.

We assume that the initial peak kilometres are 8,000 (Band 4) and that the motorist has managed to reduce peak kilometres by 1,500, moving the peak kilometres to Band 3. Their costs comprise the peak km surcharge of $300, a $100 reduction in the annual kilometre charge (Band 4 to Band 3) plus a 25 per cent discount on the ARF (for moving to Band 3) = 0.25*$500 = $125. The ARF now drops from $500 to $375. This driver saves $225 in total.

The focus is on cost adjustments, but there will also be time benefits for both peak and off peak kilometres *ex post*, due to the individual switching and adjustments associated with traffic levels. If there is no switching, then the ARF remains at $500 and the annual peak charge is $400. The net impact to the user is $900 ($500+$400) – $675 ($375+300) = $225 plus time savings. Treasury is currently receiving only $500 and no system time benefits, but will *ex post* receive $675 (i.e., $375 ARF + $300 peak surcharge). Hypothecation of the $175 is a politically worthwhile strategy to signal recognition of how the community would like to see road pricing revenue spent.

In summary, a user in the absence of the reform package, will outlay $500 ARF and Treasury will receive the full amount. After the reform package is implemented, the user incurs a net increase of $175 per annum, which is the full net gain to Treasury. Importantly, this financial outlay is accompanied by travel time savings, associated with 1,500 reduced kilometres in the peak. Although the actual time savings will be dependent on the aggregate response by all drivers, if we assume that the value of travel time savings is $16 per person hour, then $175 of cost outlay is equivalent, on average, to 10.93 hours of time outlaid. If the users can reduce their travel time by at least 10.93 hours as a result of the reduction in peak kilometres, then they will be better off, and the traffic system will also benefit by reduced congestion. Assuming 10 trips per week in the peak, spread over 48 weeks per annum, the average time that would have to be saved to be no worse off (in generalised cost terms) is 1.4 minutes per trip. Given that the percentage reduction in peak kilometres for this user is 18.75 per cent (i.e., 1500/8000), one can reasonably expect a time savings better than 1.4 minutes on average. The final outcome will be dependent on how the reform package is responded to by the population of motorists; however our knowledge of elasticities suggests that the gains are likely to exist.

In a complementary paper, Hensher and Mulley (2013) undertook a detailed assessment of the likely impact of registration-usage reform in the presence of a peak period distance-based charge, using data at the postcode (or suburb) level for the Sydney Metropolitan Area. The objective was to identify a mix of a peak distance-based charge and a revised registration fee that would, on average, make motorists and the State Treasury no worse off (recognising that fuel excise is not collected by the State government, but is a Federal tax). 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), a DBC elasticity of kilometres travelled, *ceteris paribus* of -0.25 and -0.35 respectively for peak and off-peak kilometres was used, based on Hensher *et al.* (1992). These elasticities are also applied to the fuel and toll costs together with a peak period distance-based charge, assuming no change in total *status quo* kilometres. Formulae were developed to calculate the peak kilometres under a peak only DBC:

$$PKM^{AEC} = [PKM^{BEC}*(1-(((TC^{A}|TKM^{BEC}\text{-}Regn^{A}) - (TC^{SQ}\text{-}Regn^{SQ}))/ (TC^{SQ}\text{-}Regn^{SQ})) * Abs\ Elas)] * TKM^{AEC} - TKM^{BEC}*(1-PropPKM)$$

$$TC^{A}=Regn^{A}+DBC+FuelCost+(Toll-(Toll*((TKM^{Before}\text{-}TKM^{After})/(TKM^{Before})))$$

where:
PKM^{AEC} = annual peak kms after the elasticity application
PKM^{BEC} = annual peak kms before the elasticity application
$Regn^{SQ}$ = annual registration fee before (i.e., status quo) reforms
$Regn^{A}$ = annual registration fee after reforms
TC^{SQ}= total costs before (i.e., status quo) reforms
TC^{A} = total costs after reforms
TKM^{Before} = total annual kms after DBC but holding kms to SQ levels
Abs Elas = the direct elasticity without sign
PropPKM = proportion of total kms that are peak kms.

Hensher and Mulley developed a scenario decision support system (in Excel) to establish the financial implications of alternative combinations of a peak period DBC and discounted annual registration fees, that achieves the required financial outcomes for drivers and State Treasury. 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 and State Treasury. Full details are given in Hensher and Mulley (2013).

Continuing the Sell: A Time Reduction Benefit Charge

So far we have stayed away for the sensitive (emotional) and poorly appreciated idea by the public and politicians of explicitly paying to reduce congestion *and* gain travel time benefits, although some element of this clearly exists in the proposition outlined above. The next step, possibly after a two to three year implementation of proven registration-usage reform, with or without some element of fuel excise adjustment, is to think through ways of linking the charging reform to ways of saving people (passenger and freight vehicle) time, much like

tolling of specific roads is designed to achieve, while still retaining the principles in place for a use-related registration fee. The next stage will be heavily influenced by the extent to which peak travel times are reduced as a result of the use-related registration fee reform.

Let us assume that the main objective of stage 2 is to improve travel times in the peaks, which may be a better way of describing the task than reducing traffic congestion, given that the latter is only worthwhile if travel time is reduced. Government might consider a pilot test in a small geographical area (that has a few well delineated entry and exit locations) in which on-board computers linked to satellite-based GPS are used to monitor the travel times (and speeds) at various times of the day (and day of the week) on all roads in the selected jurisdiction. It may be feasible to use smart phones to capture relevant information. Ideally all vehicles should participate if they enter the area otherwise it may fail as a real evidence-based pilot.

An alternative, less demanding pilot plan, would be to relax the need that each vehicle entering the area participates, regardless of whether a cordon or distance-based charging regime is introduced. As long as the size of this volunteering population is large enough, there will be time benefits. In the Netherlands, rewarding schemes (see below) each had between 2,000 and 4,000 participants on concentrated roads (half of the projects using smartphones, and half with in-vehicle GPS). Provided that removing a few hundred cars from these roads has travel time impacts, we do not require all vehicles to participate. The critical issue is to demonstrate real time benefits, as was the case of Stockholm's trial.

Drivers should be told that they will be charged for time reductions (or improvements) that guarantee elimination[19] of delays due to traffic congestion. Initially we are unlikely to be in a position to strike an advance notice charge per km; but it is essential that motorists know that the charge is designed to ensure that they are not (unnecessarily) delayed in the traffic, and that at the end of each month drivers will be told how much they have to pay in return for delivering maximum travel times. If travel times exceed the government backed travel times, then the payment charge will be discounted by some formula based on each additional excess travel time minute. The first two months of the pilot should involve no charge (and maybe a small financial reward) in order for most users to get used to the plan. The charge should not be called a congestion charge (or tax) but a 'time reduction benefit charge' (TRBC).

Rewarding or Charging?

There is another way forward that avoids charging for peak use by rewarding off-peak travel that has moved out of the designated peak periods? Such a reform strategy, linked to the TRBC is a financial reward that is netted off of the TRBC when motorists switch travel to pre-designated (entry) times of day that are mandated as times of day that contribute to reducing traffic in peak hours. We would not want to guarantee that there will be no congestion at these times of day, since that may not be true; but what is being done here is to take pressure off of the really serious peak times when delays are at their worst. Trips that are

[19] We must be very careful with the language here. A very specific adjustment must be unambiguous, since free flow may not be guaranteed, but a significant improvement in travel time may be.

eligible to receive this trip time reduction benefit must have been undertaken previously in the defined periods in which the TRBC is applicable. Funds to support this time of day switch would need to be derived from the TRBC source.

Such charging schemes (which are in effect rewards for 'good community behaviour') have been successfully implemented at several locations in the Netherlands with a pool of voluntary participants since 2008, in which 15 to 44 per cent of the car drivers opted for a different departure time (usually earlier), about one to six per cent chose to work from home, five to 14 per cent chose public transport, and depending on available route alternatives, up to 28 per cent chose a different route (see Bliemer *et al*. 2009). This confirms the argument that monetary incentives can have a huge impact on the travel choices, with more than half of the participating car drivers able to avoid paying any charges by changing their travel behaviour.

A Taxi Tariff as a way of being Aware of the Charge in Real Time: *It is time we want to save, not kilometres*

A simple pricing strategy that would not involve new technology, but would be related to a TRBC, is applying the taxi tariff methodology. Taxi meters around the world are often distance and time based. Distance based charging has been proposed in several countries, often so-called kilometre charging schemes; however, time based charging has been proposed less frequent. The rationale behind it is simple. During peak hours, the travel times are longer than the travel times during off-peak periods.

Hence, paying per minute (like in a taxi) essentially means that one has to pay more during the peak periods than off-peak. Cars currently only register the total distance travelled, but can potentially also register the total time travelled without any significant technological adaptations. The charges can then be based on these two numbers on an annual basis, and can be adjusted to reflect the impact on trip time reduction benefit and government revenue requirements. There may be some issues that need to be resolved, for instance what will happen when a major incident increases the travel time for car drivers, but the concept is interesting.

Vertical Equity Considerations

Regardless of the merits of each reform package in terms of the impact on levels of traffic congestion and hence time reduction benefits, there are very strong arguments opposing any reform if it discriminates between individuals on vertical equity grounds (i.e. the impact on individuals in different personal income groups). There is a large literature on the topic (e.g., Ison 1998, King et al., 2007, Levinson 2010 and Peters and Kramer 2012). Despite the recognition that revenue allocation[20] can be a major lever to gain community support for road pricing reform, there is also a view and evidence that revenue redistribution cannot resolve all equity and fairness concerns. Initial travel patterns also matter (Eliasson and Mattsson 2006),

[20] Manville and King (2012) also raise the concern about credible commitment from government in using the revenue in line with community supports for reform. The Sydney study by Hensher (see Hensher et al. 2012) found only 22 percent confidence that government would allocate revenue the way they would like it allocated.

especially the concern that individuals undertaking most of the trips will be the ones most affected by any change, even if the impact is higher levels of time benefits. We now take a closer look at mandatory trips that people cannot avoid, i.e., work, business, and education trips.

People who have a long commute to work will end up paying more. Therefore, the road pricing reform should not be an abrupt, but rather a gradual, process (e.g., several years) in which people are given the opportunity to re-evaluate their mobility choices, including changing jobs and/or residential relocation. The road pricing reform should by no means force people to move or change jobs, but rather when people are making the decision to move or change jobs, that they take the commuting distance, cost and time more into account. Even without any road pricing reforms, the majority of the working population will likely be moving at least once within the next five years for various reasons[21]. Although less frequent, people regularly change jobs in their lifetime. Hence, road pricing reform should not be a push factor that pushes people away from their current residential and employment location, but rather a pull factor (after they have chosen for other reasons to change the residential and/or employment location) that pulls people towards more attractive locations from a mobility and cost perspective. At the same time, employers should be stimulated to offer alternatives such as flexible working hours and working from home; there has been limited effort by employers to provide incentives for some occupations where working from home makes eminent sense (as shown by Brewer and Hensher 1998, 2000). There may still be a number of people who cannot avoid the long commute, e.g., a low income family with limited employment possibilities and a restricted relocation budget. Additional compensation would be required to avoid equity loss for these people.

People who travel a lot by car for business purposes will also have to pay more. Additional costs of company car drivers will likely be compensated by their employers. People who have their own business (e.g., plumbers, landscapers) will probably charge their clients, which is reasonable since all costs have to be considered when pricing a product or service. Fortunately, this increase can be assumed to be small (e.g., $1) compared to the fixed call out charge (e.g., $80) that is often asked. Any improvements to the travel times due to the road pricing reform is expected to be a benefit to people with their own businesses, given that time is money for them (see footnote 2).

The number of people who have to travel far by car for education purposes is expected to be fairly small. Full time students often use public transport or live close to the school or university. With a gradual road pricing reform process, current students will not be affected much, and future students can take the extra cost of a long trip to school into account. Again, there may be people that need extra support from the government (e.g., parents who have to drop off their child to a special school).

[21] In Australia (ABS 2010a), in the past five years, 90 per cent of young households (aged 35 or younger) without children have moved at least once, 45 per cent of parents in couple families with dependent children have moved at least once, and 59 per cent of lone parents with dependent children have moved at least once. In comparison, only 17 per cent of the older households (aged 65 or older) have moved at least once within the past five years.

King *et al*. (2007) recommend redistribution efforts that concentrate the benefits and create "strong advocates" for a proposal, and contend that congestion pricing schemes with concentrated benefits and widely-dispersed costs are more likely to succeed. Achieving this outcome is essentially empirical, and requires knowing what behavioural responses individuals on different incomes would have and how this translates into winners and losers on costs and benefits. King *et al*. (2007) and Peters and Kramer (2012) summarise gainers and losers as follows:

Net beneficiaries associated with improved traffic flow:

1. Drivers whose time saved is worth more than the fees/charges they pay.
2. People who already use public transport and will not pay road pricing reform charges but will travel faster (i.e., buses in mixed traffic).

Road pricing reform will create a net loss for:

3. Drivers whose time saved is worth less than the charges they pay.
4. Drivers who switch to a less convenient route to avoid the charges.
5. People on non-priced routes whose traffic increases when drivers from Group 4 switch to their roads.

Hensher and Mulley (2013) offer evidence in the Sydney (Australia) context of reforms proposed above, focused on use-related registration fee reforms, and a systemwide distance-based charging regime. They find that although individuals on lower incomes tend to be more reliant on car use (in part linked to relatively inadequate public transport), they do have the opportunity to reduce kilometres since a higher proportion are discretionary and are very local, and also the average trip length is much shorter. With an appropriate compensation package (including kilometre saving credits), it is possible to make all income groups winners.

Conclusions

Progress takes time when politicians are involved[22], except if there is an influential champion for the cause, yet we cannot avoid them. Short of a bipartisan commitment to road pricing reform (not in spirit, but in action), we are left with no recourse but a drip feeding and dragging along of the public (see also Ortúzar and Hensher 2013). While the Stockholm congestion charging scheme in the CBD is our best success to date in a democratic society, highlighting the essential ingredient of a trial *ex ante* prior to a referendum, it is very much a leap of faith in most societies that this experience can be duplicated, especially when the more serious endeavour of system-wide reform is proposed.

A CBD cordon-based congestion charging scheme, however, is unlikely to deliver significant benefits to a city wide transport network. The findings in Hensher *et al.* (2013) suggest that a wise transition strategy is to reform registration charges as suggested above, making the annual registration fee variable as step 1, followed later by step 2 to make it time dependent.

[22] Including obtaining community buy in, and especially when the community is uninformed.

In step 1 people get used to decreases in cost relative to their usage, and in step 2 people will actually experience time savings as well.

Returning to our main question, whether it is possible to find a road pricing strategy that satisfies the six properties that we defined earlier, we suggest that it is possible to have an strategy that (i) is acceptable as it offers discounts on the annual registration fee to the majority of car drivers, which is also transparent and easy to communicate and can even be voluntary, plus a gradual reform process can prepare people for upcoming changes, (ii) can raise sufficient revenues for infrastructure and maintenance, (iii) is revenue neutral to Treasury, (iv) will alleviate congestion and offer travel time benefits using time differentiated charges or rewards, (v) does not require any complicated technology besides annual registrations of total travelled kilometres, possibly differentiated in peak and off-peak kilometres, and (vi) with appropriate compensation packages can avoid vertical equity concerns.

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Appendix A: Summary results for Various Policy Instruments ($2007) for Melbourne, with a focus on congestion charging

Using the model system TRESIS (see Hensher and Ton 2002) we investigated the likely impact of a cordon-based charge in Melbourne, in contrast to other strategies, as summarised in the Table below. These are summarised in the Table below. The particular interest is in establishing whether a cordon-based charging scheme can produce sufficient benefits to promote the benefits of road pricing reform that would not set the full system wide reform process back. In contrast to a metropolitan-wide variable user charging scheme, if we were to limit the charge to the Central Business District (CBD) of Melbourne, as a cordon charge that has been mooted many times in the Melbourne media, and charged at $10 per entry at any time of the day, the impact on vehicle kilometres travelled is negligible (-0.075%), as it is on CO_2. Likewise the impact on consumer surplus and car use is small, although the switching that occurs benefits light rail in particular, and results in small revenue reductions for the parking stations in the CDB (-1.476 percent overall). Such a location-specific charging scheme is not recommended even though it raises $106.1m per annum of revenue. It is however relatively easier to implement than a metropolitan-wide scheme in the sense of requiring major investment in public transport, and may have value in demonstrating the merits of a congestion charging scheme that can be rolled out across the entire system in due course, as long as such small benefits are not seen a representing a failure of congestion charging schemes in general.

(Policy enacted in 2009).

Indicators	**Base levels 2009**	**$10 cordon charge to enter Melbourne CBD**	**10c/km variable user charge – metro area**	**Increase petrol price to $2 per litre (diesel not changed)**	**Rail and bus fares reduced by 50%**	**Fuel efficiency improvement by 25%**
Auto operating cost						
VehOpCost (c/km)#	11.57	negligible	-9.415%	59.55%	0.009%	-24.91%
Government revenue ($)						
Cordon/Congestion Charge Revenue	-	$106.1m	$2.291bn	-	-	-
TGovtExcise	$1.351bn	-0.073%	$111.32m	$1.492bn	-0.412%	-21.84%
TGovtPark	$264.7m	-1.476%	-3.590%	-2.615%	-2.74%	0.88%
TgovtPT	$577.5m	0.922%	22.16%	16.413%	-30.57%	-6.202%
TGovtSales	$158.2m	-0.008%	3.124% (downsizing)	2.340% (downsizing)	-0.40%	-0.975%
TGovtVehReg	$338.7m	-0.003%	-1.004%	-0.779%	-0.394%	0.31%
Total end user cost ($)						
TEUC.MoneyC @	$5.390bn	1.957% (105m)	36.873% ($1.99bn)	27.930% ($1.501bn)	-3.347% (-$202m)	-12.28% (-$662m)
TEUC.TimeC @	$4.856bn	-0.066% (-$0.4m)	-7.023% (-$341m)	-5.171% (-$205m)	-2.659% (-$160m)	2.346% ($28m)
Consumer surplus ($):						
Mode and departure time (TEMUDTMC)	$5.526bn	-0.939% (-$52m)	-127.55% (-$4.01bn)	-98.143% (-$4.120bn)	29.96% ($1.656bn)	45.425% ($2.51bn)

*Commuter Mode growth**						
TDA	74.63%	-0.2952%	-5.162%	-3.820%	-2.98%	1.44%
TRS	5.491%	-0.271%	-5.493%	-4.032%	-3.168%	1.551%
TTrain	11.47%	0.400%	24.170%	14.549%	14.549%	-6.833%
TBus	2.829%	0.455%	24.250%	31.240%	31.240%	-6.735%
TLight Rail	5.176%	2.179%	11.261%	2.632%	-2.632%	-3.31%
TBwy	0.4059%	15.717%+	14.571%	3.502%	-3.502%	-4.299%
Greenhouse gas emissions						
TCO2 (kg)	6.183bn	-0.073%	-8.406%	-6.751%	-0.412%	-21.804%
Passenger vehicle kms						
TVKM (km)	24.971bn	-0.075%	-8.041%	-6.473%	-0.418%	4.132%

*These percentages are growth in patronage, noting that bus, tram (light rail) and train are off a very small base.

+ The base is so low (i.e., 0.655%) that this distorts the percentage increase. # vehicle operating cost per km is car fuel only.

@ Adjustments in time and money cost are main set of influences on mode and departure choice. Time cost plus money cost defines generalised cost.