Australian Government
Infrastructure Australia

CONGESTION PRICING ON AUSTRALIA'S ROADS

PURPOSE

The purpose of this paper is to provide an overview of the attached report "High Cost of Free Roads – a case for congestion pricing in Australia". The attached report was prepared by Deloitte for the Office of the Infrastructure Coordinator.

BACKGROUND

Goal

The debate on congestion pricing in Australia has largely focused on specific congestion charging schemes, including the likely success or failure of schemes and the availability and cost of facilitating technologies.

"The High Cost of Free Roads" aims to provide a new perspective on the debate. Rather than propose solutions, the report draws on international experience and undertakes to engender public understanding and acceptance of congestion pricing, which is crucial to the success of congestion schemes.

Problem Identification

Congestion on Australia's roads is a national problem, undermining the productivity, liveability and sustainability of capital cities. As Australia develops its infrastructure priorities and strategies, transport reform and investment initiatives must address congestion and deliver practical solutions that will move people and goods more freely.

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Problem Assessment

Judging by international experience, charging for road use could help to combat road congestion. Setting a price signal for the use of congested roads can allow users to make more informed travel decisions, encouraging more efficient travel behaviour such as taking alternative modes of transport, consolidating trips or travelling during off-peak periods. User pricing also enables reinvestment in road infrastructure and public transport to benefit users directly and transparently.

Problem Analysis

The report aims to build the case for congestion pricing in Australia, providing the context of user pricing to efficiently allocate resources in other infrastructure sectors. A user pays approach to water, electricity and communications has been fundamental in influencing and managing infrastructure capacity in these sectors. For example, lower cost off-peak energy reduces the peak load capacity needed by energy suppliers, deferring the need for costly infrastructure upgrades that would be passed onto the consumer.

In establishing the merits of congestion pricing, the report provides broader lessons from congestion pricing schemes introduced overseas that can be used to inform decisions in Australia. It also provides an overview of estimated social, economic and environmental costs of congestion and the likely benefits of congestion pricing.

Option Generation

The report discusses potential options to introduce congestion pricing, such as types of schemes (distance-time-mass, cordon, area, road corridor) and available technologies.

Solution Assessment

The report acknowledges that well-designed congestion pricing schemes must take into account the unique nature of traffic networks, the travelling behaviour of the population, community engagement, transport alternatives, technology, charging levels, costs, application of revenues generated, and other factors. Chapter 5 notes that:

> *It is a major step from the concept of congestion pricing for a city to its actual implementation. The cities that have adopted congestion pricing have engaged in preparation over a number of years. However, even these years of careful planning do not always lead to adoption, as the authorities in Edinburgh, New York, and Manchester are well aware.*

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Attachment 1

Infrastructure Australia

The High Cost of Free Roads - a case for congestion pricing in Australia

3 November 2010

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Executive summary

'Free' roads come at a high cost

Road congestion is a national problem. It undermines the productivity, liveability and sustainability of Australia's capital cities, impacting the nation as a whole. As Australia develops its future infrastructure priorities and strategies, transport reform and investment initiatives must deliver practical solutions to move people and goods more freely.

If congestion is not addressed, more and more valuable time will be wasted - stuck in traffic.

The role of congestion pricing in transport reform

Judging by international experience, charging for road use could help to combat road congestion. Setting a price signal for the use of congested roads can allow users to make more informed travel decisions, encouraging more efficient travel behaviour such as taking alternative modes of transport, consolidating trips or travelling during off-peak periods. User pricing also enables reinvestment in road infrastructure and public transport to benefit users directly and transparently.

What is congestion pricing?

Placing a price on the use of a road or road network based on factors such as level of congestion, time of day or available parking. 'Area' or 'cordon' schemes, implemented in London, Stockholm and Singapore are the most well known examples of congestion pricing.

Most Australian roads are not currently subject to user pays pricing rules. As such, there are few clear economic signals about appropriate levels of road use and investment. With the exception of a small number of toll roads, there is no direct link between the taxes and charges imposed on road users and the funding of road investments.

Pricing is common to almost all of the goods and services we consume. Setting a price for when - or how much - we use goods and services is the most economically efficient way of allocating these resources. A user pays approach to water, electricity and communications has been fundamental in influencing and managing infrastructure capacity in these sectors. For example, lower cost off-peak energy reduces the peak load capacity needed by energy suppliers, deferring the need for costly infrastructure upgrades that would be passed onto the consumer. Why not do the same with our roads?

Congestion pricing as part of a broader transport reform

Congestion pricing should not be seen as a silver bullet. It will yield greater economic benefits if delivered as part of broader reform and investment initiatives for urban transport infrastructure and services that give people ways of travelling that create less congestion. Infrastructure Australia believes this includes:

- public transport – improving the performance of existing road and rail services, and creating new capacity
- roads – prioritising investment in roads that complete major arterial networks and alleviate congestion bottlenecks
- urban design – shaping and renewing cities to encourage transit oriented development and better connect users to services and employment areas.

These will be addressed in three future strategies being prepared by Infrastructure Australia for public transport and urban roads.

Creating a congestion pricing scheme that delivers real benefits

Overseas experience has shown that no one scheme fits all and that many issues must be considered. The following have proved to be important success factors:

- market willingness (legislative support, the existence of a champion for the project, levels of public consultation and acceptance)
- clear and measurable objectives (schemes targeting a specific congestion problem)
- traffic and network attributes (physical road network layout, population density and dispersion, traffic flows and commuter patterns, availability of alternative modes of transport)
- justifiable congestion prices (benefits clearly outweigh the costs)
- transparent re-investment (direct application of revenues to improving the efficiency and effectiveness of the transport system to users impacted by congestion pricing)
- available technology and systems options (radio frequency identification tags, GPS systems, cameras)
- the availability of supplemental transport programs (public transit, alternative commuting programs).

Success in congestion pricing depends on political positioning, thorough assessment, public consultation, planning advocacy and strong execution.

Clearly congestion is not a problem on all Australian roads at all times. A great deal of preparatory work needs to be done to ensure that any proposed congestion pricing scheme will promote the community interest. Determining a price structure that generates net benefits for the community is often difficult – both practically and politically. Accordingly, a charge ought not to be levied unless it will result in reduced congestion.

While congestion pricing can deliver significant benefits, it can also leave users worse-off, including those who:

- have no flexibility with their travel times
- cannot afford to pay the charge
- have no alternative modes of travel.

Often these are lower income earners in outer suburbs who need to travel to the central city for work during peak hours. Some of these issues can be dealt with by concession arrangements for car pools, local residents and people with disabilities, but others may have to be addressed by new investment in public transport.

Any scheme should deliver real benefits that outweigh all the costs, taking into account the interests of road users, the broader community and the environment. However, whilst economic efficiency is an important goal of public policy and should be given due weight, there are many other considerations. The distributional effects of policies, for example, are often complex. The way roads are priced (or not priced) may affect the whole configuration of a city, influencing land prices and rents. By way of contrast, as the Henry Review identified, prolonged congestion issues can have the impact of reducing economic growth and employment.

Congestion pricing, when well executed, has the capability to reduce congestion, cut the time and energy wasted in

Key features and benefits of congestion pricing

Economic Rationale

- equates travel behaviour to the cost imposed on others and the social infrastructure
- creates a market for road usage

Congestion Reduction

- reduces commute times
- increases productivity
- allows more predictable travel times.

New Revenue

- makes funds available for infrastructure improvements, maintenance and public transport.

Environmental Improvements

- reduces idling and emissions
- reduces pollution from road run off that impacts water and soil
- increases demand for and use of public transport
- reduces noise pollution.

Flexibility and Adaptability

- adjusts pricing to fit circumstances and needs
- requires less infrastructure than for building new roads or lanes
- can design equity into the system for low-income drivers or groups with special needs.

commuting by vehicles, increase revenues to improve the transport infrastructure and improve the well being of society.

1 The high cost of free roads

The number of cars on Australian roads has been growing faster than the capacity of roads to cope with them. The result is traffic congestion. Battling through traffic congestion has a significant impact on the lives of many urban dwellers. It degrades the quality of life, making travel times longer, unpredictable and often frustrating.

The costs of congestion are as varied as the people stuck in traffic jams. Delays and wasted time have an opportunity cost; as extra time spent on the road is lost family and recreation time. Delays to business users and freight transporters reduce productivity.

The environmental impacts of congestion are very real. Cars in peak hour traffic consume approximately one third more fuel, emitting higher rates of noxious pollutants than under more freely flowing conditions (Fuel Taxation Inquiry Committee, 2002, p79). The increased air pollution causes health problems. Gridlocked cars increase noise pollution and visual blight, a loss of amenity for those living near congested roads. Higher fuel and labour costs increase freight costs, which is passed on in the cost of goods and services.

Impacts of congestion

- increases travel time, reducing time available for work and family
- makes travel time less predictable
- increases car operating costs (e.g. higher fuel consumption)
- increased driver and passenger stress
- reduces the productivity of business users and freight transporters through delays and increased operating costs
- slow speeds and excessive idling increase air pollution, creating health costs
- increases noise pollution for those living near roads.

The current levels of congestion in Australia's major capital cities are widely regarded as unsustainable. This situation will only get worse as our major cities grow.

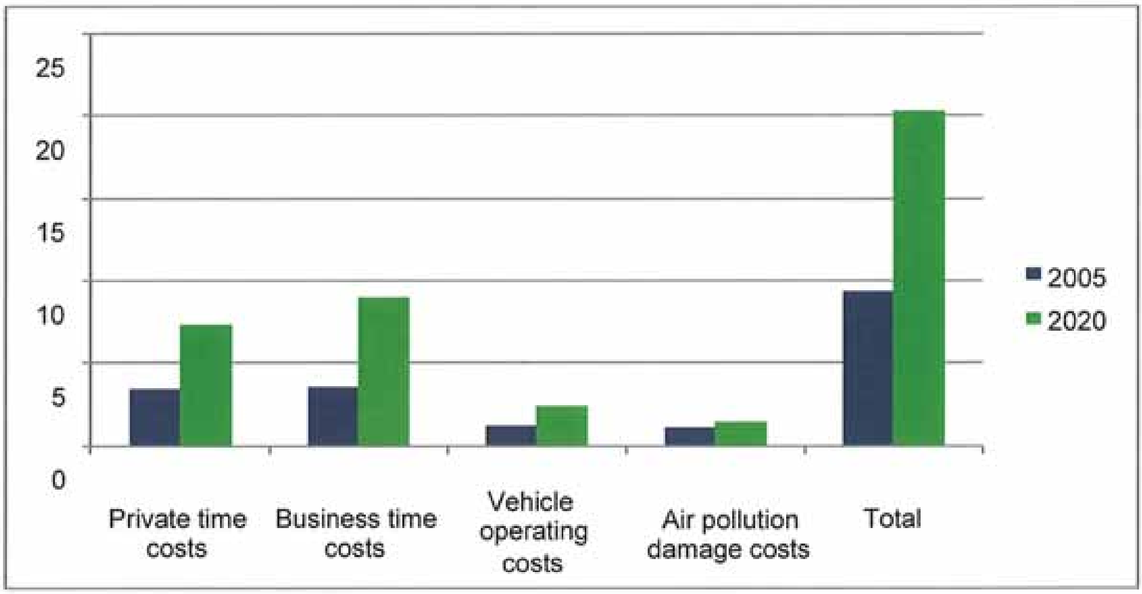
The most comprehensive and up-to-date study of congestion costs in Australia is the 2007 report prepared by the Bureau of Transport and Regional Economics for the Urban Congestion Review by the Australian Council of Governments (BTRE 2007). It provides estimates of the congestion costs in the eight Australian capital cities and projections of these costs to 2020.

The analysis avoids a common mistake of comparing the current levels of congestion to the unrealistic alternative of no congestion.[1] The avoidable cost of congestion is of much greater policy relevance than total delay costs - realistically it is not feasible to reduce total delay costs to zero for real-world traffic streams.

BTRE's approach estimates the net social costs of congestion as the difference between the social costs and social benefits of road use above an acceptable level of congestion. It can be interpreted as the potential gain from an efficient pricing scheme (where users are charged social marginal cost), which would give the efficient level of road use.

BTRE estimates that in 2005 the social costs of congestion were $9.4 billion and forecasts it to more than double to $20.4 billion by 2020. Figure 1.1 shows the split of this cost between the key symptoms of congestion.

Figure 1.1 Social costs of congestion ($billions)



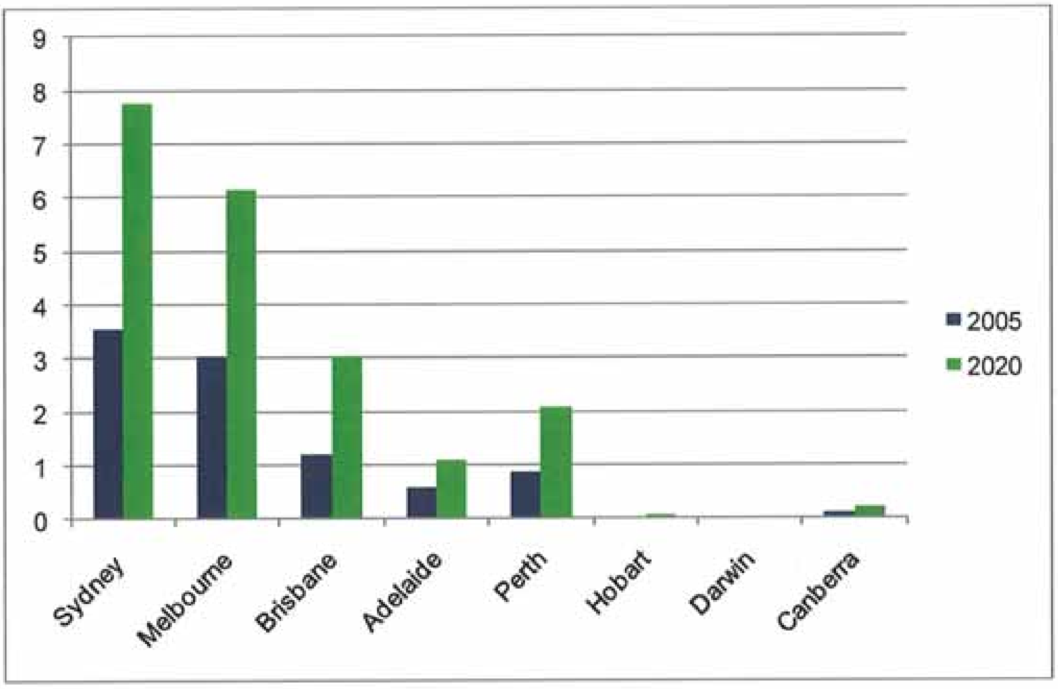
Source: Derived from BTRE (2007)

Based on estimates of vehicle kilometres travelled (VKT), the 2005 cost equates to an average cost of 6.8 cents per passenger car equivalent unit kilometre (PCU-km) for the eight metropolitan areas. The cost per PCU-km rises to 10.8 cents by 2020 through a predicted 50 per cent increase in travel times and 37 per cent increase in vehicle kilometres driven with car traffic assumed to grow with the population and increased in income and freight traffic growing with GDP and reductions in real freight rates (BTRE, 2007, p111).

1 For an overview of the alternative methodologies used to measure congestion see BITRE (2008) Appendix B, p. 127.

Figure 1.2 analyses the social costs of congestion by capital city. These estimates would be higher if all the regional urban areas, such as Newcastle, Geelong or parts of South-East Queensland, were also included.

Figure 1.2 Social costs of congestion by city ($billions)



Source: Derived from BTRE (2007)

Sydney and Melbourne accounted for approximately 70 per cent of the estimated capital city congestion costs in Australia in 2005. This distribution is broadly maintained in the BTRE projections for 2020, notwithstanding the higher rate of growth anticipated for congestion in Perth (150 per cent) and Brisbane (133 per cent), relative to 123 per cent and 103 per cent growth in Sydney and Melbourne respectively.

These figures represent the most authoritative national analysis in this area and make a considerable contribution to identifying long-term trends in urban traffic growth:

> *... the costs imposed on Australian society by urban traffic congestion are likely to be in the range of $5 to $15 billion for current levels...with a median value of around $10 billion. This is likely to rise, under base case demand growth assumptions, to a level of between $10 and $30 billion by 2020, with a median projected value for the potentially avoidable social costs of congestion of around $20 billion (BTRE, 2007, p122).*

In practice, the median values tend to be adopted, which dismisses the uncertainty associated with the estimates indicated by the broad range.

The researchers caution that the estimated costs used aggregate analysis, which only provides broad estimates of the scale of a city's congestion situation (BTRE, 2007, p. iii). Each capital city has its own unique circumstances relating to size, geography, demographics, town planning legacies and public transport systems. But one factor is consistent across all cities which is that the expected growth in traffic will result in increased potential for congestion. This is summarised in Table 1.1.

Table 1.1 Car Traffic Projections for Australian Cities

City	2005			2020			
	Car VKT / Person ('000)	Population ('000)	Total Car VKT (million)	Car VKT / Person ('000)	Population ('000)	Total Car VKT (million)	Percent Change 2005-2020
Sydney	7.47	4,382	32,715	7.91	5,103	40,340	23%
Melbourne	8.60	3,682	31,651	9.10	4,143	37,702	19%
Brisbane	7.30	1,780	12,996	7.73	2,233	17,264	33%
Adelaide	7.96	1,135	9,032	8.43	1,195	10,069	11%
Perth	7.58	1,505	11,411	8.03	1,835	14,731	29%
Hobart	7.59	194	1,474	8.04	192	1,540	5%
Darwin	6.33	99	630	6.71	130	871	38%
Canberra	9.55	328	3,133	10.11	362	3,663	17%
Metro	7.86	13,106	103,041	8.32	15,193	126,475	23%
Rest of Australia	9.42	7,244	68,265	9.98	8,049	80,308	18%
Total Aust.	8.42	20,350	171,306	8.91	23,241	207,154	21%

Source: BTRE Working Paper No. 71

Table 1.1 shows growth coming from the absolute increase in personal travel (car VKT/person). Depending on the location this stabilises out at around eight to ten thousand kilometres per person per year and is a function of income and geography and the growth in the absolute population for that location. Each capital city has its own unique characteristics and propensity for congestion, some comparable data is summarised as follows (BTRE 2007):

Adelaide

- estimated congestion cost increase from \$0.6 billion (2005) to \$1.1 billion (2020)
- passenger travel grew by 65 per cent from 1977 to 2004
- public transport share of passenger travel is constant at around 5 per cent.

Currently, Adelaide has no existing road charging schemes. The primary modes of passenger transport are car, rail and bus.

Brisbane

- estimated congestion cost increase from \$1.2 billion (2005) to \$3 billion (2020)
- passenger travel grew by 250 per cent from 1977 to 2004
- public transport share of passenger travel is constant at around 8 per cent.

The primary modes of passenger transport are car, rail and bus.

Brisbane has had a tolled bridge for many years. The recent new tolled road developments within the city have suffered demand issues and suggest that local road users have yet to accept free flowing tolled roads as an alternative to congested free roads. Based on Austroads data, actual average travel speeds across Brisbane's monitored network have declined in the last decade due to population growth in South East Queensland. Quite considerable changes have occurred during both the AM and PM peak periods: average speeds have declined by 10.9 km/hr (25%) and 7.4km/hr (15%) respectively.

Canberra

- estimated congestion cost increase from \$0.11 billion (2005) to \$0.2 billion (2020)
- passenger travel grew by 120 per cent from 1977 to 2004
- public transport share of passenger travel is constant at around 6 per cent.

Currently, Canberra has no existing road charging schemes. The primary modes of passenger transport are car and bus.

Darwin

- estimated congestion cost increase from $18 million (2005) to $35 million (2020)
- passenger travel grew by 270 per cent from 1977 to 2004
- public transport share of total passenger transport has risen to around 10 per cent in recent years.

Darwin has no existing road charging schemes. The primary modes of passenger transport are car and bus.

The high growth in passenger travel reflects a low base and the recent economic development in Darwin.

Hobart

- estimated congestion cost increase from $50 million (2005) to $70 million (2020)
- passenger travel grew by 175 per cent from 1977 to 2004
- public transport share of total passenger transport travel is constant at around 4 per cent.

Hobart has no existing road charging schemes. The primary modes of passenger transport are car and bus.

Melbourne

- estimated congestion cost increase from $3 billion (2005) to $6.1 billion (2020)
- passenger travel grew by 101 per cent from 1977 to 2004
- public transport share of passenger travel is constant at around 8 per cent.

The primary modes of passenger transport are car, rail, light rail (tram) and bus.

Melbourne has an extensive existing and planned network of fixed tolled roads providing corridors into, around and within the city. As is the case in other cities, there has been an increase in the duration of peak times on Melbourne's freeway network. The morning peak period lasted for around two hours in 2003/04, but increased to almost two and a half hours by 2007/08. The afternoon peak increased from around three hours to three and a quarter hours by 2007/08 (VicRoads 2009). Whilst average travel speeds in Melbourne have not changed materially over the last few years, the spread of the peak into non-peak periods indicates an increase in congestion.

As noted in Sir Rod Eddington's report "80 per cent of daily travel occurs on approximately 20 per cent of the road network. These practical limitations mean that traffic density is high at a number of key points on the network – freeways, major arterials, river crossings, important collector roads and strategic intersections – leading to congestion" (Victoria Department of Transport, 2008, p92). The State Government has introduced a congestion levy of $800 a year to off-street long stay parking for cars and larger motor vehicles within a defined area. The levy is paid by car park owners and is designed to improve CBD amenities and encourage take up of public transport (Victoria Department of Transport, 2008, p99).

Perth

- estimated congestion cost increase from $0.9 billion (2005) to $2.1 billion (2020)
- passenger travel grew by 101 per cent from 1977 to 2004
- public transport share of passenger travel grew to around 7.5 per cent from 5.5 per cent with the opening of the northern rail line and is estimated to grow to 9 per cent with the opening of the southern rail line.

Currently, Perth has no existing road charging schemes. The primary modes of passenger transport are car, rail and bus.

Sydney

- estimated congestion cost increase from $3.5 billion (2005) to $7.8 billion (2020)
- passenger travel grew by 98 per cent from 1977 to 2004
- public transport share of passenger travel is constant at around 13 per cent.

The primary modes of passenger transport are car, rail and bus.

Sydney has a number of toll road corridors into and around the city and although most provide a faster trip than taking alternative 'non-tolled' roads, only the Sydney Harbour Bridge and Tunnel have differential time-of-day pricing.

In January 2010, charges on the Sydney Harbour Bridge and Tunnel were increased to $4 during week-day peak periods (6.30-9.30 am and 4-7pm), and maintained at $3 during the rest of the day and reduced to $2.50 for the low demand period (7pm-6.30am).

Opinion is mixed on whether it has been successful. The New South Wales Roads Minister, Michael Daley, stated that the higher charge led to a reduction of almost 1,400 cars using the Bridge and Tunnel during peak periods, with around 13 per cent more people using the Bridge and Tunnel off-peak (before 6:30am), and a 4 per cent reduction during peak times (ABC News, 2009). In contrast, an NRMA poll of commuters concluded that 'the new congestion tax on the Sydney Harbour Bridge was failing to deter peak hour drivers' with only one in 20 commuters from Sydney's north and north-west changing their behaviour to travel into the city outside peak times because of the higher toll (NRMA 2009).

The Review of Australia's Future Taxation System (the Henry Review) examined the road transport tax system and considered the impact of congestion. The Review cites research from the USA which indicates that increased congestion will reduce long-run employment growth and concludes that "poor management of infrastructure therefore reduces productivity" (RAFTS 2009, p.380). The Henry Review recommends that state governments formally examine the benefits and costs of introducing variable congestion pricing to existing toll roads and extending existing technology across other congested roads. Recommendation 61 also states that congestion charges should apply to all vehicles and the use of revenues should be transparent to the community (RAFTS 2009, p.377).

Reform to address infrastructure overuse in other sectors

The problems of inefficient pricing and provision of infrastructure have been faced in other industries. Over the past 20 years, reform has been focused on improving efficiency in infrastructure use and supply, particularly in the water and energy sectors.

Historically, most economic infrastructure was supplied by statutory public monopolies which faced no competitive pressures and were often required to cross-subsidise household consumers through higher charges levied on businesses. These monopoly providers typically failed to cover their operating costs or provide a financial return to the community on the capital invested in service delivery. Many investments decisions were not made on a commercial basis (PC 2008).

Over the past two decades, governments in Australia have made a concerted effort to reform infrastructure, with a focus on enhancing efficiency. Governments initiated these reforms to:

- improve productivity
- achieve higher levels of cost recovery and reduce the financial burdens on the community by increasing prices in some industries to reduce subsidies from the public purse (user-pays)
- make prices more reflective of the cost of providing services to different customers, such as removing cross subsidies and under-pricing.

The underlying goal was to improve community living standards (PC, 2002). Extending this approach to our road infrastructure should be aimed at creating similar benefits.

2 Efficient pricing in infrastructure reform

Pricing of economic infrastructure encourages the efficient use of the infrastructure and signals when new investments are warranted to meet growing or changing user demands.

Economic infrastructure has traditionally been provided by government trading enterprises (GTEs) operating in non-competitive environments. The water and energy reforms of the 1980s and 1990s aimed to introduce competition into these sectors and to drive efficient pricing, in particular requiring GTEs to achieve full cost recovery. These reforms also attempted to eliminate any cross-subsidies between households and businesses.

Introducing an efficient price structure has often been difficult, faced with formidable practical political and economic barriers such as lack of information, costs of implementation and public opposition.

User pays has been widely adopted by the water and energy sectors, although there are still a number of the utilities that have not yet adopted this approach. Despite the move towards commercialisation and corporatisation, land transport is the least commercialised of the utilities. Further reforms are still required to address existing inefficiencies such as cross subsidisation. However, there remain significant opportunities and challenges to introducing efficient pricing both politically and practically.

User pays water reform

A major reform initiative has been the change from property-based charging to consumption-based charging.

Under the property-based charging system, significant cross subsidies existed as water allowances varied depending on the land rates paid and the type of property.

The introduction of volumetric charging saw the consumption of water per capita fall by about 17 per cent between 1990-91 and 2000-01.

Water reform

In 1994, the Council of Australian Governments (COAG) agreed on a national water reform framework including:

- separating the roles of water resource management, standard setting and regulatory enforcement
- a move towards full cost recovery and the reduction of cross subsidies.

In 1995, the water reform framework became part of the National Competition Policy and in order to receive payments from the Australian Government the States and Territories were required to achieve progress against the national reform commitments (PC 2002).

In 2003, COAG agreed to a new National Water Initiative which included reforms for best-practice pricing. The National Water Commission stated that while there had been considerable progress on the National Water Initiative further improvements were still required. For example, in a number of states, a water usage charge is not levied directly on all users, who therefore do not receive a price signal providing an incentive to use water prudently (NWC 2009, p.160).

Despite these reforms some GTEs are not achieving commercial rates of return. These performance issues relate to cost inefficiencies and community service obligations. Pricing reform in the rural water market has been limited and underpricing of irrigation water still exists. The charging regimes do not reflect the scarcity of water in times of shortage (PC, 2008). Non-price rationing in the form of water restrictions is still common.

Electricity reform

User pays electricity reform

As part of the reform of the electricity industry's tariff structures, time-of-use tariffs have been introduced which charge customers an access charge and a usage charge that is higher during peak periods of the day.

These reforms have led to declines in real electricity prices paid by both households in most capital cities and businesses.

The reforms to the electricity industry have included:

- user pays approach to fulfil full cost recovery requirements
- changes to the governance structures of GTEs
- introducing competitive neutrality measures.

Competition in the market was introduced by separating generation and retailing from transmission and distribution. The National Electricity Market was established in 1998 as a spot market allowing generators to price supply energy at half-hourly intervals and purchasers to buy the energy at the spot price (PC 2002, p.13).

Real prices paid by small, medium and large businesses in NSW fell by between 30 and 60 per cent in metropolitan and non-metropolitan areas between 1990-91 and 2000-01 (PC 2002, p.25).

Despite the declines in real prices, the profitability of several utility companies has been maintained – some achieving return on assets of 10 per cent since the mid-1990s (PC 2002, p.33).

Natural gas reform

Reform of the gas industry began in 1994 with the Council of Australian Governments committing to 'free and fair trade in natural gas' (PC 2002, p.48). Similarly to the reforms in other utility industries, the commitment focused on removing barriers to competition and corporatising government owned gas utilities. It also entailed introducing legislation to structurally separate any vertically integrated government owned transmission and distribution activities.

Cross subsidisation from large to small customers was removed with the introduction of regulated charges for wholesale access that refers to the use of transmission pipelines. However, the level of wholesale charges has been contentious stemming from the Australian Competition and Consumer Commission trying to reduce charges.

One of the major changes to the pricing structure has been the introduction of access charges. With the exception of Perth and Brisbane, real gas prices charged to households increased in all capital cities between 1990-91 and 2000-01 as cross subsidies were removed and supply reflected full cost.

Transport Reform

The delivery of water and energy to consumers via on-site meters has supported the implementation of a user pays approach.

In contrast, the lack of monitoring of road and rail access has led to very different reforms in the transport sector.

Rail

Traditionally, the rail industry has been a fragmented system with priorities developed at the state rather than national level and the financial performance of the sector relatively poor due to low usage and high maintenance costs. The use of bulk haulage charges, particularly for coal, was viewed as a cross-subsidy to fund intermodal freight and passenger services.

Since the 1980s, productivity has increased as a result of longer trains and higher axle mass limits, increased utilisation of the network following major investments (such as longer passing loops) and structural and regulatory reforms (PC 2006, p.92). Rail operators were fully vertically integrated until third party access regimes were introduced as part of the National Competition Policy (NCP) reforms.

Roads

Petrol excise has been in place since the early 1900s and in 1957 the base was expanded to include diesel fuel. Fuel excises were formally hypothecated as road grants to expand and upgrade the road network between 1926 and 1959 and then between 1982 and 1988 (PC, 2006).

In 1992, heavy vehicle charges, known as the Pay-As-You-Go (PAYGO) approach, were introduced to recover heavy vehicles' share of road spending. The National Transport Commission determines the costs of road expenditure attributable to heavy vehicles and allocates a share of the common costs of road provision such as the cost of street lighting to heavy vehicles. PC (2006) reports that given recent increases in expenditure, it is unlikely that heavy vehicle charges currently are sufficient to recover the network costs attributed to those vehicles. Also heavy vehicles that travel less than average and carry lighter loads cross subsidise better utilised heavy vehicles (pp. 118-122). Furthermore, PC (2006) cites that network average charges under PAYGO convey negligible signals to road users about the costs of them using particular roads and there is a 'disconnect' between road charges and future road spending. These shortcomings indicate that there is still progress to be made with the current heavy vehicle charges scheme.

Light vehicles are also charged in cities that have introduced toll roads. Cost recovery schemes have been in place for many years with Sydney's Harbour Bridge and Tunnel, and Brisbane's Gateway Bridge. Tolling has increased over the last decade as new urban motorways have been constructed in Melbourne, Sydney and Brisbane with the tolls contributing to the funding of projects.

3 Creating infrastructure efficiencies through user-pays

Creating efficiencies in the transport network can contribute to Australia's productivity, liveability and sustainability through reducing congestion and pollution.

Unlike water and energy infrastructure, roads are not subject to user pays pricing rules. As such, there are few clear signals for road providers and users alike about appropriate levels of usage and investment.

Traditional taxes on road use, such as fuel excise and registration fees are ineffective in dealing with congestion. The pressures of escalating urban congestion costs, limited financial capacity to expand the road network and issues of land availability have focussed policy attention on the potential role of congestion charges as a more direct way of managing road use in urban areas. The growing adoption of congestion pricing in other countries, combined with improved technology, has strengthened interest in Australia (Wachs, 2003).

Economic rationale for congestion pricing

Congestion pricing is often judged on its financial, political or technical success. It is its economic success, however, that determines whether it is in the community's interest.

The cost of road use is reflected in the final output prices of nearly all goods and services. Inefficient use of the road infrastructure distorts the allocation of resources within the transport sector and throughout the whole economy. The economic case for congestion pricing depends on whether it increases efficiency: whether the overall benefits are greater than the costs.

Congestion pricing is based on a simple economic rationale that road space is often a scarce commodity. At certain times during the day, more people want it than can be accommodated without congestion. To limit overconsumption, a fee can be charged for the use of the road, forcing users to understand the true costs of their driving and modify their behaviour according to their willingness to pay.

The economic ideal is to face each user with the full cost of their actions, including the cost imposed on others and the effects on the environment. In economic jargon, an appropriate road use charge can 'internalise the externality'. That is, the costs to others are transferred back to the user so their decision reflects the full cost their travel imposes on society.

Charging for road use sets a price for the decision made to use a road at a particular time, enabling road users to weigh up the cost against taking alternative modes of transport, taking trip at another time (off-peak), or consolidating trips. It encourages people to use roads and other forms of transport more efficiently.

It also provides a price signal on the value users place on road services, which provides information for efficient investment decisions. Congestion pricing presents an opportunity to get more value for money of both existing capacity and new capacity and can provide a source of funding for new infrastructure.

Congestion can be reduced through both mode shifts and trip reduction. Drivers who do not value the ability to travel on that road at that time will not drive on it and the road will become less congested. Drivers who are not willing to pay a price will:

- drive at a different time
- share cars
- change destinations
- change routes to the same destination
- change modes of transportation
- decide not to travel.

The drivers who are willing to pay will reduce their journey times and have less variation in journey times. The road space is allocated more efficiently to the highest valuing users.

The environmental impacts from idling, emissions and noise pollution from congestion are reduced.

Valuing Road Use

For any scheme to reduce congestion, it must reduce the number of vehicles or use revenue to build new roads. In the case of most Australian capital cities, reducing the number of vehicles means those who have no choice but to travel during peak congestion periods will need to make a modal shift to public transport or share travel.

When the value of time differs among road users, high value users may be made better off – that is, their value of the time savings exceeds the toll paid. One group of users with a high value of time (and so a high cost of delay) include business users and freight transporters. For example, Table 3.1 sets out the Austroads' estimated average value of time for occupants of different types of vehicle in urban areas in 2002, with business users having two to three times the value of time than private users. Further, cars average more than one occupant per vehicle. Freight vehicles incur a further freight travel time cost, amounting to $20-40 per hour for articulated and larger trucks in urban areas.

Table 3.1 Value of time for urban vehicle occupants

Vehicle	Value of time
Private vehicle	$9.23 per person-hour
Business travel	$29.52 per person-hour
2-axle rigids	$19.69 per person-hour
Articulated trucks	$20.94 per person-hour
Road trains	$22.71 per person-hour

Source: Austroads (2004, table 8, p.12)

There is potential for business users to gain from congestion pricing, although the optimal tolls for trucks are greater than for cars, because they produce more congestion and pollution costs. Congestion is affected by vehicle type. For example, larger and heavier vehicles cause more congestion than smaller, lighter vehicles because they occupy more road space, require greater braking distances and have slower acceleration. The relative effect on congestion of different vehicles is measured in terms of 'Passenger Car Equivalents' or PCEs. Large trucks and buses generally have 1.5–2.5 PCEs.

Although high income earners tend to have a high cost of time, it is not necessarily true that road users with a high cost of time are high income or that the road users 'tolled-out' are low income. For example, experience with charging for express lanes in the US is that most people who use the express lanes do so intermittently, and the mix of incomes using the express and the free lanes on any given day overlaps considerably. This may reflect users' desire for fast, congestion-free journeys at specific times and for specific purposes. That is, optimal tolled lanes provide users with a choice where, on occasion, they may be prepared to pay for faster travel times (BITRE 2008, p.79).

Delivering real benefits

The most important outcome of any congestion pricing scheme is that the revenue is used to benefit those who bear the cost of the scheme – those that pay for continued road use and those that change their behaviour to reduce the number of cars during congested times.

Congestion toll revenues should be used to create a broader coalition of winners from the policy change, for example, a mix of spending on transportation alternatives, road improvements and reductions in other taxes.

Cost of implementing congestion pricing

It is technologically feasible to implement a distance based pricing system that varies the toll motorists pay based on both the distance traveled and the time of day or traffic conditions, but there will always be trade-off between the cost of the system and the accuracy of charges. The administrative costs involved in setting and charging prices and collecting relevant information should be taken into account and set against efficiency gains. It might not necessarily be best to have a perfect pricing scheme reflecting all variations in marginal cost as the cost of implementing finely differentiated charges may exceed the benefits. For example, it may be better to use cordon pricing in a downtown business district, combined with a network of tollways in surrounding suburbs.

Setting a price

The most critical component of introducing a congestion pricing scheme is to set appropriate charges for a network that reflects the level of congestion and environmental damage.

If the toll is set too low, then the full potential gains from congestion pricing would not be realised. If the toll is set too high, it could reduce efficiency and be worse than doing nothing. The loss to road users could be greater than the revenue and environmental benefits. Any accompanying fall in fuel tax revenue would reduce efficiency further.

Each congestion pricing scheme needs to have an efficient price set based on the costs and benefits that each scheme aims to deliver. As congestion is generally time-related, differential pricing depending on the time of day will be a likely outcome for most schemes.

4 International experiences

Road authorities around the world are grappling with the twin pressures of congestion and funding constraints.

Congestion pricing has been adopted in a number of cities in Europe, Singapore and the United States. However, the international experience has been mixed. The lessons learned from the design and implementation of international schemes can provide crucial lessons for delivering successful schemes in Australia.

Types of road-user charging used internationally

There are a number of types of road-user charges used in other countries. They can be broadly divided on geographical grounds and can have differential charges based on mass-distance-time:

- **Cordon:** where vehicles are charged for entering a designated area
- **Area or zone:** where vehicles are charged travelling within, into and out of a designated area
- **Corridor or facility:** where vehicles are charged for travelling along a specific segment of road network. Charging is often based on distance travelled or accessing a facility such as a bridge or tunnel.

Charges that vary directly with the traffic levels (usually proxied by 'time of day') rank as congestion charges.

The London scheme, introduced in 2003, is probably the best known congestion charging scheme. Singapore has a scheme that has been operating for more than 30 years. Both schemes are widely regarded as successful.

Further variations within the above broad categories are possible and examples of these charging systems are provided at Table 4.1. Technological advances have facilitated the development of increasingly sophisticated congestion pricing systems and undoubtedly will continue to provide more options for charging road users in the future. These examples provide useful lessons in how congestion pricing systems would most benefit in Australia.

Table 4.1 Selected congestion pricing schemes: Implemented

Scheme	***Stated objective***	***Response***
Cordon		
Singapore 1975 area licence 1998 electronic congestion pricing	Reduce congestion; maintenance of travel speeds	13 per cent fall in traffic
Stockholm 2006	Reduce congestion, improve environment and fund public transport	20 per cent fall in traffic
Trondheim 1991 initiated 1998 expanded to time-of-day pricing 2005 pricing scrapped	Originally to finance new infrastructure, then used to manage congestion	Met the financial goals and then reduced congestion by 5 per cent. Scheme was stopped but now there is pressure to have congestion pricing reintroduced.
Area or zone		
London 2003 2007 – area extend	Reduce congestion and fund public transport	30 per cent fall in traffic
Corridor or facility		
91 Express Lanes, Orange County, California 1995	Finance 91 Express Lanes and reduce congestion elsewhere	50 per cent reduction in travel time in peak periods
Salik, Dubai 2007	Congestion charges on selected roads and facilities	25 per cent reduction in traffic and halving of journey times
Interstate 15, San Diego, California 1999	Improve HOV lane utilisation ; part fund public transport, and test efficacy of congestion charging	Peak period travel time reduced by approximately 20 minutes to six minutes

Table 4.2 Selected congestion pricing schemes: Proposed or Rejected

Scheme	*Stated objective*	*Response*
Cordon		
San Francisco 2004-2010	Reduce congestion	Under review
Hong Kong Trialled in 1983	Reduce congestion targeting private car road usage	Rejected, largely for privacy reasons
New York 2008	Reduce congestion, improve environment and fund public transport	Contentious with neighbouring boroughs, due to delays a Federal grant was reallocated. Scheme shelved.
Edinburgh 2005	Reduce congestion, improve environment and fund public transport	Contentious with neighbouring boroughs. Rejected by referendum.
Greater Manchester, Bristol, Leeds, Cambridge and others	Reduce congestion improve environment and fund public transport	Promoted through Britain's Transport Innovation Fund (TIF) as a precursor to a 2015 national scheme. Schemes shelved following rejection by Manchester's boroughs.
National Scheme		
The Netherlands Successful trial (one city area) completed February 2010	Replace fixed costs of vehicle ownership with a variable cost (road-user charge) based on kilometres travelled later on congestion levels.	Decision on hold

London – a detailed case study

The roads in London are severely constrained and have long struggled to cope with modern traffic levels and congestion has been a major problem for decades.

The development of congestion pricing in Britain can be traced to the 1964 Smeed Report, which introduced the concept of congestion pricing as a way to influence road user behaviour and ensure more efficient use of the network.

In the early 1970s, studies commissioned by the Greater London Council recommended a paper-licence system, presumably along the lines of the original Singapore scheme (described below). However, it was not until the mid to late 1990s that congestion pricing gained momentum as a measure to address increasing traffic growth and pollution. The Road Charging Options for London Study presented recommendations formed the basis for the London scheme (BITRE 2008, p.123).

A decade later, research undertaken for the London Planning Advisory Committee concluded that the management of congestion was central to transport policy in London (Dix 2002). In August 1998, the Review of Charging Options for London Working Group was formed to provide an assessment of congestion pricing options available to the new Mayor of London (Government Office for London 2000).

In 1991 increasing concern about congestion led the Department of Transport to commission the London Congestion Charging Research Programme. The study was published in 1995 and reported that the introduction of congestion pricing in London would reduce congestion, yield net revenues and provide a rapid payback on the initial costs in both financial and economic terms.

The London congestion charge was introduced in February 2003, charging general road users £5 a day to drive within the central city zone between 7.00 am and 6.30 pm, Monday to Friday—an area of 21 square kilometres. There are many exemptions, including buses and emergency vehicles, licensed taxis, some alternative fuel vehicles and motorcycles. Residents of the zone qualify for a 90 per cent discount.

The congestion that ate London

"By the 1990s, the average speed of trips across London was below that at the beginning of the twentieth century—before the car was introduced (Newbery, 1990, p. 35).

Traffic speeds in central London had fallen more than 20 percent since the 1960s, from an average 20.5 kph for the morning peak period in 1968 (and a high of 22.9 kph in 1975) to 16.1 kph in 1998. Even in the larger area of inner London, drivers in 1998 spent almost 30 percent of their time stationary during peak periods and more than half their time travelling at speeds of less than 16 kph (Department of the Environment, Transport and the Regions, 1998).

By 2002, the all-da*y average travel speed in central London was just 14.3 kph), compared to an uncongested* (night-time or "free flow") average speed of around 32 kph)."

The daily fee allows the driver to enter and leave the charging zone as many times as desired throughout the day. Each vehicle's number plate is recorded using automatic number plate recognition technology. The vehicle registration number is stored in a database and compared against a database with payments for that day.

In June 2005, the charge was increased to £8 a day and the charge period shortened to end at 6.00 pm, in response to requests from the theatre sector.

Figure 4.1 The London charging zone.

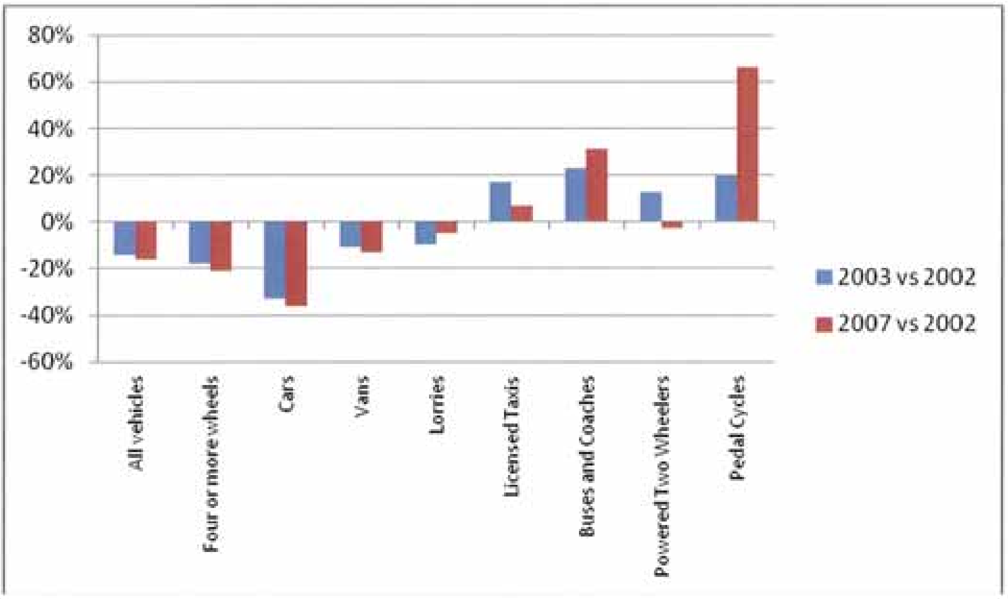
Source: http://www.iapsc.org.uk/document/1208_Richard_Atkinson_1.pdf

In 2007, the charging zone was extended westward to include the Western Extension Zone, despite the overwhelmingly negative response to Mayor Ken Livingstone's consultation process. Transport for London (TfL) reported a 14 per cent reduction in the traffic volume entering the extended zone in 2008. May 2008 saw the election of a new Mayor, Boris Johnson, who promised to remove the Western Extension Zone from the scheme. Following the adoption of the Draft Mayor's Transport Plan in 2010, TfL will start the final part of the legal process to end congestion charging in the WEZ before 2011.

In 2007-08, annual operating costs were £131 million and revenue £268 million. For the first 10 years, the net revenues from the scheme are required to be spent on measures relating to the Mayor's Transport Strategy (TfL 2008, p.220). In 2007-08, just over 80 per cent of net revenues were directed to bus network improvements. The remaining amount was largely spent on upgrading roads and bridges.

In London, the road system became less 'car user friendly', in that the number of access points to the charged area was reduced and some general lanes were converted to bus lanes.

Figure 4.2 Year-on-year percentage change in vehicle kilometres driven within the London charging zone during charging hours, annualised weekdays for 2002-2007



Source: derived from http://www.konsult.leeds.ac.uk/private/level2/instruments/instrument001/l2_001c.htm

Evaluations focusing on the economic success of the London scheme have produced mixed results. As noted in BITRE (2008) the conclusions reached depend critically on the assumptions adopted. The more favourable benefit cost analysis has produced ratios of around 2.0 and 2.5 with £5 and £8 charges, respectively. However, other analysts, such as Prud'homme and Bocarejo (2005), point to the high operating costs of the scheme and, based on the £5 charge, concluded that the economic costs exceed the economic gains. The scheme's operating costs tend to be around 10 times those of the Stockholm, introduced at a later date.

Leape (2006) concluded that from an operational and political point of view, the London scheme is a success. He is more circumspect about the economic gains, observing 'that net benefits of congestion prices seem to be positive, but less than commonly anticipated' (p. 173).

In terms of transferability of the 'success' of the London scheme, it is generally concluded that London is a special case in that there was a unique combination of features in London that had a strong bearing on the outcome of the scheme:

- traffic congestion in London was severe, even by the standards of other large cities in high-income countries
- road capacity is limited as Litman (2006, p.1) observed, 'the streets network in the core area has hardly expanded since the medieval ages'
- peak period trips by private cars were a minor share of the traffic, accounting for around 10 per cent
- London is endowed with relatively good travel alternatives: a comprehensive and well-functioning public transport system, taxi and walking options
- London's geography and roads made drawing a boundary around inner London relatively simple.

Singapore

Singapore introduced a cordon based congestion charging scheme in 1975, using paper based licenses. An electronic system was introduced in 1998, which allows vehicles to be charged automatically as they enter the restricted zone. A gantry system is deployed in conjunction with in-vehicle units in which a stored-value smart card is inserted.

In contrast to the London scheme, the rates vary by time of day, vehicle type and location of the gantry. Rates are reviewed quarterly to maintain optimal travel speeds of 45 to 65 kph for expressways and 20 to 30 kph for arterial roads. Traffic speeds in the CBD remained in this optimum range of 20 to 30 kph (Santos 2005, p.525).

Further gantries were introduced in 1999 to manage congestion outside the city and in 2005 for home-bound trips on a major expressway and for intra-city traffic in the shopping district (Chin, 2010). More recently, the charges were revised to manage intra-city traffic through ensuring that vehicles travelling solely within the city roads were included in the charging system (Chin 2010, p.10).

The cost of operating the scheme has remained about 20-30 per cent of total revenue collected (Chin 2010 p. 8).

In terms of congestion management and technical performance, the scheme is widely regarded as a success. However there are a number of factors that require caution when considering the transferability of the Singapore scheme:

- Singapore is a densely populated island state with severe land constraints
- government policies restrict car ownership through a quota scheme, supplemented by punitive taxes
- the government is stable and secure and there was little chance that it would be put at risk by any political backlash to the scheme.

Stockholm

The Stockholm congestion charge was trialled from January 2006 for a seven month period.

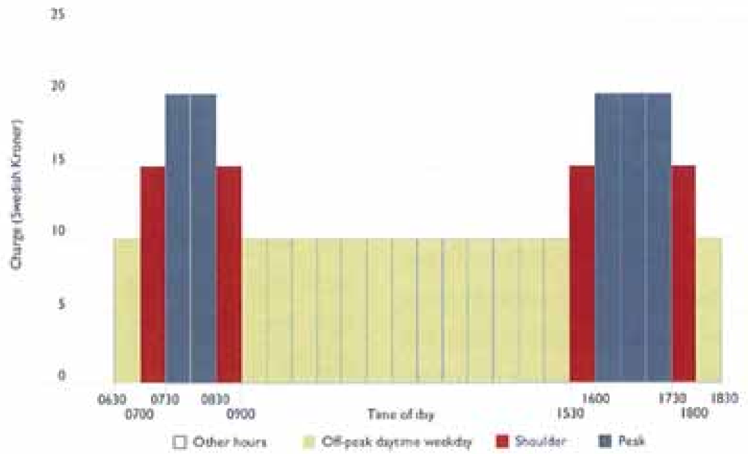
Public acceptance of the scheme increased throughout the trial period from under 30 per cent prior to the introduction to over 50 per cent towards the end of the trial (FHA 2008, p.11). The referendum held after the trial saw just over half of respondents in the Stockholm municipality in favour of adopting the scheme. A separate referendum held *outside* the Stockholm municipality revealed that just over half of respondents were against the adoption of the scheme.

Main features of the Stockholm scheme are:

- electronic tolling only
- charge incurred when crossing the cordon
- daily cap of three peak tolls (60 kroner)
- peak period charges double those during the middle of the day (10 kroner)
- non exempted vehicles pay the same toll, regardless of size
- no tolls are payable between 7.00pm and 6.30 am.

The largest project of its kind in Europe, the scheme today covers more than 23 square kilometres of Stockholm and has reduced traffic in the Swedish capital by around 20 per cent.

Figure 4.3 Structure of Stockholm's Congestion Charges



Source: BITRE (2008) p. 68

There is evidence of modal shift including an additional 45,000 public transport trips of which two thirds are attributable to the charge (Prud'homme and Kopp 2006, p.17). So about half of those no longer driving shifted to public transport.

Similarities with London are worth noting. In both cities public transport plays a major role in the daily commute. In London, around 85 per cent of commuters use public transport. In Stockholm, public transport accounts for almost 70 per cent of daily commuter trips (TOLLROADSnews 2007a). Also approximately one million person trips of the four million in the Stockholm region involve trips through, into, or out of the central congestion charge zone. 69 per cent are now by public transport, 26 per cent by car which represents a slight shift to public transport. In London, there are around a million person trips daily into the central charging zone (TfL 2002, p.3).

The major difference is in the cost of both schemes. The Stockholm system, while larger in scope, was only slightly more costly to London in terms of capital costs. However, the Stockholm system costs a tenth to operate due, in part, to the higher degree of automated identification and payment processes in Stockholm (Hamilton 2010, p. 8).

United States

The United States has pioneered High Occupancy Toll (HOT) lanes - tolled lanes, with exemptions for High Occupancy Vehicles (HOVs). These are dedicated lanes alongside general traffic lanes, where high occupancy normally requires a minimum of two occupants (HOV2), with some cases where three is the minimum (HOV3).

Increasingly, these systems are adopting congestion pricing to ensure the smooth flow of traffic. Two examples have applied congestion pricing since their inception: 91 HOT Lanes and the I-15, both in California.

> State route 91 HOT Lanes
>
> The traffic flow on the tolled lanes during peak hour averages 100 kph compared to 25 kph for road users of the free lanes (FHA 2008).
>
> The unique aspect of the 91 HOT Lanes is that as the toll lanes diverge from the express lanes, drivers are able to see the level of congestion ahead and then decide whether to enter the toll lanes or stay on the free lanes. Vehicles with three or more occupants (HOV3) are able to use the Express Lanes free of charge except during peak period on weekdays.

State Route 91 HOT Lanes

The State Route 91 Express Lanes is a four-lane, 16 km toll road built in the median of California's Riverside Freeway (State Route 91) connecting Los Angeles to the dormitory suburbs. The facility is the world's first fully-automated toll facility and the first application of charging in the US. It is also the first privately financed toll road in the US in more than 50 years.

Travel time for the 29 km eastbound afternoon peak trip portion of State Route 91 that included the toll lane corridor dropped from seventy minutes in June 1995 to just under thirty minutes in June 1996 (Boarnet and Dimento 2004, p.28). Average peak period travel speeds on the eastbound free lanes more than doubled as traffic diverted to the toll lanes (Boarnet and Dimento 2004, p.28).

The increase in travel speed is due to both the expansion of the highway and the introduction of the congestion charge.

Interstate 15

In 1996, the conversion of a 13 km HOV2 lane along a section of Interstate 15 in San Diego represented a major step to real time charging based on congestion levels. In March 1998, the flat fee monthly US$70 pass was replaced by an automated dynamic system where tolls ranged between US$0.50 and US$4. Tolls are calibrated to maintain 'free-flow' conditions, and may vary every six minutes.

The current toll level is displayed on a real-time sign post in advance of the entry to the lane. Tolls are deducted using transponders and over-head readers. A similar scheme has since been introduced in Houston, Texas. In addition, higher peak fees on existing toll roads and bridges have been introduced in Lee County (KonSULT database).

Dubai's Salik

In July 2007, congestion charges were introduced to selected bridges and roads in Dubai - a first for the United Arab Emirates. In September 2008, further toll gantries were added. Motorists pay four dirhams ($1.10) each time they go through the new toll points, paying a maximum of 24 dirhams ($6.70) in any one day.

The first phase led to a reduction of traffic on the charged areas of 25 per cent, halving the journey time on primary corridors and doubling the average speed from 40 to 80 kph (AME 2008). The system offers drivers alternative free bridges and roads, however this has also resulted in driver behaviour creating congestion in previously uncongested areas as they avoid the tolls.

Proposed and rejected schemes

While there are important lessons to be learnt from those schemes currently in operation, for Australian cities, there is also a lot to be learnt from schemes that have either been rejected or have still to reach the stage of the final decision.

Edinburgh

The City of Edinburgh in Scotland had advanced plans for a congestion pricing scheme, which it took to a referendum in February 2005. The scheme involved a daily charge of £2 to cross the double cordon: one around the historic city centre and the other around the ring road. The outer cordon would be restricted to the morning peak (7am to 10 am) while the one around the historic centre would operate most of the day (7am to 6.30pm). Like the London scheme, automatic number plate recognition technology would be used to enforce the payments. Net revenues generated by the scheme would be allocated to public transport.

The results of the referendum were unequivocal: almost three quarters of votes cast rejected the proposed scheme. Transport Initiatives Edinburgh attributed the public rejection to the following issues:

- absence of a focal champion of the scheme
- inconsistent political will
- significant opposition from a broad group of stakeholders, including the councils and residents from the contiguous boroughs, retailers and transport groups
- unclear commitment from the local authority to investing in transport alternatives and improved infrastructure before the congestion scheme was implemented (Cain & MacAulay, 2004).

Other UK schemes outside London

In June 2005, the Government announced the establishment of the Transport Innovation Fund (TIF) to provide £2.5 billion to fund local authorities to implement local congestion pricing schemes. This was seen by the Government as a precursor to nation-wide charging.

The future of the Government's stated plan to introduce a national road pricing scheme by 2015 hinged on the success of the local congestion pricing schemes:

> *...in accordance with the Department's evidence-based approach to policy making, the Department decided that the best way forward was for congestion pricing pilot schemes to be set up to see whether a wider scheme would be viable (Butcher 2008, p. 7).*

Several local authorities made bids for TIF funds, with the Government announcing Greater Manchester's TIF bid had been granted 'programme entry' and would receive almost £2.8 billion to support improvements in public transport and a congestion pricing scheme for central Manchester. The plan was for a dual cordon scheme, an outer cordon of Greater Manchester and an inner city centre cordon with variable congestion pricing arrangements.

Support for the scheme was divided and the political parties used the issue for their own ends. Community dissatisfaction led to a public referendum, the charging scheme would go ahead if voters in seven out of the ten affected councils voted in favour. On 12 December 2008, it was announced that almost 80 per cent (of the just over one million people who voted, a 53 per cent turnout) rejected the charge, with a significant 'no' majority in each of the ten council areas (Butcher 2009, p. 12). The main reason for the failure was that it became a political issue and did not receive cross party support. This was despite concerted education programs to promote the proposed TIF investment to upgrade and extend the existing transport infrastructure.

This represented a major setback to the UK Government's plans for widespread adoption of congestion pricing ('charging schemes in 20 towns and cities by 2010'), widely regarded as a prelude to the introduction of a national scheme in 2015. A number of other cities that had been developing their own schemes, in response to the Government's Transport Infrastructure Fund (TIF) inducements, quietly shelved their plans for congestion pricing.

San Francisco

The San Francisco County Transportation Authority is nearing the completion of a Mobility, Access and Pricing Study (MAP Study) into a proposed congestion pricing scheme. The Authority began investigations into a scheme in 2004 following the success of the London congestion charge. As part of the United States Department of Transportation Urban Partnerships Congress Initiative the city will receive federal funds to support the program. A range of cordon options are being considered and an extensive environmental study has been undertaken to model the impact on the broader community. The particular geography of San Francisco and its relationship with the hinterland is a critical element to the depth and scope of the MAP Study.

The intent is for the scheme to use the existing FasTrak transponders used for tolling on the Bay Area bridges combined with cameras. Congestion fees are anticipated to be around US$3 to enter, leave or pass through parts of the city at peak times (Cabanatuan 2008). Concerns have been raised at public meetings and from lobby groups regarding the impact on commerce, the knock on effect to neighbourhoods bordering the cordoned area, the cost impact on low-income commuters and the capacity of alternative modes to manage additional demand. The current consultation program intends to address the issues raised from the public consultation process.

The Netherlands

The Netherlands has been developing a nation-wide road-user charging system for more than a decade. In February 2010, the completion of a successful trial was reported. Conducted in the city of Eindhoven, success was judged by: satisfactory performance of the technology; a decline in traffic congestion, a reduction in both vehicle kilometres travelled and vehicle emissions.

In 2001, the *Anders Betalen voor Mobiliteit* or Payment-For-Mobility scheme was introduced. Revenue neutrality was regarded as an important feature of the scheme. Accordingly, the variable usage charge would replace the fixed taxes associated with motor vehicle use (vehicle ownership and sales taxes). At a later date, the scheme would be refined to accommodate time-of-day charges to reflect congestion levels. Modelling indicated that, initially, more than half of the road users would pay less under the new system.

By December 2007, the Dutch Transport Minister felt confident enough to announce that a road-use charge, based on GPS technology, would be implemented in 2011 for heavy vehicles and 2012 for passenger cars with full national coverage achieved by 2016.

In April 2009, certification and tendering began for the scheme and phasing out of fixed motoring taxes was initiated. Presented as a 'green' road tax, the system gained Cabinet approval in December 2009. Camiel Eurlings, the Minister of Transport, introduced the enabling legislation into Parliament. Subsequently, his party the Christian Democrats, decided to oppose it. The Dutch Government fell in February 2010 on an unrelated matter. Given the opposition by the Christian Democrats and their strong role in the new coalition government, it could still be some time before a scheme is implemented.

Measuring success

The success, or otherwise, of congestion pricing schemes operating around the world, depends on how success is defined. Welfare economics focuses on the long term pursuit of the community interest, determined normally by evaluation techniques, such as benefit and cost analysis.[2] In the case of congestion pricing, the costs include the loss of welfare for those that are 'tolled-off' and for those that pay the toll but are still worse off than previously. Revenue from the charges is not included as a benefit since, from the perspective of the community, it is a straight transfer between two groups within the community.

With congestion pricing schemes, inevitably there will be ambiguity about the calculation of the economic benefits and the costs, as evidenced by the differing views on the economic benefits of the London and Stockholm schemes. Hence, it is not surprising to observe that most established schemes are regarded as successful if they reduce congestion, the technology works and do not impose 'too onerous a burden' on motorists. These factors are much more readily measured than 'economic success' and hence, more easily agreed upon.

In essence, for policy makers concerned with the reality of daily congestion, a scheme would generally be ranked as successful if it provided economic benefits for the broader community and reduced the level of congestion.

2 Economic benefits and costs would normally incorporate externalities, such as environmental impacts.

For the Singapore, Stockholm and London schemes, the main objective was to reduce congestion. For the Singapore ERP, success was defined by achieving target travel speeds:

> *Given that revenue was not the reason for ERP [Electronic Congestion pricing], there were no explicit cost-benefit assessments, although there was much effort to contain the costs of implementing and operating the system. Instead, it relied on the outcome in terms of observed travel speeds on the roads to gauge the effectiveness of the ERP (Chin 2010 p. 8).*

Technical success will always be a prerequisite to political success, as a high error rate in the monitoring process would seriously undermine public support.

Financial success is also linked with political success, in that a scheme that produces net revenue for funding other projects, would often be easier to sell to the public.

Environmental benefits would also add to the 'success score', although these can be difficult to measure since air quality is complicated with many factors, including the prevailing weather conditions. Further, schemes such as London and Stockholm account for only a small area within a much larger urban zone.

The Third Annual Monitoring Report produced by Transport for London concluded that in 2005, CO_2 levels were down 20 per cent and fine particle matter (PM10) down 12 per cent. It is safe to assume that if VKT has declined and vehicles are operating at a more efficient speed, fuel use will be reduced and, accordingly, emissions will decline.

Lessons from international experience

The lessons from the international experience have been mixed and require careful interpretation when applying them to Australian congestion issues. The findings suggest that congestion pricing can be a useful tool to manage and influence road user behaviour but the experience also shows that success depends on many inter-related factors. Significant lead time and planning, while critical, does not guarantee that a congestion pricing system will reach implementation stage. Where schemes are introduced permanently, it will be necessary for the scheme to be adaptive to changing circumstances, whether it be traffic flows or technology changes.

Table 4.3 Key lessons from international experience

Lesson learnt	Discussion
Behavioural change	**The core feature of a successful congestion pricing scheme is one that brings about behavioural change. If there is no change in behaviour, then the congestion charge operates as a tax with the sole purpose of raising revenue.** Given that schemes are costly to implement and operate, congestion pricing is a high cost way of raising revenue. The charging schemes discussed in this chapter have all resulted in a fall in traffic levels compared to pre-charging periods. However this is due to both congestion pricing and other improvements to public transportation and expansion/contraction of the road network introduced along with congestion pricing. Behavioural change is likely to be more forthcoming where there are more alternatives to peak period driving. To some extent, this will rely on whether public transport is regarded as a close substitute for driving.

Lesson learnt	Discussion
Transport alternatives	**Schemes have been more successful where alternative modes of transport are in place.** Without a good public transport system the level of charges would need to be significantly higher in order to achieve the necessary driver behaviour change (BITRE 2008, p.57). In conjunction with the implementation of the London scheme, an extra 11,000 spaces were provided on London's buses during peak hour while in Singapore both the rail network and the quality of bus services were improved (Santos, 2005). In Stockholm, an additional 200 buses at a cost of SEK 580 million (AUD$ 88 million) were introduced during peak hours in line with the introduction of the congestion charges. However, the increase in public transport patronage was associated with a deterioration in service quality. Punctuality declined by about 5 per cent in the subway and cancellations increased on subways and trains (Prud'homme and Kopp, 2006). This highlights the need to recognise the role of capacity constraints on public transport networks in limiting mode shift.

Lesson learnt	Discussion
Community engagement	**The recurring theme in the international literature on congestion pricing is the importance of gaining public support for a scheme. This, it is argued, will be more readily achievable if road users regularly experience high levels of congestion and if the opportunity exists for users to trial the scheme before endorsing it.** A lack of experience and 'erroneous subjective predictions of effects' is seen as the source of much opposition (Brundell-Freij *et al* 2009). An example of this is in Stockholm, where there was a significant increase in support for the scheme after a seven-month trial. This was principally due to: • familiarity with the scheme, including an appreciation of the favourable impact on congestion and travel speeds within the area; • a commitment to allocate the net revenue raised to the road network, reversing the previous Government's pledge to allocate the revenue to public transport (TOLLROADSnews 2007b); and • the rebranding of the congestion charges as 'environmental charges' (Eliasson 2010, p. 11) An element of choice can be an important factor in gaining popular support for congestion pricing. The conversion of underutilised High Occupancy (HOV) lanes in the US to High Occupancy Toll (HOT) lanes provides drivers a choice of paying for a faster journey or using the free general lanes.[3] Choice of payments methods will also add to the acceptability of a scheme.
Technology	**The choice of technology has a significant impact on the cost and effectiveness of a scheme.** For instance, the London scheme is costly to operate in part because of the manual checking required of the infringements. The Stockholm scheme is more automated, with significantly lower operating costs compared to London. There is invariably a trade-off between adopting relatively safe, 'off the shelf' technology as was used in London and the risk of delays and technical glitches with something more cutting edge, as with the German GPS/GSM based lorry charging scheme.

3 Hence the development of the more marketable term 'value pricing'.

Lesson learnt	Discussion
Legal and institutional barriers	**The lack of integration between transport (both public and private) and urban development is a major barrier to major changes in how urban road use is paid for.** The split of legal responsibilities across councils and transport authorities can inhibit the development of a coordinated approach to deal with congestion. A single implementation agency, such as Singapore's Land Transport Authority (LTA) or London's Transport for London, is important for a successful scheme. In recognition of the need for a more coordinated approach to urban transport issues, the LTA has announced that it will take over responsibility for public transport in early 2010 Further, institutional taxation arrangements make it difficult to implement a revenue neutral option for congestion pricing. For example, a state government would have to negotiate with the Federal Government to reduce fuel excise if that was one of the options to pursue revenue neutrality.
Costs of implementing and operating schemes	**Implementation costs, as in the case of the London scheme, can be high and bring into question the benefits of introducing a congestion pricing system particularly if the impact on road user behaviour is minimal. Advances in technology are reducing implementation costs.** Alternative financing sources such as public private partnerships can provide an alternative to publically funded charging systems. However, the SR 91 provides some useful lessons for private sector involvement particularly in terms of restrictive contracts that may impinge on the charging system from being modified or the road network expanded in response to changing road user demand patterns.
Revenues generated	**The lesson from international experience is that there has been greater acceptance when revenues are directed at public transport and improving roads rather than going to general revenue.** For the first ten years under the London scheme, net revenue is earmarked for public transport. In contrast, revenue in Singapore forms part of the government's consolidated revenue. However, to offset the higher road-usage charges, the Singapore Government reduced the annual road-taxes, to achieve an overall revenue-neutral impact of the ERP to the government (Chin 2010, p.7).

Lesson learnt	Discussion
Exemptions	**Exemptions can have a significant detrimental impact on the effectiveness of the scheme.** The logic of 'no exemptions' is straightforward - a charge to internalise the congestion externality should apply to all vehicles that contribute to congestion. The extensive list of exemptions for the London and Stockholm schemes contrast with the Singapore ERP where exemptions have gradually been removed and now only emergency vehicles are exempt.
Congestion levels	**An absence of serious congestion is a major barrier to the introduction of congestion charges.** The greater the congestion, the greater will be the gains from a scheme. The benefits achieved by reducing traffic by about 15 per cent are about ten times larger in London than in Stockholm simply because London was much more congested than Stockholm (Prud'homme and Kopp 2006, p.31).

5 Congestion Pricing in Australia

As congestion pricing is used to address congestion in international cities, the question must be asked as to whether successful schemes can be established in Australia. The major attractions of such an option are seen as a reduction in congestion and an enduring source of funding for public transport and road network improvements.[4]

It is a major step from the concept of congestion pricing for a city to its actual implementation. The cities that have adopted congestion pricing have engaged in preparation over a number of years. However, even these years of careful planning do not always lead to adoption, as the authorities in Edinburgh, New York, and Manchester are well aware.

One important conclusion from our review of schemes in London, Singapore, Stockholm and other international cities is that they need to be designed to take into account location specific factors. These factors include:

4 Environmental benefits also feature, although these tend to be more controversial and of a secondary order.

- the geographic size of the zone, usually a city centre, under consideration
- any unique constraints on that zone or accessing that zone, e.g., rivers, seas, islands, railways, airports, bridges, tunnels etc
- the geographic reach of the commuter hinterland and related public transport infrastructure
- the existing proportion of commuters using public transport relative to private transport
- the effectiveness and efficiency (capacity) of the existing transit corridors (road and rail)
- the parking capacity with the zone and contiguous boroughs
- the blend of activities in the zone, e.g., retail, office, manufacturing, education, warehousing, leisure etc
- the political configuration of the zone and the contiguous boroughs
- existing controls and taxes on vehicles and fuel.

Building a business case for congestion schemes

Congestion pricing could improve the outlook for Australian capital cities. However, such policy decisions need to be taken with detailed analysis of individual proposals, taking into account the unique nature of each traffic network and the travelling behaviour of the population.

The economic barriers arising from the difficulty encountered in ensuring that a congestion pricing scheme is in the community interest. A congestion pricing scheme that can operate efficiently, reduce congestion and generate surplus revenue will always produce a net benefit for the community. If charges are set too high then individuals who impose a marginal external congestion cost less than the charge would be discouraged from using the road/area, thereby creating an efficiency loss.

Ideally, charges should:

- reflect marginal external costs
- vary over time
- be based on the trip segment
- reflect actual cost rather than anticipated cost
- apply to all vehicles without exception (BITRE 2008).

Determining the level and structure of charges that would ensure an efficiency gain is a major challenge, made difficult by the complexity of both urban travel behaviour and traffic operations on urban road networks - and the lack of data.[5]

To ensure that a congestion pricing system is community enhancing, the necessary analysis requires microsimulation, using a good quality urban transport model that takes account of traffic flow on individual links. [6]

Types of schemes for Australian conditions

Cordon or area charging

The extent to which Australian cities lend themselves to cordon charging will vary between the cities. Sydney does not appear to be a likely candidate for cordon or area charges since the severe congestion occurs on the approaches to the CBD, rather than *in* the CBD. As observed by Hensher (2003) in his rejection of a specific proposal to pursue a cordon based congestion charge for Sydney, 'much of the traffic moving in the areas adjacent to the CBD does not go through the proposed CBD charging zone.'

Furthermore, both Hensher and Cox (2010) point out that a congestion pricing scheme limited to the CBD (which currently accounts for between 15 and 20 per cent of city employment) would see jobs move out of the CBD to other locations. Hensher identifies a negative unintended consequence of such an option:

> *There is an interesting paradox here – congestion charging limited to the CBD will, in the long term, induce the relocation of offices. These jobs will relocate to locations where public transport is not so good and where greater circumferential travel is required, encouraging the growth in car use. The system-wide impacts will be counter productive.*

5 Aggregate travel (measured as total vehicle kilometres) on the urban network is often used to bypass these complexities. While the data is readily available, this approach involves gross simplifications that are not adequate for sound policymaking.

6 For details of the methodology see BTCE (1996).

Melbourne's different spatial form and travel behaviour mean that the pattern of congestion is markedly different, leading to some researchers advocating the implementation of a cordon congestion pricing system

Corridor or facility charge (toll road)

There are a number of international case studies of successful congestion pricing on a facility, such as California's San Diego's Interstate 15 (I-15) and the 91 Express Lanes connecting Los Angeles to the dormitory suburbs in Orange County. The Singapore scheme has also been extended to include key roads that feed the city centre.

The main recommendation of *Urban transport challenge: driving reform on Sydney's roads*, produced by Infrastructure Partnerships Australia, was that 'the New South Wales Government and motorway operators consider and agree to implement a variable, time of day tolling system for Sydney's various motorways' (Infrastructure Partnerships Australia 2009, p.vii).

This is a different model to the Californian examples in that there are no parallel untolled lanes that drivers can opt to use. However, given that key motorways in Sydney and Melbourne are currently tolled, the challenge would be to develop a different toll structure that more closely reflects the marginal congestion costs imposed by each additional driver that would lead to behavioural change.

If, as in Singapore, the tolls were set to avoid an increase in total payments by motorists, then public support would be more readily forthcoming. This would mean that off-peak tolls were reduced and peak-period tolls increased. It may be that the increase needed in the peak tolls to achieve a behavioural change is so great that off-peak tolls are removed.

There are a number of challenges that would need to be addressed, including:

- determining the level and structure of the charges that would generate a net gain to the community. As with 91 Express Lanes and the Singapore ERP, there would be scope to adjust the charges as the behavioural response is better understood
- renegotiating existing toll road arrangements with the private sector, of which there are a number around Sydney and Melbourne
- coordination of charges across the network
- accommodating the 'tolled-off' that still need to travel during peak periods, either on other (free roads) or on public transport. If, as in Dubai, those avoiding the peak tolls divert to alternative routes, congestion on secondary roads increases and the situation could worsen from the network perspective. Hence, a significant mode shift to public transport is generally regarded as the preferred alternative.

The role of Australia's public transport system

The benefits of congestion pricing are generally directly related to drivers' response to the charges, the greater the response, the greater the benefits.[7] While there are a number of ways of responding (rescheduling or cancelling trips, car pooling, changing routes, etc), there is a great deal of interest in the scope for a mode shift to public transport. This can potentially produce a 'double dividend' if, by increasing patronage, it makes public transport more viable.

In Singapore, London and Stockholm public transport usage increased after the introduction of the charges. However, not all the mode shift can be attributed to the higher cost of motoring as a result of the congestion charges. Part of it will be due to the enhancements in the public transport system. Separating the two is often problematic. Researchers often resort to sensitivity analysis, to enable them to determine, say, the extent of the mode shift that would be required to make a scheme 'viable'.

A major mode shift may create another set of problems in Sydney and Melbourne. A significant influx of new patrons could result in a major deterioration in service levels. While physical capacity could be expanded, this requires a major investment of funds. Improving asset utilisation across the network is certainly seen as an opportunity to improve the way public transport systems currently operate, for example increasing numbers of trains at peak times, and better integration of bus and car access to the urban rail network. Also, if the rate of cost recovery did not improve, then the cost of running the system would escalate. In 2007-08, Sydney's RailCorp's passenger revenue only recovered

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7 Up to a point, of course

approximately 22 per cent the cost of operating RailCorp (NSW Auditor General 2008, p.282). Other Australian cities have a similar cost recovery rates.

Although congestion pricing puts pressure on public transport systems, it creates opportunities to improve public transport services. The dependence of service quality on frequency and route coverage is a form of economies of scale. This means that any modal shift toward public transport can touch off a "virtuous circle" of further cost savings and/or service improvements, hence possibly further modal shifts. There would need to be careful planning to improve public transport services and change behaviours, which should be a key part of Government's planning for any congestion pricing scheme.

However, the major barrier to a significant mode shift towards public transport is the fact that, relative to London, Singapore and Stockholm, public transport does not currently play a large role in the daily commute in Australian cities. In London, at the time of the introduction of the congestion charge, only 10 per cent of commuters travelled by car, with 85 per cent using public transport. This contrasts to Sydney and Melbourne where public transport accounted for 13 and 8 per cent respectively of the daily commute in 2005.

From a political perspective, the low public transport share of peak-period travel means that, potentially, a very large share of those that enter the charged area during peak periods are at risk of being made worse off by the charges. Mees et al (2007), attribute low public transport patronage to land settlement patterns that favour cars over public transport, the construction of urban motorways and public transport service quality.

Low patronage suggests that there is significant scope to expand public transport usage. It could also indicate that public transport is not regarded as a close substitute for private travel. The propensity to shift from car use to public transport is an empirical question that needs to be answered as part of developing a case for congestion pricing.

There is solid evidence to suggest that the public transport systems in Sydney, Melbourne and Brisbane (the cities that account for the bulk of the congestion costs in Australia) could be operated more efficiently.

However, the task is wider than reforming public transport. As identified by many analysts:

> *...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 (Hubbard 2009, p. 9).*

Congestion pricing technologies

Technological developments have enabled a range of congestion pricing schemes to be introduced around the world. In Melbourne, Sydney and Brisbane, electronic tolling systems have been implemented using dedicated short range communication technology in conjunction with vehicle transponders or 'e-tags'. Under this system, users are charged as they pass under tolling gantries that recognise the vehicle's 'e-tag'. It allows the implementation of variable charges.

Currently available technologies are as follows:

The vehicle detection approach

Automated Vehicle Identification (AVI) In-Vehicle Transponders

AVI relies on transponders in vehicles that electronically transmit relevant vehicle information to roadside readers so that the correct toll can be charged. Transponders transmit low-frequency radio signals; they are also known as radio frequency identification devices (RFID).

Microwave transmitters and receivers are positioned over or beside the road, on gantries or poles. This equipment identifies oncoming vehicles and broadcasts a signal, which is returned by a transponder unit on or in the vehicle. If the transponder does not respond, a camera enforcement system is triggered.

Each transponder contains information about the user such as ID number, the toll facility crossed, vehicle type and can be linked to a customer account for automatic deduction and billing. They can take the form of a window sticker or a small plastic package and can range in price from $10 to $40.

Information from the roadside equipment is collated centrally to produce a charge, which could be varied by time, vehicle type and location. This system has been implemented on toll roads in Sydney, Melbourne and Brisbane.

Refinements of this approach include the use of a smart card to enable direct debit of the charge.

Automatic Number Plate Recognition (ANPR) Cameras

ANPR cameras take a series of snapshots of a vehicle as it approaches; when it has gathered sufficient information, it reconciles the number against a list of plates. The technology is heavily dependent on the correct set up of camera, lens, light, angle of view, and configuration. The cameras are more accurate at city speeds than highway speeds and for narrower roadways than multilane highways. Variation in license plate size and type can impact accuracy.

The position sensing approach

The vehicle carries equipment to determine its position on the national road network. This may be done through satellite technology, FM radio, cellular telephony or other means. The equipment in the vehicle tracks its movement and compares it to a network map that is calibrated for charges for roads and sections of roads. The charges can also be varied by time, place and vehicle type. The on-board unit then calculates the charges. Accumulated charges are downloaded from the vehicle either automatically using wireless communication or manually by removing a smart card.

For example, tolling authorities can use in-vehicle Global Positioning System (GPS) units to convey information relevant for vehicles moving within a tolled area. The GPS unit and a wireless communication link are installed in a vehicle. The unit contains information concerning when and how the vehicle should be charged. These devices can be installed during vehicle assembly or added onto a vehicle; these devices are significantly more expensive than AVI transponders.

Manual Toll Collection

The traditional tolling process generally relies on manned or automated cash toll booths. Vehicles need to stop or pause to pay a toll. Toll rates are administered though a point-of-sale type machine. With cash payments, no technology is required for driver to pay fee.

Area Pricing

Area pricing involves charging a fee to drive into an area or zone, usually a city centre or dense urban area. A ring of toll points, or "cordon" boundary, can define the perimeter of a tolled environment, or facilities placed on various intersections can define a given area within which tolling occurs. Area tolling is particularly well suited to areas with a dense urban centre or central business district, such as London, and those in which the geographic features create an easily defined cordon pricing environment such as in New York or Stockholm.

Depending on the size of the area, area pricing may require more enforcement procedures, equipment and general infrastructure than cordon pricing, as it describes an area in space rather than a circumference. Further, the impact an area system will have on congestion will vary based on the number and travel patterns of residents and vehicles within the zone, whereas a cordon may not be as impacted by these factors

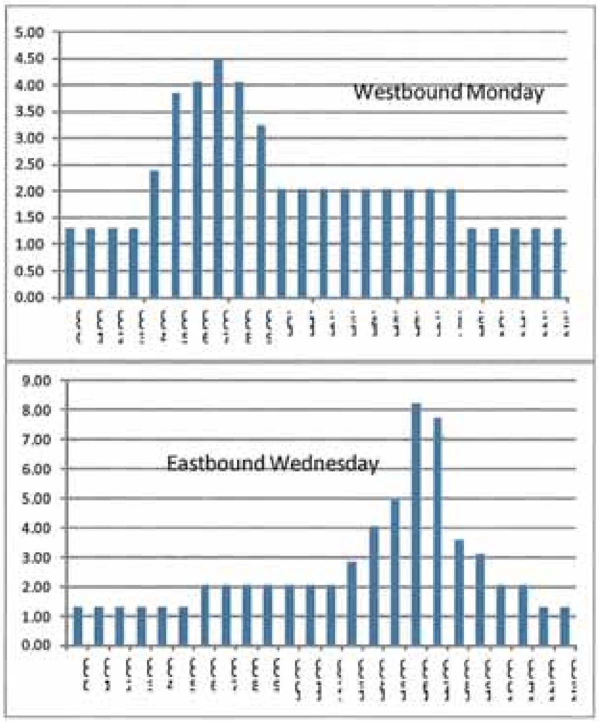
Setting transparent prices and ease of use

International experience indicates that the level of transparency of the congestion charge contributes to the level of public acceptance. To achieve the desired level of behavioural change it is critical that drivers are aware of the charges they will face if they decide to enter a charged area at a particular time of day. Even with more complex charging systems such as Singapore's ERP and California's SR 91 Express Lanes and I-15, the applicable charges are communicated to road users through publication on the Land Transport Authority website (Singapore) and road signage prior to entering the tolled region (California).

Electronic toll collection generally provides 'ease of use', providing that there is not a plethora of different systems within an urban conurbation. The UK Government, in its efforts to encourage the introduction of local congestion pricing schemes, devolved most responsibility for the schemes to the local areas. However, they retained the power to ensure interoperability between the schemes: a key factor since they were envisaged as the prelude to a nation-wide charging system. An important lesson from the retrospective (and costly) 'patch-up' necessary to achieve interoperability between the Melbourne and Sydney 'tags' is that national guidance is likely to be required at an early stage.

While the charging system needs to be understood by motorists, Eliasson (2010) cautions against implementing a system that is too simplified that it may lead to design restrictions and not deliver the intended congestion reduction. A complex tolling structure might appear to be at odds with the 'ease of use' objective. However, in practice, road users may not have to fully appreciate the details of the tolls, but rather the structure. In particular, they probably need to know the upper limits and when they apply. The tolls for 91 Express Lanes are 'posted' but vary according to the time of the day, the day of the week and the direction of the traffic. The end result is that they appear to be very complex, as illustrated in Figure 5.1.

Figure 5.1 Toll variations on 91 Express Lanes for two periods



Source: Derived from 91 Express Lanes toll schedule, effective 1 January 2010, http://www.91expresslanes.com/tollschedules.asp

Despite the wide variation in tolls, consumer acceptance is high. This may be due, in part, the transparency associated with toll setting.

California's State Route 91 Express Lanes Toll Policy

The toll policy for the 91 Express Lanes is designed to optimise 91 Express Lanes traffic flow at free-flow speeds. Hourly traffic volumes in the 91 Express Lanes are continually monitored and if they are consistently too heavy then rate adjustments are made.

Since the toll policy was adopted in 2003, tolls increases have applied to eastbound traffic on Thursdays and Fridays from 4pm – 6pm and Fridays at 3pm – 4pm. During these "super peak" rush hours, the toll is $5.50

Transparency is also important in the setting of the tolls. For both 91 Express Lanes and Singapore's ERP there are published criteria setting out when and how the tolls are to be adjusted. Where traffic numbers have declined in Singapore below the target level, the tolls have been reduced.

Privacy and security

Public concerns of the monitoring systems and the use of the data collected have been raised as issues under some of the congestion pricing schemes. For example, in New York a significant level of opposition arose from concerns over the lack of the lack of privacy protection associated with the surveillance cameras (Kogu 2009).

Not all observers regard the privacy issue as important. Cottingham *et al* (2007) noted the paradox in that:

> *... potential users should not be so concerned with this new scheme, given that they are willing to make use of mobile telephones and debit cards, both of which can be used to derive a great deal of information about the their locations and habits (Cottingham, p. 25).*

Public concern over privacy and security will need to be considered in the Australian context.

Social considerations

Congestion pricing is likely to both create benefits to some members of society and makes others worse-off. There will be those who cannot change their travel behaviour and will incur a greater cost of travel. There will be those who cannot afford the increased cost. Typically congestion pricing will impact those travelling to the city for work, and most cities find low-income earners travelling into the city from the outer suburbs at peak times. There are a number of concession arrangements that can be used to mitigate the increased cost such as car sharing, resident and disability permits.

More fundamentally, increased public transport services will be required before a scheme is introduced, as was evidenced in Stockholm and Singapore, to provide a viable and accepted alternative to a personal vehicle. As part of a package of measures the Singapore government also promoted flexitime arrangements within government agencies and with companies generally to ease congestion on the public transport system caused by the road pricing scheme.

Dynamic nature of schemes

All of the international schemes have changed over time, either through the development and tendering stage or after implementation. This can be because of technological developments (as with Singapore) or as a result of changing objectives, as with London. When the London scheme was introduced in 2003 by then Mayor Ken Livingstone, it was an economic instrument aimed at decreasing congestion. By 2009 Ken Livingstone's stated aim was to transform the charge into a mixed economic and environmental tool through the introduction of a £25 charge for cars emitting a high level of CO_2.

6 Conclusions

High levels of congestion indicate a failure to ensure that the decisions made by individuals take account of the benefits and costs faced by the wider society. Hubbard (2009) presents this as 'a 'tragedy of the commons', in which a commonly accessible (but unpriced) resource is over-exploited to the detriment of all. Congestion pricing provides a mechanism to correct those signals, thereby aligning the interests of individual road users with those of the group of road users.

Technological developments have enabled a range of congestion pricing schemes to be introduced around the world. As with any charging system, there will always be a trade-off between the cost of the system and the accuracy of the charges. As technology improves, scale production 'kicks in' and prices fall, the case for congestion pricing strengthens. On the demand side, a combination of growing economies and expanding populations in an atmosphere of constrained budget outlays creates significant pressure for policy instruments, like congestion charges, that are aimed at dealing with the source of the problem rather than the symptoms.

The benefits of congestion pricing to target congestion vary between observers, but importantly include:

- individuals automatically promote community welfare when pursuing their own self-interest
- pressure for infrastructure expansion is reduced while patronage of public transport is often increased
- the behavioural response to congestion pricing provides valuable information to urban planners when considering land use options and the development of the transport network - roads and public transport.

From a welfare economic perspective, the main determinants of a successful congestion pricing scheme are more basic:

- high degree of existing congestion
- low system installation and operation cost
- low marginal cost in public transport (Hamilton 2010, p. 8).

Political success depends on a range of factors, of which transparency, accountability and use of the revenue are prominent. The Singapore congestion pricing scheme, introduced in 1975 and widely regarded as a political success, embodies a transparent and predictable system for adjusting the charges. The scheme also aims for revenue neutrality, where the net revenues generated are deployed to reduce other motoring taxes.

Australia is well placed to benefit from the lessons learnt from the pioneering ventures into congestion pricing. The charging technology is constantly developing with implications for the timing of the adoption of a congestion pricing scheme in Australia. The choice of technology will significantly impact on the success of a scheme. For each city, the source of congestion is different. Hence, the solution needs to be tailored to the situation.

Success in Australian cities will depend, in part, on how success is measured. However, regardless of the criteria adopted, there can be no success without significant behavioural change. Nevertheless overseas experience shows that the benefits of a well targeted congestion pricing scheme include:

- reductions in congestion
- reduction is travel times
- improved responsiveness to changes in travel demand
- increased public transport use
- environmental benefits.

Schemes can also generate revenue to fund improvements in transport infrastructure or increased public transport. Alternatively congestion pricing schemes can be revenue neutral where other vehicles based taxes are reduced. This has the effect of moving from taxing vehicle ownership to charging vehicle use.

Pressure to implement more road pricing programs in Australia will increase as our cities grow and generate greater congestion. Current technology allows decision makers to create systems endowed with the flexibility necessary to meet the changing needs of the very unique populations they serve and provide interoperability across systems and over time.

When drivers see an obstacle ahead they change lanes to avoid it. So too must our city planners and administrators when facing the cost of congestion.

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