Urban congestion — why ‘free’ roads are costly

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The inhabitants of Australia’s larger cities suffer from frequent traffic jams. Many see this as an inescapable fact of city life, but its root cause is overuse of a common resource — the urban road network. Most roads are nominally ‘free’ to drive on, resulting in demand for many roads that exceeds capacity at relatively predictable times. This means that motorists do in fact pay — in wasted time — to drive on ‘free’ roads at peak periods. This disrupts the flow of people and goods in the economy, harming productivity and growth — as well as frustrating all road users.

Putting a price on access to roads at busy times might encourage individuals to change their travel plans, and reduce their vehicle’s contribution to congestion. New South Wales has taken a first step in adopting time-of-day pricing on the Harbour Bridge and Harbour Tunnel.

In theory — unlike paying in time, which is wasted — the money paid by motorists to drive on busy roads at peak times could potentially be redistributed to ensure no one is worse off. Some potential compensation mechanisms currently available to governments include cutting taxes on vehicle ownership or use (such as registration or fuel excise), adjusting income taxes, and investing in alternative transport options for those ‘tolled off’ the roads.

1 This article has benefited from comments and suggestions provided by Brad Archer, Jeremy Coghlan, Graeme Davis, Dimity Elson, Matthew Mansell, Jason McDonald, Brant Pridmore, Troy Sloan and Andrée Wheeler. The views in this article are those of the author alone and not those of the Australian Treasury.

Introduction

Cities are an economic success story, allowing for specialisation and networking, and contribute to the generation of technology, know-how and wealth. While the discomfort of traffic jams and the time they waste inevitably discourage people from living and working in busy cities, these disadvantages are outweighed by the opportunities available to firms and individuals from locating in populated areas (Arnott, Rave and Schöb 2005).

Individuals and businesses demand access to urban transport in order to reap the opportunities that the city has to offer. However, there is a limit to the supply of available road space. When roads become busy, particularly in peak times at the beginning and end of the working day, there is competition between commuters for limited road space. At these times, roads are not ‘public goods’ that anybody can use without imposing costs on others. The nature of roads changes to being more like ‘private goods’ — as an additional motorist must compete for access to the road. At this point, public roads are not ‘free’ — a cost is paid by all road users in wasted time.

This presents a ‘tragedy of the commons’, in which a commonly accessible (but unpriced) resource is over-exploited to the detriment of all. This occurs when people do not consider the costs that they are imposing on others who also want to access the same resource. In the context of roads, a road user accepts travel delay times as a cost of travel at peak times, but does not necessarily take into account the fact that their decision to put an extra vehicle on the road in a minor way will delay all other road users.

Individuals do attempt to minimise the cost of wasted time by adjusting their own behaviour. While these individual responses seek to reduce the private costs of congestion, one person’s decision to avoid congested roads at peak periods might simply make room for another person to switch back into congested roads. The sheer number of motorists and the absence of tradeable access rights to roads means that uncoordinated individual actions will not solve the problem of congestion. Further, the resources expended by individuals to reduce their own costs of congestion are examples of the types of economic costs that the failure to properly ration road use by more efficient means imposes on society.

The Bureau of Transport and Regional Economics projects that the avoidable social costs of congestion in Australian capital cities will rise from $9.4 billion in 2005 to $20.4 billion in 2020 (Cosgrove et al. 2007). As Australia grows richer, the costs of allowing unpriced access to congested roads will become higher. However, while the aggregate congestion costs are large, these costs are spread across almost all road users at congested times. For this reason, it is possible for modest congestion charges to have significant effects. In practice, the actual process of setting congestion charges is likely to be a process of continual adjustment.

Elimination of congestion should not be an end in itself — that would require a strict curtailment of economic activity or vast expenditure on roads that are used to capacity for a small proportion of the day. Some small amount of congestion may be efficient given the large capital costs of building additional roads supply and the technical difficulty in properly setting congestion charges. Nevertheless, if potential road users were required to pay the costs they impose on others then significantly less time would be wasted in traffic. Those trips for which the costs to society outweigh the benefits to the individual could be rescheduled for times when use of the road is less costly.

Faced with the true costs of their decisions, a potential motorist who is indifferent to taking public transport, travelling at a different time or not travelling at all, will leave the roads at peak times. This allows the resource — the road — to be put to its highest value use.

The method for pricing congestion depends on the underlying market structure. Where roads are treated as publicly owned, open-access resources, then there is a strong argument for a tax designed to correct price signals. Where the road is owned by a road agency or firm that can charge for access, then the presence of congestion limits the amount the potential road users would be willing to pay. In this case, the external costs that road users are imposing becomes a cost to the owner of the road. Alternatively, given adequate property rights and low transaction costs, externalities can be resolved within markets through voluntary trades.

The primary dividend from pricing congestion — whether through a tax, charge or market mechanism — is the more efficient use of an economic resource that is a vital input to much economic activity. Existing road users who value their journey less than the costs that they impose on others will need to adjust their behaviour, and might demand compensation. Road users who value their time highly would be better off.

Although optimal congestion charging improves overall social welfare, the transition from unpriced to priced roads would require compensation to ensure that all groups are better off. In theory, there are a range of instruments available to do this. For example, the transitional impact of new pricing could potentially be offset by reducing other transport-related taxes. Alternatively, taxes on income might be adjusted to offset the impact of congestion prices on the cost of living for people with lower values of time. An alternative approach is to compensate those who are 'tolled off' the roads, by investing some of the revenue in public transport. The desirability, and practicality, of different compensation arrangements depends partly on the ability of different levels of government to coordinate their revenue and spending decisions.

This paper briefly examines the economic theory of congestion, different approaches to reducing it to a socially optimal level, and concludes with a discussion of compensation options.

What is congestion?

When demand for a limited resource is greater than the supply at a particular time, it must be rationed in some way. For most goods and services in a market economy, the price system performs the rationing function. This allows scarce goods and services to be used by those who are willing and able to pay for them. Prices provide information to suppliers about the goods and services that consumers value, and, if accompanied by a transfer of money to the supplier, can provide resources to expand supply.

Queuing is a common non-price mechanism for allocating limited resources. In the most basic queue, access to a service is provided to consumers in the order in which they arrive. This is more or less the rule for accessing physical road space — although the 'first-come, first-served' queue discipline (Cox and Smith 1961) is mediated by traffic rules, which give right of way to some vehicles in certain circumstances. Provided that road users obey common rules, allocating roads in this way has the advantage of being easy to understand and implement.

Where the arrival of people in the queue is random, but average levels are predictable, queuing can smooth service. For example, a shop manager could significantly reduce queuing by keeping all checkouts open at all times. However, this could mean that some check-out staff were unoccupied, except at the busiest times. For this reason, the manager restricts the number of checkouts — saving on labour costs — and customers tolerate some queuing. These costs are kept in check through competition — as those consumers who are most inconvenienced choose to shop in more expensive, but less congested, shops or to choose to shop at less congested times.

Because there is only one road network, it is much harder for road-users to opt out of the queue. The first vehicle to arrive at a red traffic light is the first to move off when the light turns green, followed in sequence by those behind. Vehicles can overtake each other in some circumstances, but opportunities to do this are constrained by road rules, speed limits, and physical space.

In special cases, the law allows some vehicles to take priority. For example, traffic must yield to an ambulance with flashing lights or a siren. This is efficient given that the value of getting a patient to hospital earlier is very high, relative to the delay that this will cause other road users. In other cases, transit lanes are set aside for taxis, buses or cars with multiple passengers.

The costs of congestion

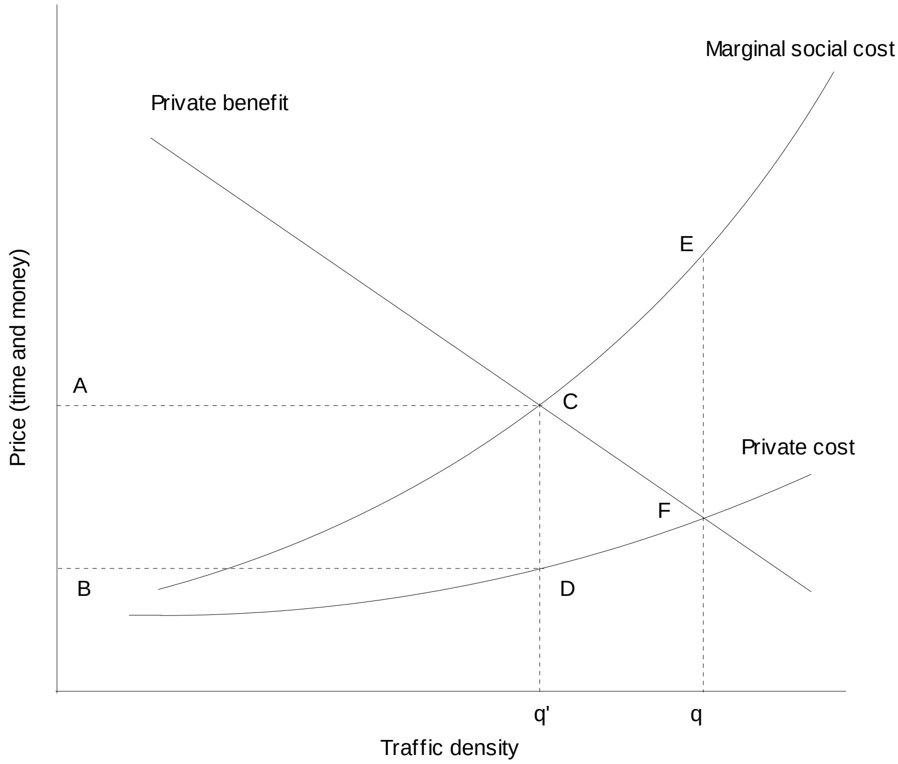
Motorists already pay to access congested public roads. This is not obvious because payment is made in time rather than money. As Becker (1965) demonstrates, the price of a commodity includes both the cost of acquiring it and the time taken to consume it. At the very least, even if there were such a thing as a free lunch, it would take time to eat.

In the same way, although access to the public road network is nominally free (although paid for in taxes), use of the network still involves a cost in terms of travel time. Those for whom the anticipated wait is too long forgo their trip — the private costs would be greater than the private benefit (see Chart 1) — while those who delayed forgo the benefits they could enjoy from other activities. In addition to the time costs, motorists also face increased costs in running their vehicles, including fuel and maintenance costs. Society also bears additional costs from increased local pollution, greenhouse gas emissions and noise.

Congestion does provide some social value in rationing road space, but it does so by imposing the greatest costs on those who are most sensitive to congestion (who value their time most highly) while imposing much lower relative costs on those who are indifferent to waiting. However, paying in time can be wasteful compared to paying in money, because others can reuse the money for beneficial purposes.

Queuing is a form of rationing 'by ordeal'. Unlike rationing through price, the resources expended in rationing by ordeal are not transferred to the supplier and are lost to the economy. Without some transferable good to act as a medium of exchange, time cannot be transferred from someone who values it more to someone who values it less. This is illustrated in the following chart.

Chart 1: Optimal congestion pricing on a link



Congestion results in the inefficient use of a valuable asset. When deciding whether to drive a particular route, motorists consider whether the expected private benefit to them will outweigh the private cost — including the time cost (see Chart 1). The private cost rises as traffic density increases, as denser traffic results in more delay. Because people only balance private benefits with private cost (point F in Chart 1) the quantity demanded (where no money price is charged) is q. However, the marginal cost to society is higher, because other motorists are also delayed.

The marginal user of the road (the person who values it least, who is still willing to enter the road) receives only a marginal benefit, but imposes large costs (vector F, E) on others. By charging a money price that equates the private cost with the social cost (vector D, C), overall demand for road space is reduced to the socially optimal level (q’). This results in a social gain (area C, D, E, F) that outweighs the lost private benefit to marginal road users (triangle C, D, F).

If charged as a tax, then the tax authority receives revenue (rectangle A, B, C, D) which can be reused, although the amount is reduced by costs necessarily incurred in administering the scheme.

This applies to goods in general — not just to roads. If bakers could not charge for bread, but were instead paid by the government to produce a fixed quantity to be given away for free, then it too would need to be rationed. Bread would be cheap for those who could afford to wait longest in queues, and more expensive or inaccessible to those with pressing demands on their time. The baker also gets no clear signal about the degree to which their customers value different products, nor do they get additional resources or reward for providing better goods or services.

The costs of congestion can be estimated according to how much people are willing to pay to jump the queue. This varies between different individuals, in different circumstances and at different times. Faced with the same length of traffic delay, a parent taking time off work to take their child to the doctor would be more inconvenienced than a tourist on a campervan holiday. Becker (1965) gives further examples of how different individuals will economise on time by choosing less time-intensive goods.

Before actual prices are introduced, and people given the opportunity to react, it is uncertain what people would pay to avoid delay (Small 2005). As a general assumption, those with the potential to earn high hourly wages would be willing to pay more to avoid an hour in traffic. That said, those on higher incomes are also best placed to reduce the time they spend driving in congestion through more flexible working hours (Lindsey and Verhoef 2001) or living in more expensive housing closer to their workplace or reasonable public transport.

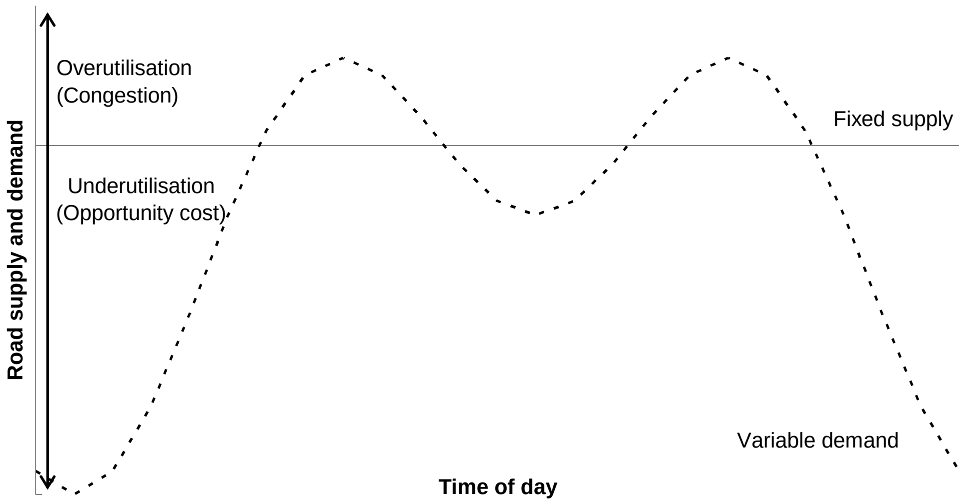
Individuals can and do make choices to reduce their personal cost of traffic congestion. For example, buying a more comfortable car can reduce the discomfort of delay. Over time, individuals may change their place or time of work, or move house, in order to save time (Downs and Downs 2004), although taxes that increase the cost of choosing appropriate vehicles or moving home act against this.

These choices reflect individual costs and benefits of transport choices. An individual decision to drive a private car or to take public transport may be influenced by the relative comfort, speed and private cost of different modes. On a free access road system, however, private users have neither the incentive nor the necessary information to consider the impact of their choices on others. The result is a set of decisions that make sense for each individual driver, but result in a poor outcome for society as a whole.

A resource management problem

A typical response to congestion is to attempt to increase the supply of roads. This can be done by adding lanes to existing roads or building new roads. However, increasing supply — particularly in built-up urban areas — can be very costly. Moreover, increasing a fixed supply for the purpose of meeting peak demand increases the underutilisation (opportunity cost) of roads at off-peak times. To put it another way — increasing roads to meet peak demand (at a zero money price) entails overinvestment in roads at non-peak times (see Chart 2).

Chart 2: Peak-period congestion



Another problem is that by increasing supply alone, congestion costs will fall which will encourage more people to travel during these periods. Because it does not tackle the underlying cause of congestion (that potential motorists have little incentive to reduce the delay they impose on others), supply side expansion may simply encourage more motorists back onto the road. A study of urban congestion in Los Angeles by the RAND Corporation found that non-price strategies to mitigate congestion induced additional peak-hour traffic. (Sorensen and Rand Transportation, Space, and Technology 2008).

This suggests that supply side-measures are likely to be a very costly way of attempting to reduce congestion. The alternative approach is to correct the incentives facing users of roads at potentially congested times. This is sometimes called 'demand management'. A key part of the solution is to ensure that potential motorists face a price signal that reflects the impact of their choices on others.

The price mechanism (specifically, prices that vary over the course of the day based on congestion levels) is designed to flatten out demand and is aimed at reducing both congestion costs (by reducing demand at peak times) while making better use of infrastructure at non-peak time (by shifting some demand from peak to non-peak). Smoothing demand in this way allows more efficient use of existing road resources.

The decision about whether to deal with congestion by expanding supply or limiting demand should depend on the relative cost and benefits of each approach. The cost of implementing demand management strategies is partly a function of technology. Congestion pricing was first proposed in the 1950s when manual tolling options were not well suited to variable pricing. Existing technology now allows more timely and targeted road pricing.

Using technology for variable pricing

Electronic tolling using fixed gantries to identify passing vehicles using a tag mounted on the vehicle’s windscreen. An example is the eTag system used in Melbourne, or Sydney’s E-Toll system. This electronic tolling system is used to apply the time-of-day tolls on the Sydney Harbour Bridge and Harbour Tunnel. This technology has been used for more extensive congestion pricing in Singapore since September 1998 (Land Transport Authority (Singapore) 2009).

Automatic Number Plate Recognition uses cameras to identify cars passing a cordon. The London Congestion Charging Scheme uses a network of 340 high-definition closed-circuit television cameras to read number plates that are then cross-checked against a central database to ensure that charges have been paid. The charge is not payable on weekends, public holidays or between 6 pm and 7 am (Transport for London 2008).

Global positioning satellite (GPS) devices in vehicles can monitor use of the road network, and congestion levels, in real time. This means that congestion can be monitored across the entire road network, potentially alleviating the problems of vehicles shifting to unpriced roads to evade tolls. The feasibility of GPS to provide real-time price information to motorists has been trialled in Seattle, where it was found to be a ‘mature and reliable’ system (Puget Sound Regional Council).

In an efficient market, investment in transport infrastructure would follow demand for it. The introduction of congestion pricing also provides valuable information to transport authorities when planning new roads or public transport options. The advantage of pricing over simply counting vehicles with unpriced access to the road is that pricing reveals the value that motorists place on accessing a particular road at a particular time. This can help guide decisions about where funding is required for road upgrades and maintenance.

This suggests that measures to address urban transport congestion require coordinated action that addresses supply, demand (that is, efficient pricing) and planning issues (including the integration of transport systems). Leaving one of these out means that the other methods will be less effective — demand management is only a piece of the urban transport congestion puzzle.

Regulating demand for roads using markets, taxes or charges

Whether the price of a congested road is determined through market trades, imposing a tax or charging for access, the prime purpose is to manage demand for the resource to maximise the welfare of those involved.

Markets — tradeable permits

Where motorists with different values of time are competing to use the same street, there are potential gains from trade between members of the group. Although it would be impractical for all the potential motorists to negotiate and enforce individual contracts, those who face the greatest costs from delay may be willing to pay for priority over other road users when demand for roads outstrips supply. The potential of, and the impediments to, individuals acting in this way were identified by Coase (1960). Primarily, it is poorly defined property rights, and the costs of transactions that prevent trade occurring in many of these situations.

This approach provides insights into possible solutions to the market failure of congestion. One method of government regulation in traffic networks, over and above the regulation of traffic flows through road rules, would be to refine the property rights in roads. In most cases, the government is the owner of the road, to which it allows access to all registered motor vehicles (although some classes of vehicles are excluded from some roads). However, access to some roads at peak times could be restricted to those who hold a permit.

A fixed number of permits could be allocated, depending on the capacity of the road network, for a particular area at a particular time. These might be issued as part of motor vehicle registration. Permit holders could trade between themselves so that road rights would be allocated to their highest value use (Raux 2007). Those who only infrequently use these roads could sell their excess permits to those who value them more highly, resulting in a more rational allocation of road space.

Some local councils already adopt a similar approach for parking on public roads, whereby the right to park a car in particular zones is restricted to vehicles with a permit. While these permits do not tend to be tradeable between people, they are an example of property rights allowing better resource allocation.

Corrective taxes

Where one person undertakes an activity, and that activity has measurable negative effects on others, there is sometimes justification to impose a tax on that activity. Taxes, by definition, are a ‘compulsory, unrequited transfer to the general government sector’ (Australian Bureau of Statistics 2005). This type of tax — named after AC Pigou (Pigou

1920) — is designed to improve society's welfare by ensuring that individuals face the full cost of their actions. It is not designed primarily to raise revenue, but the consequence of the tax is to transfer resources to government to spend on goods or services, or to reduce other taxes.

Whether or not a tax is necessary or appropriate depends on the underlying market structure and the nature of property rights. If roads are generally treated as owned by society as a whole, with equal rights to all for public access, then the congestion tax model is appropriate.

To achieve an efficient outcome, the tax has to be closely targeted to the use of cars on congested roads. Fuel tax is sometimes seen as a proxy for charging the variable costs of road usage. However, there are serious limitations to this approach. First, the amount of fuel tax paid is strictly related to the amount of fuel consumed in a vehicle, not the variable use of public roads. The relationship between fuel consumption and road use has changed over time as vehicles have become more fuel-efficient. This fuel-efficiency has been, at least partly, induced by fuel tax (Parry and Small 2005).

In addition, discounts and exclusions from fuel tax for some transport fuels mean that any price signal provided through fuel tax would not affect all modes of transport. However, vehicles contribute to congestion because they take up space on the road. Whether the vehicle is fuelled by petrol, diesel or an alternative fuel is irrelevant to the congestion cost.

The major objection to fuel tax as a proxy for congestion charging — even if it were closely related to distance travelled — is that it does not reflect variable congestion costs. In many cases (as in rural areas), motorists can use road space without inconveniencing other road users,[2] in which case the efficient use of existing road infrastructure would entail charging no congestion fee. Hybrid electric-petrol motor vehicles do not use any fuel when stationary or at low speeds. Fuel taxes raise the cost of motoring relative to public transport or walking, but do not encourage motorists to shift from congested to uncongested roads, or from peak to off-peak times (Parry 2002). While this may marginally decrease the cost of congestion, it also increases the opportunity cost (underutilisation) of roads at times of no congestion.

By contrast, a well-calibrated congestion tax would regulate access to a limited resource (road space) at times when it is scarce. Unlike fuel taxes, it does not have the disadvantage of discouraging utilisation of the network at times when competition for road space is not an issue.

2 The question of other social costs of motor vehicle use – like air pollution, accidents or noise, should be taken into account for more comprehensive road pricing, but is not discussed here.

User charges

Pigovian taxes are unnecessary where property rights in the road are clearly assigned and the owner of the road (whether a government authority or a private firm) is allowed to charge for access to it. Frank Knight, in response to Pigou, demonstrated that in this circumstance the owner of the road has incentives to charge a fee that takes into account the congestion (Knight 1924). When faced with an alternative between two roads, some consumers will pay a higher price to take the less congested road, even if the other is nominally free. This is because the time saving is worth more to some consumers than the monetary cost.

In Australia, private toll road concessions have tended to be negotiated to allow an adequate return on congestion, but not to allow efficient variable pricing of congestion (Clarke 2008). Restructuring tolls to allow them to respond to demand at peak periods may require renegotiation of existing contracts, but would unlock efficiency gains.

The introduction of the congestion premium on the Sydney Harbour Bridge and the Sydney Harbour Tunnel from the start of 2009 — after the introduction of electronic tolling — demonstrates the feasibility of this approach.

Congestion premiums on Sydney Harbour Bridge and tunnel tolls

From 27 January 2009, New South Wales introduced time-of-day tolling for the Sydney Harbour Bridge and Sydney Harbour Tunnel. Three levels of pricing are now charged for peak ($4), shoulder ($3), and off-peak ($2.50) tolls. The peak toll is not charged for weekends or public holidays.

The New South Wales Road Traffic Authority has noted that ‘[m]otorists have adapted well to the changes and traffic volumes reflect a marked increase in people travelling before the peak period, with numbers falling again during the peak period between 6.30am and 9.30am on all crossings, including the Ryde and Gladesville bridges, when compared to the same time last year.’

The additional revenue from the peak toll is to be invested in public transport (Roads and Traffic Authority (NSW) 2009).

Revenue and compensation

The primary purpose of pricing congestion is to encourage efficient use of roads — not to raise revenue. Economists have tended to focus on the efficiency benefits, rather than the distributional impact of road pricing. However, while overall welfare is increased from optimal congestion charging, those people who would have preferred to pay in time rather than money may need to be compensated to be better off.

In the absence of redistribution to road users, then the government or road owner (whether public or private) is the major financial beneficiary (Button 1993). The community may be concerned that, in the absence of independent pricing or regulation, the government or road owner might face incentives to maximise revenue rather than social benefit.

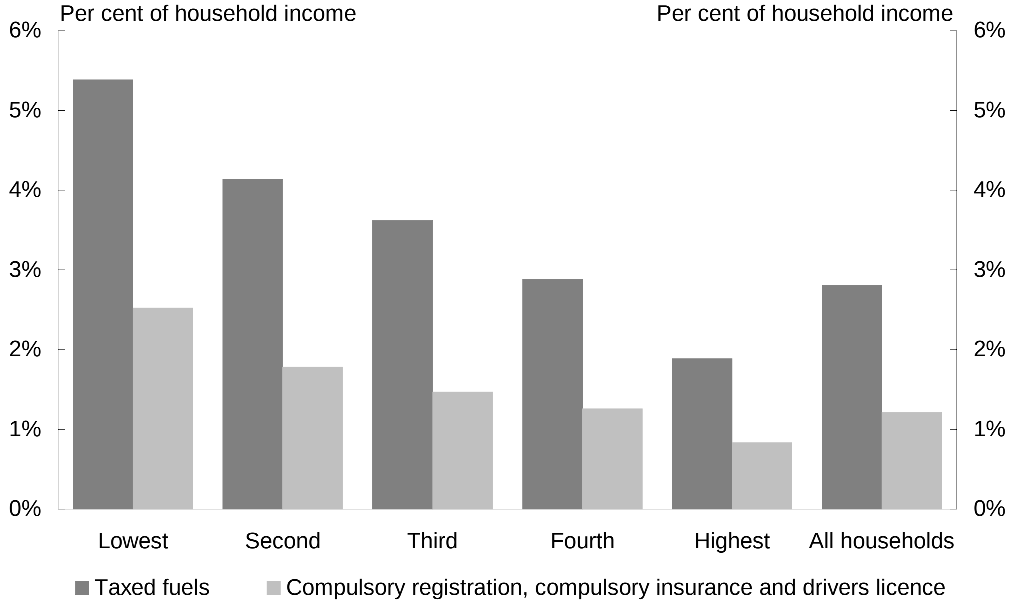
Because congestion charging provides efficiency gains, the additional benefits from congestion charging should be greater than the amount of compensation required to ensure that most individuals are better off. There are a number of theoretical options for providing compensation to motorists, although in practice options may be constrained by the degree to which compensation can be targeted effectively to particular groups, and coordination between the revenue and spending responsibilities of different levels of government.

The amount of compensation might be limited also by administrative costs of whichever scheme is chosen. These costs can be large, and should be considered when assessing the overall costs and benefits. For example, while the Central London Congestion Charging Scheme generated £268 million in total revenues for 2007-08, almost half of this was spent on operation, publicity, enforcement and other costs of the scheme (Transport for London 2008).

Adjusting transport-related taxes

Currently, most taxes on motor vehicles and motor vehicle fuels are designed for general revenue raising purposes, not to change a motorist's driving decisions. Expenditure on taxed fuels, and compulsory motor vehicle-related charges forms a much greater share of the budgets of low-income households than high-income households, and can therefore be seen as regressive (see Chart 3). For this reason, a reduction in these taxes might address concerns about the potential impact of congestion pricing on low-income motorists.

Chart 3: Household expenditure on taxed fuels and compulsory road charges
By gross household income quintile



Source: Australian Bureau of Statistics, *Household Expenditure Survey, Australia: Detailed Expenditure Items, 2003-04*, Australia, cat. no. 6535.0.55.001, Canberra, 2006.

This approach would require some coordination between different levels of government as fuel taxes and general motor vehicle taxes are levied at different levels. In addition, there may be difficulty in targeting compensation only to urban motorists (who would face the biggest effects of congestion charging).

An alternative approach might be to provide motorists, as part of existing motor vehicle-related taxes and charges, with a fixed entitlement to spend on congestion fees. Motorists who successfully reduce congestion could be given the opportunity to benefit by 'cashing-out' money that they do not spend on congestion (see box on Seattle pricing trial). The size of these initial endowments could be set to reflect equity concerns.

Seattle Pricing Trial — Providing benefits to those who reduce congestion

In a trial of congestion charging in Seattle, GPS-based tolling devices were placed in the vehicles of 275 volunteers. Their daily driving routines were monitored to collect comprehensive 'base-line' data on driving behaviour.

Participants received a 'travel budget' based on their previous driving behaviour. The GPS unit provided information on current tolls, and money was deducted when driving on congested roads at peak times.

The study found that drivers did make small changes to their behaviour that, if applied across the population, would create significant network efficiency gains.

In this case, some of those gains were returned to the volunteers. Motorists who did not use their full travel budget — by taking the opportunity to drive at less congested times and places — were able to 'cash out' their initial entitlement, and thereby receive a benefit from their private contribution to reducing congestion (Puget Sound Regional Council).

Interaction with taxes on labour income

It is sometimes argued that a government tax on an 'externality' (like congestion) creates a 'double dividend'. The 'double dividend hypothesis' holds that when Pigovian taxes are imposed by governments, there are two social benefits: reduced negative externalities (for example, less congestion) and the opportunity to reduce other taxes using the revenue generated.

However, while such a tax improves efficiency in transport markets, it can exacerbate the distortions caused by existing taxes. The interaction with the labour market and existing income taxes is generally taken to be the most significant (Parry and Bento 2001). Recent studies suggests that for many such tax, the additional labour market distortion can outweigh the benefits in correcting the externality itself (Bovenberg and Goulder 1996).

However, Parry and Bento (2001) found traffic congestion to be a rare case in which efficiency gains might also arise in the labour market. This is because better allocation of road resources might encourage labour force participation, therefore increasing the net return to labour.

Providing compensation through taxes on labour income might therefore be theoretically attractive, both for improving work incentives (efficiency) and addressing equity concerns. If done through the progressive income tax, then it might be easier to target compensation to wage earners on low or middle incomes. High-wage earners, to the extent that they have a particularly high value of time, are likely to be better off even without compensation.

There are difficulties in targeting this form of compensation only to motorists affected by the tax. This approach might overcompensate those whose use of motor vehicles is already low, and undercompensate those who already depend on using motor vehicles in urban areas. This approach would also require coordination between governments.

Increasing funding to alternative forms of transport

An alternative approach is to provide compensation by providing increased public transport services to motorists who are 'tolled off' the roads. This provides a way of targeting compensation to those who are required to change their behaviour from the toll, although existing users of public transport would also receive benefits. Those who continue using roads but only marginally value the time saving would not receive compensation under this approach.

The Central London Congestion Charging Scheme adopts this approach and is required by law to spend the net revenue of the scheme to improve overall transportation. In 2007-08, around 80 per cent of the £137 million net revenue from congestion charging was spent on improving the bus network, with the remainder on planning, upgrading roads and bridges, road safety, environmental and walking and cycling measures (Transport for London 2008).

This approach has coordination benefits where the authority receiving the congestion revenue also has responsibility for public transport networks. Because public transport and urban road networks overlap in many cases, it may provide a good way of targeting compensation to those in the geographic area affected by the charge.

Funding public transport from congestion revenues may be consistent with compensation objectives desired by governments. However, to the extent that public transport is priced partly to take into account its contribution to reduced road congestion, the introduction of comprehensive congestion pricing for roads would reduce the efficiency arguments for subsidy (Smart 2008).

Conclusion

The net benefits of road congestion charging in major Australian cities may be considerable, but so are the challenges. Because congestion is a localised problem, most of the implementation issues for congestion pricing on key road infrastructure remain state and local government responsibilities. The slow progress of reform to date may reflect both the profound planning difficulties associated with introducing road congestion pricing, as well as community distributional concerns. Both of these problems suggest attempts at further coordination by all levels of government may be worthwhile.

The principal purpose of charging for congestion is to encourage efficient market outcomes. For this reason, there are strong arguments for returning the revenue from congestion charging back to those who would be worse off under a system of pricing.

This paper has suggested three theoretical approaches to how this might be done, although the practical implementation of any of these, or a mixture of all three, is likely to depend on the degree of coordination between different authorities, the taxing and spending responsibilities of different levels of government, and the administrative arrangements for any charging system.

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