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Subsidies and the social costs and benefits of public transport

Prepared for

Independent Pricing and Regulatory Tribunal of NSW

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1

Introduction

THE NSW INDEPENDENT PRICING AND REGULATORY TRIBUNAL (IPART) is responsible for regulating fare structures and for setting aggregate fare levels for the majority of rail, bus and ferry services in metropolitan areas in NSW. In its 1996 review of public transport, the tribunal drew attention to the wider environmental and social costs and benefits of providing public transport. This study follows up a recognised need to identify these wider costs and benefits and to clarify their appropriate role in public transport pricing issues.

Since its first major review of public transport in 1996, various stakeholders who have made submissions to the Tribunal's transport pricing reviews have called for further study of the nature of environmental and social consequences of the pricing of public transport as compared with private road use, the major alternative for urban travel.

Under recovery of total (and even operating) costs of public transport through fare revenue is a well known phenomenon in both Australian and overseas cities. At the same time there are continued strong claims that private road use is underpriced when its full costs (including environmental and social costs) to the community are taken into account. Should any underpricing of road services be factored into pricing (and funding) of public transport? Under what circumstances? What are the practical obstacles? And if environmental and other 'externalities' can be used to justify government funding assistance to public transport what form should any such funding take? Should it be directed at financing the under recovery of operating costs of existing and future public transport operations? Or should the emphasis be on investment?

These are the issues that this paper explores. In seeking answers, it is necessary to:

- clarify what is meant by the full 'environmental and social costs' of private road use and public transport;
- discuss attempts in Australia and elsewhere to estimate the size of these externalities and the evidence on their relative importance;

- suggest how they might be accommodated in transport pricing and with what effect, referring to approaches elsewhere in Australia and overseas; and
- look at the alternatives to 'pricing in' the external costs and benefits of transport in achieving improved community outcomes.

The role of transport taxes and subsidies in aligning private and social benefits and costs

Taxes and subsidies are used to achieve equity, revenue and efficiency objectives of government. In the case of public transport, the efficiency aims relate to achieving:

- a total amount of travel that reflects its benefits and costs not just to those who travel but to the community as a whole; and
- a mix of public and private transport that does likewise – a mix where society would stand to gain little by shifting to a greater proportion of resources in one transport mode at the expense of another.

The equity underpinnings of transport subsidies relate to avoiding exclusion or too little travel by citizens from certain socioeconomic groups or geographical locations and too much or too cheap travel by others.

Transport taxes and charges, designed both to raise revenue and to affect transport mode choice, can also have important equity effects. Fuel taxes have differential effects on wealthy and poorer car travellers.

Typically any given subsidy will have both equity and efficiency effects. Free school travel will not only impact on household budgets, school choice and educational outcomes. It will also affect use of private cars to some extent.

The chosen mixture of charges, taxes and subsidies has its influence on how much travel occurs, by whom and by what mode. The effectiveness of these different instruments in altering travellers' choices is a matter of some debate. The influence that subsidies will have, for instance depends to a great extent on the form they take.

Pricing principles and public transport – some preliminary comments on the role of ‘subsidies’

Because metropolitan mass transport services are typically provided by either government (or government approved private) monopolies the prices they charge to the fare paying public are typically regulated. As a result, the fares faced diverge from what purely commercial unregulated operators would charge. (Service standards will also differ, particularly in extensiveness and frequency of service.)

Public transport fares can diverge from commercial pricing levels because of:

- targeted concession fares to particular groups (pensioner, school travel etc) with compensating payments from a government ministry to the transport service provider;
- explicitly recognised service related payments from government that fund uncommercial off peak and thinly patronised routes;
- *general* price concessions - prices which are set below operating costs at government direction for a variety of reasons with direct funding of the shortfall from the government. (These reasons could include an attempt to expand patronage and generate patronage related social benefits);
- availability of government funding for capital projects that would otherwise require retained profits or market capital or debt raising by the service provider;
- failure to achieve *efficient* cost levels for a given service in the absence of adequate competition or incentive; and
- the setting of some prices well above the cost of supply to cross subsidise some other group of travellers.

For purpose of this review it is worth emphasising the distinction between:

- subsidies designed to influence public transport *prices* and within these the subsidies designed to influence specific prices to selected customer groups as opposed to general price subsidies; and
- funding of public transport infrastructure which may have its effect primarily on accessibility rather than price.

The rationale for specific targeted fare subsidies recognise the divergence between the so called private and social benefits of education, for instance and are part of the process of subsidising the total cost of education. They have the incidental effect of affecting overall patronage. But the efficiency

rationale for *general* price subsidies lies in the idea that fares affect patronage and increased public transport patronage confers an increase in net social benefits. It is this link that is explored in detail in this paper.

2

Public transport subsidies in NSW and other states

HOW ARE SUBSIDIES IN PUBLIC TRANSPORT currently employed in NSW? Do they differ from the use of subsidies in other states.

NSW

In NSW, both the STA which operates bus and ferry services and CityRail, the urban passenger business of the State Rail Authority, have Community Service Obligation (CSO) contracts with the State Government. Under these, *targeted* concessions to senior citizens and others are funded by the government. The revenue foregone through free school travel is reimbursed. CityRail also provides general price concessions to all travellers as a result of the government funding its *overall* operating deficit. The STA has an explicit 'services-CSO' payment from government to compensate it for running non commercial services.

Where government has identified specific passenger groups as targets for concession fares and contracted to reimburse the service provider, it has implicitly put a value on the social benefits to the community of servicing these groups' transport needs. But the pervasive use of prices (fares) that under recover operating and capital costs of public transport go well beyond these targeted benefits. They are only loosely linked to the harder to measure external costs and benefits of these services, including the avoided social and environmental costs of private road use that might emerge in the absence of subsidies to public transport.

The State Rail Authority is charged a negotiated access fees by the Rail Access Corporation for use and maintenance of the tracks and other 'below rail infrastructure but government picks up the bill. It does so in recognition of the externality benefits of rail. NSW Treasury, in its submission to the 1996 Tribunal inquiry, expressed the view that '...the externality benefits from rail are higher than from other passenger modes and justify a subsidy for *below rail public infrastructure costs* (our italics)...

the Government's general subsidy for below rail public infrastructure operating costs should be seen as sufficient payment for externality benefits.' (Submission, p. 22)

In this case, a core agency has argued that the maximum external benefit from urban passenger rail is less than the rail access fee charged to CityRail. If this were so, it would seem to imply that no *externality* benefits could be used to rationalise fares that under recovered *other* (above rail) costs.

When it comes to buses and ferries, the two other major public mass transport modes in NSW, there is no attempt to set subsidies in such a way that they explicitly recognise and reflect any beneficial externalities. As mentioned, targeted and service CSOs are paid for by government. But these transport modes, and especially bus services which feed rail and ferry services, arguably generate important external benefits.

The composition and size of contributions from government to these service providers is shown in table 2.1.

2.1 Public transport subsidies in NSW

	1996–97	1997–98
	(\$m)	(\$m)
Cityrail		
▪ Social programs	507.5	495.5
▪ Capital and other government contributions	413.6	422.1
▪ Operating deficit before abnormals	72.1	38.3
Total	993.2	955.9
STA		
▪ Sydney buses		
– Free/concessional reimbursement	90.2	96
– Pricing CSO	20.3	24.3
Total	110.5	120.3
▪ Sydney ferries		
– Free/concessional reimbursement	8.03	8.92
– Pricing CSO	14.12	14.66
– Deficit	2.49	4.43
Total	24.64	28.01
▪ Newcastle buses and ferries		
– Free/concessional reimbursement	13.24	
– Pricing CSO	4.64	
– Deficit	6.02	
Total	23.9	23.51
– STA total	159.04	171.82
TOTAL	1 152.24	1 127.72

Source: IPART 1999.

Victoria

The move towards privatised services

During the 1990's Victoria undertook a program of bus privatisation such that by mid-1998 the services previously provided by MetBus were transferred to two private-sector companies. At the current time, the metropolitan route bus service is operated by 39 private sector companies.

In furtherance of this move towards private operation of public transport on 29 August 1999, Victorian tram and train services became the responsibility of a number of private-sector companies including MetroLink Pty Ltd; Connex Melbourne; and National Express (Australia). These operators entered into 'franchise' contracts with the government and hence are commonly referred to as franchisees.

The fact that public transport services are largely privatised has not removed the perceived need for government subsidies. However it has been accompanied by the introduction of more incentive based payments.

Subsidies and incentive payments

The tax payer funded payments made to public transport operators in Victoria include a combination of incentive structured payments and general subsidies.

Operational performance incentives and penalties

The Victorian Government has in place an Operational Performance Regime (OPR) whereby tram and train operators may either be required to pay a penalty or may receive an incentive payment. The amount to be paid or received is dependent on various performance measures such as the reliability and punctuality of the service provided.

Passenger growth incentives

A further incentive payment is made on the basis of an operator generating a significant increase in the number of passengers using their service. More specifically for metropolitan trains there needs to be an increase in patronage from the time when the franchise commenced of 10 per cent and for trams the equivalent figure is 20 per cent. It is interesting to note that unlike the performance based measure there is no penalty payment required in the case where a public transport operator loses passengers.

Other payments to franchisees

Other payments made to franchisees include the mixture of general subsidies and CSO-type payments found in NSW. These include, base subsidies, concession travel-related payments and capital grants. The term base subsidies refers to payments which are made by the Government to franchisees simply for the delivery of public transport services. The amount of these subsidies is determined in the initial franchise contracts between the Government and the operator. It should be noted that these contracts provide for base subsidies to be scaled down over time.

As well as these base subsidies, variable payments are made to operators to cover contractual obligations. Such obligations include allowing concession card holders to travel at discounted prices; allowing free travel for certain groups; and, the provision of additional services for special events. Further, operators are expected to make investments in new and upgraded infrastructure and rolling stock over the term of the franchise. The government contributes pre-specified amounts of capital grant funding for such works.

Total Payments

The total subsidies and incentive payments paid in Victoria for the provision of public transport for the year August 1999–September 2000 is approximately \$500 million. The vast majority of the total payments comes from the base subsidy rather than the incentive based OPR. The base subsidy accounts for 71 per cent of the total (Department of Infrastructure Vic 2000). No evidence could be found that any element of these total payments was related to measured externalities.

Australian Capital Territory

Public transport services for the ACT are provided by ACTION (ACT Internal Omnibus Service). ACTION is a government owned enterprise which supplies bus services including scheduled bus services, school bus services and special need transport services. From mid 2000 ACTION was established as a statutory authority to allow it to operate more independently from the ACT government.

ACTION receives approximately 70 per cent of its revenue as CSO payments. This is largely a result of government objectives to maintain services and particular fare levels. For 1998–99 government contributions

were \$39 million. The three major areas which receive government support include:

- pricing CSO's which involves reimbursement for offering fares below commercial levels.
- school transport services which covers the estimated cost of providing subsidised travel for both tertiary and school students.
- general route off-peak service CSO's which includes reimbursement for providing services at off peak times.

These three components accounted for 82 per cent of the total government contribution (IPARC 2000).

In setting fares the Independent Pricing and Regulatory Commission (IPARC) does consider ecologically sustainable development (ESD). Under this heading it was noted that:

‘the Commission realises that significant price rises could result in customers switching to alternative modes of transport, mainly cars, which have higher environmental costs.’ (IPARC, 2000, p. 40).

In a similar vein the report states that:

The Commission acknowledges that patronage levels and revenue expectations for ACTION need to take into account broader environmental objectives and the willingness of the community to adopt price signals and other measures to encourage public transport. (IPARC, 2000, p. 41).

While these considerations were noted there were no explicit calculations of such costs included in the report. Further, there was no linkage of the level of subsidies with the benefits created by use of the bus network rather than the car.

Western Australia

The population of WA, approximately 1.7 million, is largely concentrated in Perth (1.2 million) and hence this discussion focuses on the public transport system of Perth. The TransPerth system involves both government organisations and private companies and provides bus, train and ferry services. Bus services are provided by CGEA Perth Bus, Southern Coast Transit, Swan Transit and Path Transit; ferry services are provided by Perth Water Transport; and train services are provided by Westrail.

The WA Budget for 2000-01 indicates that grants, subsidies and transfer payments for metropolitan public transport were \$224 million. Approximately 50 per cent of this was for train services. Further, inner city travel in Perth is provided free of charge. This includes Perth's CAT system and all bus services within Perth's central transit zone.

While there is no available evidence that the external benefits of public transport form a part of the pricing of public transport in WA there is evidence that consideration is given to these externalities. In particular, such factors have been considered in the WA Implementation Plan for the National Greenhouse Strategy in the areas of Transport, Urban Land Use and Planning (July 1999). The report discusses the use of fares, and in particular subsidies, to increase the patronage of public transport and concludes that:

'Practical experience demonstrates that lower fares require additional government expenditure to maintain service levels and investment in the system. If the quality of service is sacrificed in an effort to reduce expenditure, this can have a greater detrimental effect on public transport patronage than the reduced fares and requires careful consideration.' (Transport, Urban Land Use and Planning Working Group, 1999)

The Department of Transport has also considered the social benefits that arise from public transport in its report *The Way Ahead: Metropolitan Transport Directions for Western Australia* (2000). It notes that:

'public transport can be an efficient user of roads, especially during peak periods and at locations where effective road use is critical due to road congestion. Public transport must play an increasing role in promoting a more balanced transport system and so reduce road congestion, fuel use, emissions and the need for parking space.'

South Australia

The public transport system of Adelaide covers the metropolitan area and provides access to the CBD, regional and district centres. The predominant mode of transport is the bus network which includes the Adelaide O-Bahn road network. A small proportion of public transport is provided by the rail network and a tram line. With the introduction of the *Passenger Transport Act (1994)*, competitive tendering became the basis for the delivery of public transport services. The contractors include Australian Transit Enterprises Pty Ltd, Serco Australia Pty Ltd, Torrens Transit Pty Ltd and TransitPlus which is a joint venture between TransAdelaide (a government owned enterprise) and Australian Enterprises Pty Ltd. The Passenger Transport Board is responsible for setting the fare structure.

Payments made by the government to public transport providers include both grants and subsidies and payments made to metropolitan service providers for the provision of services. Further, some metropolitan services are provided free to the public. These include the CityFree bus services (the CityLoop and BeeLine). Total payments made by the government for metropolitan service provision were approximately \$214 million. The vast proportion of this, 96 per cent, was payments to service contractors (PTB Annual Report 1998–99).

The PTB Annual Report 1998–99 reports that a decision was made to freeze Metroticket fares at 1998 prices until at least July 2000. As part of the justification for this decision it was noted that:

*‘The fare initiatives are expected to encourage greater public transport use, leading to social and environmental benefits for the whole community.’
(Passenger Transport Board, 1998–99, p. 5)*

This gives some indication that the external costs and benefits are considered in decisions as to fare levels. However, it is by no means explicit in listing either what these benefits are or in estimating their values.

3

Defining and measuring social costs and benefits of transport

WHAT ARE THE FULL SOCIAL COSTS and benefits of public transport? How do we measure these values and to what end? What attempts have been made to do so? These are the questions which are to be addressed in this chapter.

Urban transport, like any other activity, generates an array of costs and benefits both private and social. The difference between the purely private costs of an activity – those borne exclusively by the person undertaking it – and the wider costs becomes important when those generating the costs (and enjoying the benefits) are not faced with the full costs of their actions. Choices get distorted and resources are misallocated. The best means of dealing with these wider costs and benefits has been a central issue for transport policy makers.

Social costs and benefits and their consequences: some useful distinctions

Externalities –the difference between private and social costs

In deciding to travel by private car or via public transport, the individual will consider those costs and benefits which he or she bears directly as a consequence of that decision. The private direct costs of using the CityRail network in Sydney, for example, will include the fare that must be paid in order to purchase a ticket and the opportunity cost of the person's travel time. Effectively, the individual makes a decision after a consideration of the private (or 'internal') costs and benefits involved. However, the choice of transport mode has consequences that reach beyond the individual and extend to the community as a whole.

Any increased use of public transport at the expense of car travel may lead to a reduction in the level of air pollution. Clearly, the benefits of a cleaner environment are not exclusive to those who choose to switch to public

transport. Rather, such benefits accrue to the community collectively. However, because the individual does not bear such costs and benefits directly, they will not form a part of his or her decision making process. Hence there may exist unpriced or uncaptured costs and benefits so called *external* costs and benefits. The *full social cost* of any activity will be the sum of both the private and the external costs involved. With passenger transport the presumption in most large urban centres is that the social (internal plus external) costs exceed the social (largely private) benefits of car use. As the example suggests, the external benefits of expanding one activity (public transport travel) may include the *avoided* external costs of another. Just what should be legitimately included in these external costs is a matter of some controversy. But where there is agreement is in the need to account for them in the cost signals that face the travelling public and in making infrastructure investment choices – both the timing and the mix.

Full social costs for what purpose?

In deciding what to include as comprising the full social costs of a transport service, it matters a good deal what the purpose of the measurement is. Is it to construct performance measures that allow comparisons of one service with another or to track performance of a service through time? Is it to inform choice between competing projects where cost-benefit analysis is employed? Or is it to establish prices for existing services with a view to achieving more efficient current and future resource use? Lee (1997) has raised this issue of purpose in canvassing the uses and meanings of social cost estimates in transportation. Lee suggests that capital costs (land and structures), facility and vehicle operations and maintenance costs, ‘social overheads’ (including tax concessions) and externalities should all comprise the full social cost of *existing* networks.

This definition would provide a means of comparing performance across modes. It assumes that existing capital – land, structure etc. – invested in road, rail and other modes has an opportunity cost and that replacement cost can be used to value capital. This in itself is contentious if it assumes inevitable replacement of all parts of the network.

Facility and vehicle operation and maintenance costs are less contentious, although the treatment of non-residential parking, as discussed below is a source of some dispute.

Externalities and social costs created by taxation, discussed in detail below, are among the most difficult to measure of the cost categories suggested as comprising full cost. But unless they are included, we do not get a true

picture of the full opportunity costs imposed by a transport mode – one with which the social benefits can be compared.

Cost effectiveness performance measures – the relative cost of moving people by different means – can be constructed when the full social costs are known. These are obtained by dividing the full social costs by a measure of ‘quantity’ – for example, passenger kilometres or vehicle kilometres travelled. Cost effectiveness measures obtained in this way can be useful in tracking transport service performance over time. But in isolation from some measure of the social *benefits* of each mode, they are of limited use in transport pricing and investment decisions.

The full social cost of *existing* transport modes are of limited use when evaluating *new* transport infrastructure projects using cost benefit analysis. Transport planners may wish to calculate the respective merits of a road widening project compared with the addition of a bus transitway or a light rail. The broad cost *categories* (capital, operating, external) will be important in assessing the *incremental* social costs of each project option. But the cost (and benefits) of the *existing* system will only be important to the extent that they change *as result of the project*.

Pricing to reflect social costs at the margin

In cases where the private and the social costs of an activity are divergent, the level of that activity undertaken by the economy as a whole will differ from the efficient or optimal level. Such an optimum will only be reached by a full accounting of the relevant costs and benefits. In the case of external costs this means incorporating these external costs into the effective price paid. Taxes or subsidies may be used as a means of *internalising* the unpriced costs or benefits – effectively by making them impact upon the consumer’s decisions. In this way the gap between the private costs and the full social costs of a given action can be narrowed, giving the prospect of a more efficient resource allocation. How well these taxes and subsidies work depends on how well they reflect the externalities (a measurement problem) how readily they can be implemented and how responsive the travelling public is to price.

The presence of ‘unpriced externalities’ is not the only source of inefficiency in transport outcomes. Unless prices facing travellers cover the full efficient resource costs of the service, with neither underpricing nor overpricing, efficiency will be lost. But here, as with other infrastructure pricing debates, there is no settled view on what should comprise ‘full efficient costs’.

Unless transport operators are minimising operating and other costs there is scope for overpricing that recovers inflated costs. This kind of inefficiency is one reason for ongoing regulation of public transport prices.

The 'natural monopoly' features of rail track networks have long been used as a justification for their regulation to avoid 'overpricing'. Systems with some spare capacity can provide additional services at a marginal resource cost (the cost of the extra trip) that is typically significantly less than the *average cost* of a journey, which includes all the sunk costs of the network. Where this is the case the debate is about whether prices (fares) should only cover these marginal resource costs created by satisfying additional public transport travel demand. Or should there be an attempt to recover more than this, given the costs to society of raising funds elsewhere to cover transport deficits?

This raises the issue of whether to subsidise the *total internal costs* of public transport in the interests of reducing excess capacity in the public transport system – excess capacity that might be taken up through increased demand if prices only cover marginal costs rather than also making a contribution to fixed costs. But the central issue for this discussion is whether there is a case for going beyond this, further subsidising price below marginal costs to compensate for inefficient pricing elsewhere – on the roads.

Second best pricing

Where it is not possible, for whatever reason, to price in the full social costs of road use, drivers will over use existing road infrastructure and automatically generate signals to transport planners that additional road capacity needs to be brought on line sooner than it would otherwise be.

A *second best* approach to pricing would suggest that, failing the ability to correct for externalities directly, there could be gains by pricing the substitute means of travel below its marginal cost. The additional social *benefits* of any additional rail, bus, ferry and tram travel would be the avoided external costs through lower-than-otherwise road use.

On a cautionary note, even where a case can be made for subsidisation due to the existence of external benefits this is by no means the end of the discussion because the use of subsidies is not the only method by which to correct the problem of external costs and benefits.

Where many distortions exist concurrently in the economy the attempt to correct just one of these inefficiencies may have unexpected (and

deleterious) side effects which will differ with the policy measure being employed. The use of a subsidy must be evaluated against a range of other policies and the consequences of each in achieving the set aim as well as the effects on other sectors of the economy should be compared.

What are the external costs and benefits of *public* transport?

To identify the full social cost of an activity we need to know both the private (internal) cost and the external cost which is borne by society. The private cost of an activity will either be captured via the prices faced or through opportunity costs such as time foregone. If prices diverge from the true resource costs of providing a service then the internal costs faced will not be a true reflection of resource costs. But a further problem area is the external component because it remains unpriced. If public transport is to enjoy subsidies on externalities ground, the relevant external benefits must be determined.

Benefits as the avoided external costs of private car use

Private car use generates negative externalities in the form of environmental degradation (including air and noise pollution), accidents and congestion. By increasing the number of people that use public transport relative to private cars we effectively reduce these costs. Hence some of the external benefits of public transport arise from a reduction in the external costs of private car use. Table 3.1 provides a list of the social costs of road transport and is useful in distinguishing between the internal and the external components involved. It represents a 'traditional' view of these externalities. Others consider a more extensive list appropriate, as discussion below reveals.

In brief the external benefits of public transport include (but are not restricted to) reductions in:

- traffic congestion;
- air pollution;
- noise pollution; and
- accidents.

3.1 The marginal social costs of road transport

<i>Description</i>	<i>Internal</i>	<i>External</i>
Private resource costs	Average resource costs	Change in resource costs of other vehicles due to the decrease in speed caused by the additional vehicle
Time costs	Average time costs	The time losses of all other road users due to the decrease in speed caused by the additional vehicle
Accidents	Costs associated with average risk (except direct economic costs)	Cost of the increased accident risk + direct economic costs associated with average accident risk
Air pollution	-	Damage to the rest of society
Climate change	-	Damage to the rest of society and to future generations
Noise	Damage to the vehicle users	Damage to the neighbourhood

Source: Mayeres et al. (1996).

Traffic Congestion: what is the external cost component?

Congestion is costly to road users themselves. It involves higher resource costs by way of fuel cost and personal time costs. But only reductions in the external congestion costs of car travel can be thought of as a potential benefit of public transport.

Congestion itself requires definition. In practice, working definitions often look at travel speeds on roads in known peak periods and compare them with off peak as the uncongested benchmark. But this is arbitrary and somewhat circular. Problems of congestion cost measurement are discussed further below.

Road users account for congestion by acknowledging that the time they need to allow for a trip and the fuel costs and vehicle wear and tear will be greater in the presence of traffic congestion. That is, road users account for the *average* congestion cost. They internalise it as part of their travel decision, consciously or unconsciously working it into the total costs of a trip.

However, there is a further cost attached to that trip that each individual driver does not internalise. An additional car on the road network at the point of becoming congested increases the driving time and other direct costs for *all* existing users of that network. This is the marginal external cost of congestion. This cost is external because the individual does not consider what his or her use of the roads means for other drivers when making the travel decision. Greater use of public transport may have the effect of lowering the level of congestion. This would provide an external benefit to

all car users by reducing their travelling time and hence reducing the time lost in traffic delays (De Borger et al., 1997).

Air Pollution

The byproducts of the fuel consumption necessary for transport provision are a contributing factor to the level of air pollution. The particulates released by transportation vehicles include carbon monoxide (CO), nitrogen oxides (NO_x), carbon dioxide (CO₂), hydrocarbons (HC) and sulfur dioxide (SO₂). Such emissions have been linked to the depletion of the ozone layer, climate change and the existence of acid rain. The external costs of such pollution include the effects on morbidity, mortality and agriculture. Public transport has the capacity to move a larger volume of people than private car use and hence has the benefit of generating lower levels of air pollution per capita.

Noise Pollution

The use of vehicles along public roadways or railway tracks generates noise that can be heard by the residents of the surrounding areas. The discomfort suffered by these residents as a result of the noise is an external cost of vehicle use. Road transport would be expected to create greater levels of noise pollution than rail transport because the road network has much greater reach into urban areas. Effectively, cars and buses are able to pass by many more residential buildings and thus can create a disturbance for a greater number of people.

Accidents

It is difficult to determine what proportion of total accident costs should be designated as being external. In general, that part of the total accident cost which is not accounted for by the driver directly or through the driver's insurance policy is considered to be the marginal external accident cost. (De Borger et al. 1997). We return to a discussion of the appropriate definition of accident externalities in reviewing measurement problems below.

A broader definition of the social costs of road use

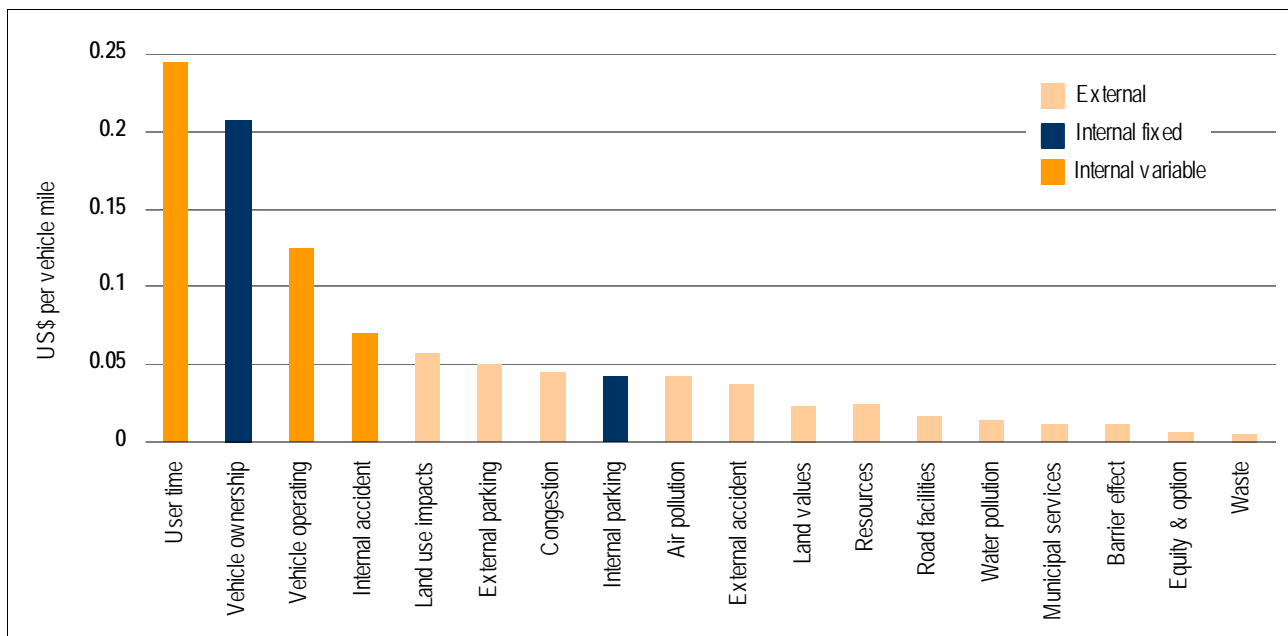
The external costs of road use discussed above – congestion, noise pollution, air pollution and accidents – have traditionally been the focus of the literature in this area. However, the costs examined so far are by no means an exhaustive catalogue. Litman (1999a and b) takes a much broader view of the components of external cost of road use and arrives at

correspondingly larger estimated values. Litman includes non residential parking resource costs, roadway land value (the opportunity cost of land used for roads) along with public services devoted to vehicle traffic, the disamenity affects on pedestrians and cyclists, and the costs from 'low density automobile oriented land use' – the urban sprawl effect. Banfield et al. (1999) also include land costs and council parking infrastructure costs in an attempt to estimate *total* road use costs for Sydney. Figure 3.2 shows this broader definition and quantification for the US.

The inclusion of costs such as land value in estimates of road users' external costs is contentious. Arguably there is little prospect of closing other than a few local roads and reduction of road use at the margin would release little land. When it comes to satisfying expansion of demand for transport by road use access or some other means there is an opportunity cost of land. It must be carefully defined to measure only the *additional* land cost over and above the next best transport corridor alternative for servicing that demand.

There is debate over whether non-residential free parking is really an external cost of motoring. An alternative view is that when shopping centres and office blocks commit resources to the provision of parking space that allows greater access by car, the price – in the cost into their goods and services.

3.2 US automobile costs ranked by magnitude: external costs broadly defined



Note: Costs are average costs per vehicle mile, not marginal costs.

Data source: Litman, T., 'Transport Cost Analysis' 1999a.

But unless it is the motorist *only* who bears these higher costs then parking costs have been passed on to others as an externality. This effect is even clearer when local councils use local rates to fund the parking facilities that service motorists from outside the municipality.

Litman has estimated that the external costs associated with parking are approximately US 5 cents per vehicle mile and as much as 12 cents for urban peak hour.

But what part of these can be considered *marginal* costs that vary with traffic volume? The answer depends on existing parking capacity and whether a long run perspective is being taken. External costs of parking are only variable in the longer term when *new* car parks are required.

Which transport external costs and benefits matter for decision taking?

The answer to this question depends on the problem. External costs and benefits are relevant for 'getting transport prices right.' Pricing to factor in an externality through pollution taxes or congestion charges, or subsidising public transport to price-in the benefits of avoided road use are examples of different methods of adjusting inadequate price signals. By leaving prices unadjusted, resources will be misallocated.

The relevant costs for such tasks are *marginal* costs, whether internal or external. NSW Treasury has made this point in its submission to the Tribunal. A knowledge of the *total* externalities of road use is of little help. These marginal external costs can be differently defined depending on whether concern is with getting best use of *existing* transport infrastructure capacity (*short run*) or with satisfying *long run* transport demands in long run marginal internal costs of infrastructure – be it transport, water, electricity telecommunications – are themselves difficult to define. The amount by which a given increase in demand brings forward in time this need, augmentation of the network, and therefore, raises costs, is often perceived as a useful way of thinking of these costs.

Which external costs of road use are marginal costs?

Some transport externalities tend to be less 'lumpy' than others. A proportionate increase in road traffic may add continuously to air pollution, and to air pollution costs. There is also a fairly continuous relationship between traffic and accidents. Congestion can have more lumpy features because of threshold effects. (A critical volume of traffic has to be reached below there is slowdown from additional cars.) But perhaps the most contentious issue is whether the costs of land for roads and parking

land and structures which are not paid for directly by motorists are costs which vary with road use and would be included in an 'ideal' road user charge. In a long run sense, they may be.

Public transport's own external costs

As following discussion of the attempts to measure the external costs of various transport modes shows, public transport has its own external costs through its impact on the environment, on accidents and noise. In the case of buses, congestion costs are also present. It could also be argued that increased rail travel in peak hours inflicts disamenity on existing travellers through overcrowding and impacts on embarkation times. But the quantification that has been undertaken in the field of negative transport externalities suggests that those costs for public transport are a fraction of private road use external costs. The figures given in appendix A below bear this out.

Positive property value effects and external benefits

The University of New South Wales Transport Program has argued in a submission to the Tribunal that 'the leading economic beneficiaries of public transport are landholders located close to stations or interchanges, followed by car drivers and lastly people travelling on public transport.'

This may suggest that there are wider benefits of the public transport network – or any improvement to it – including increased property values that should be factored into cost-benefit appraisals.

Businesses near stations and interchanges do not pay for public transport but benefit from it. Should this uncaptured effect be included when assessing the benefits and costs of a public transport project for instance?

The answer would seem to be 'no' and suggests a confusion between 'benefits' and 'transfers'. Small (1998) makes the point in the context of a new subway station. Increased travel convenience which generates increased travel demand wipes out some or all of the benefits of travel to a shopping centre located by the station as rents rise and prices rise. '...The existing landowner will end up with a transferred benefit exactly equal to the originally measured travel benefit.'

If a cost-benefit study were done properly to capture the value of increased travel demand provided by the station, there would be double counting involved if increased property values were included.

How do we value transport externalities?

It has been shown that the costs and benefits of public transport are inextricably linked to the alternative - private motoring. Avoided external road use costs can help to justify a public transport project when added to the benefits of the project. And the marginal external costs of road use are clearly of relevance to finding efficient prices for each form of transport. However, obtaining such estimates is by no means an easy task largely owing to the fact that externalities, by their nature, are not directly observed. As noted in a paper produced by the European Commission (1995) 'Different methods for measuring externalities can lead to significantly different results...A large part of the differences can be explained by different assumptions'. Before examining the estimates themselves we must take some time to discuss the methods by which these numbers were derived.

Congestion costs

Calculation of congestion costs is notoriously difficult with ambiguities arising at each step of the process. The first question to ask is: How does the volume of traffic per unit of time (the flow) affect the average speed at which that traffic moves? The answer to such a question gives a speed flow relationship. The importance of such a relationship is that it allows assessment of the impact on average speed of a proportional increase in all trips. This enables a calculation to be made of the resulting proportionate increase in trip time for travellers on a given route. There is no set 'law of congestion' function to be used in determining this relationship. This 'speed flow' relationship between traffic volume and speed is a matter of choice for the transport modeller. (As an example Mayeres et al. (1996) use an exponential aggregate congestion function. Others use different forms and the ultimate estimates of congestion costs (time lost) are somewhat sensitive to this choice.)

A related issue is the reference point to be used in comparing the congested state with the non-congested traffic situation. There must be some base state in order to calculate the extra cost due to congestion. The base state commonly used is a hypothetical state of 'zero' congestion where cars are able to travel at the free speed. This state of zero congestion is by no means noncontroversial in its assumptions. First, some assumption must be made as to what the 'free speed' is. This is usually taken to be the speed that can be travelled with low traffic volumes but is not a precise figure. Second, it is generally assumed that road users make the same number of trips and follow the same routes with or without the presence of congestion. This is

questionable in that congestion may cause motorists to change their choice of route. If congestion were calculated based on preferred routes then the cost would be higher because there is the further delay of using a less direct route. Further, some trips may not be made at all in order to avoid congestion. Hence the choice of reference situation can affect the final estimate of the cost of congestion. In particular, the fact that congestion can significantly alter the traffic pattern tends not to be captured by the existing measures (BTCE 1995, p. 45).

The primary difficulty arises once the speed-flow relationship has been established permitting estimates of the impact of more or fewer vehicles on the journey time of all. The existence of congestion means that a set trip takes a longer period of time. The cost is the value of the loss of time involved through slowdown. How much is that time worth or what is the value of the time lost? The answer will differ depending on who is involved. For example, a delivery person who supplies restaurants with ingredients will place a higher value on the time that has been lost than would a person who was simply visiting a relative where there was no expected time of arrival involved. This question is so important because the cost of congestion depends crucially on the value of time involved. The Bureau of Transport and Communications (BTCE) notes that 'Determining the value of time is a complex and controversial exercise. (1995, p. 25)

One approach (and that used by Austroads (1997)) is to assume that a person who is travelling for a business related purpose has a value of time equal to their after tax wage and labour overhead costs. Non-business travel time is more difficult to value given that the opportunity cost involved is less obvious. The common practice is to place a dollar value on nonbusiness travel time equal to a given proportion of average hourly earnings. The difficulty is choosing the proportion to use. BTE (1999) report the use of 40 per cent in the UK, New Zealand and British Columbia while the US Federal Highway Administration uses 60 per cent. Austroads recommended using 40 per cent without providing much explanation but the decision appears to be based on (selective) overseas precedent. The decision is arbitrary and the small number of Australian studies which have been devoted to this issue have varied substantially in their results (BTE 1999).

The Ministry of Transportation in British Columbia calculates the travel time value for a commercial vehicle driver at the hourly wage rate plus fringe benefits. A personal vehicle driver is then allocated a value of time equal to 50 per cent of the average wage (BC Ministry of Transportation and Highways, 1992 cited in Litman (1999a), p. 9).

Wardman (1998) found that the value of time is 35 per cent higher for commuting than leisure travel in London and the South East and it is 14 per cent higher elsewhere. If no distinction is made between the two areas, a figure of 25 per cent would seem reasonable.

The study by Wardman reviewed studies of data collection between 1980 and 1996. This yielded 444 different value-of time estimates.

From this brief discussion it can be seen that there is no clear method for the estimation of congestion costs. The impact on travel time depends on assumptions about speed flow relationships and the value of that time depends on the composition of the travelling public. These are both open to the discretion of the researcher and help to explain why estimates of congestion costs are likely to differ significantly from study to study.

Air pollution costs

There are three steps involved in valuing marginal road transport emissions. First, a relationship must be established between a change in the emissions and the concentration levels of various air pollutants. This may in fact prove to be difficult and often requires the use of complex atmospheric dispersion models. Mayeres et al. (1996) state that:

There is still a great need for information in the domain of air pollution effects and most particularly for summary information (such as emission-concentration studies). (p. 115)

The second step is to establish a link between the change in the concentration levels and the effects this has on health, vegetation, materials, visibility and ecosystems. Finally, a monetary value must be given to the different effects of air pollution. Much of this work is hampered by the lack of information available. Further, value estimates are made using a range of assumptions and the results are sensitive to these assumptions.

The methods of evaluation used here are primarily indirect ones. First, there is a technical estimate of the damage done and then there is an evaluation of the cost of repairs or protection. Damage refers to human health, material damage and effects on plant life.

Noise pollution

To calculate marginal external noise costs, it is necessary to determine the effect on the noise level in a neighbourhood of an additional car kilometre travelled. An index for noise which can be used is the energy mean sound

level. This gives the average sound level over a given period. The given level of noise then needs to be related to the traffic flow.

The most widely used method for determining the monetary valuation of the social costs of noise is the hedonic pricing method. This method uses the idea that the value of a house is a function of the level of noise to which it is exposed. It is expected that houses located in noisy areas will have a lower value than similar houses located in quiet areas. Distance from noisy thoroughfares is used to help explain the difference in property values. In this way the housing market can be used as a proxy for measuring the externality of noise pollution. This gives a value for the *total* noise cost. To transform this to the *marginal* noise costs associated with increased road use again involves a degree of arbitrariness (De Borger et al. 1997). A further problem with this method is that where it has been applied researchers have tended to disregard the effect of the noise on buildings other than dwellings.

A second method for evaluating the costs of noise is by use of cost of abatement. This involves examining the costs of actions which would have to be taken to eliminate or attenuate the road traffic noise. Unlike the hedonic price of housing method this method does include the poorly perceived effects of noise but the question of the standard of noise which is acceptable introduces uncertainty in much the same way as the need to define an uncongested road does in valuing congestion costs. A third method involves evaluating the damage caused by noise and the cost of corrective action. The main component in such an evaluation is damage to health which is itself difficult to assess.

Car accident costs

There are two main problems in determining the external costs of an accident. First, a relationship needs to be derived between the number of road users and the number of accidents to establish a marginal effect (this is something like the derivation of the speed-flow relationship for congestion). Second, the proportion of the marginal cost which is external needs to be determined.

There is no consistent view on the relationship between the level of traffic and the number of accidents. An argument can be made that an increase in the level of traffic will increase the exposure of each vehicle to the risk of a crash and therefore the number of crashes. In Mayeres et al. (1996) the assumption is made that the number of accidents is proportional to the traffic volume. However, a conflicting view is that drivers adjust to different traffic conditions such that the number of accidents remains the

same whether or not there is congestion (BTCE 1996a). This distinction is important because if there is no link between the level of congestion and the number of accidents then it cannot reasonably be said that congestion increases the accident cost.

Assuming that there is a relationship between the volume of traffic and the number of accidents, it must still be determined what part of this marginal cost is external. In calculating the total private and social cost of an accident, relevant values include the 'warm blooded' costs (the willingness to pay of the (potentially) injured party and his or her relatives and friends in order to avoid an accident) and the pure economic losses (net output losses, ambulance costs and medical costs). While the economic losses can be observed, the 'warm-blooded' costs are more difficult to establish. Motorists will to varying degrees factor in the cost impact of accidents on relatives in choice of vehicle, insurance cover etc., thereby internalising these costs.

Road users will account for the private marginal costs which they have to bear personally and insurance may cover part of the utility lost as a result of an accident. The cost which is not accounted for in these ways will be designated as the external cost of the accident. For practical purposes, it is difficult to determine the proportion of total costs that is external with any accuracy. This necessitates the use of many (and varying) assumptions (see Mayeres et al. 1996).

Estimated Externalities: International and Australian Studies

Employing the various measurement techniques discussed above a large body of research has been built up which tries to quantify the external costs of road (and other) use. The majority of international and Australian work that seeks to quantify externalities does so following the narrower definition mentioned above. Comparisons from study to study are often made difficult because of the choice of units (physical measures rather than values, vehicle kilometres versus passenger kilometres etc.) and depending on whether there is a partition into peak-off peak travel and rural urban. Studies are not always clear on whether they are measuring *marginal* external costs. Nevertheless, the results reported in appendix A contain certain broad consistencies. These are

- where comparisons are available for different transport modes on either a physical or cost per passenger kilometre basis, public transport external costs are far smaller than those for cars;

- congestion costs dominate as a source of road use externalities unless the external costs of land and parking are included, in which case these became the most important cost components and, for the US at least, double the value of external costs.
- Big variations in estimates are to be found. A composite value of approximately 25 cents per vehicle kilometre for road use in New South Wales compares with an earlier EPA estimate for Sydney at over \$1.00 for congestion alone and a value of 62 cents for Sydney CBD peak by the BTE. Litman's estimates of total externalities of road use in the US convert to approximately 70 cents per *passenger* kilometre. Peirson and Vickerman (1998), on the other hand put the value for London peak car travel at the equivalent of 57 cents.

Clearly it matters as to whether certain land and parking costs are regarded as relevant externalities, and whether peak-off peak distinctions are being made.

4

The relative effectiveness of subsidies

IT IS ONE THING TO MEASURE transport externalities and demonstrate that the mix between private road use and public transport use is not optimal. It is quite another to settle on the best combination of charges, taxes, subsidies and 'non price' instruments to improve on the status quo. What light have previous studies shed on this 'policy mix' issue? How big are the potential gains? What practical difficulties stand in the way of implementing 'best mix' policies?

There are strong indications that the social costs of use of the private automobile in metropolitan NSW is at a level where the total of private and social costs exceeds the corresponding benefits. Both pricing policies (including fuel taxes, road charges, parking fees, public transport subsidies) and regulatory instruments (emission norms, speed limits, traffic regulations etc) have been canvassed as possible remedies. Efforts have been made to simulate the various effects of one or a combination of these instruments in seeking better outcomes.

Policy makers are frequently urged to pay heed to the 'instruments for targets' approach. This takes the view that the best way to deal with a distortion is to use an instrument that bears most directly on the incentive that needs to be changed. If road congestion is the main contributor to the imbalance between the private and social net benefits of road use then governments should introduce road user charges that have the best chance of taxing congestion, according to this approach. Time of day pricing rather than the blunt instrument of fuel taxes suggests itself. Such peak period pricing, if feasible may only incidentally affect the social costs of accidents, however and an additional instrument, or instruments, may be called for to deal with the social costs of accidents. Fuel taxes, on the other hand may be a relatively efficient way of dealing with transport greenhouse effects, but not with the relatively localised effects of particulates and oxides of nitrogen.

Attempts to model the effectiveness of alternative policies for addressing transport externalities

Targeting congestion

Whilst there is some debate on what make up the list of true transport externalities there is broad agreement that road congestion, appropriately defined, must be included. When it is, it dominates all other 'traditional' components in dollar terms as the results in appendix A demonstrate.

It is not surprising then to find that some recent studies have concentrated exclusively on assessing the relative effectiveness of different policy combinations to combat congestion in an efficient way. One such study, (Parry 2000) conducted by Resources for the Future in the US, looks for policies which, if implementable, would best allocate travel among competing modes at any given time of the day, the allocation of freeway traffic across peak and off peak periods and the efficient 'streaming' of peak period freeway traffic into faster and slower lanes.

The policy options considered include variants of road tolling, gasoline taxes and *rail* subsidies (which lower the price of rail travel relative to other modes regardless of the time of day). They therefore ignore the potentially important explicit role of bus transport and suppose a minimum effective level of electronic road use pricing is feasible. Travellers are divided into those with high opportunity costs of time and those with low. The travel options available to the commuter are freeway peak, back roads at peak, rail and off peak freeway travel. The setting is not tied to any particular area. Rather there are background parameters which can be varied to simulate different traffic circumstances.

The findings on the effectiveness of rail subsidies in the absence of other measures is of relevance to this report. Given the choices facing commuters the effect of the rail subsidy is to raise the *relative* cost of freeway travel. But it also reduces the price of rail relative to back road travel. It does not have the 'fine tuning' necessary to get an efficient allocation of traffic among freeway, back road and rail. And as it is a general subsidy which does not discriminate between peak and off peak, it will not affect peak versus off peak driving. It therefore has no means of influencing the redistribution of traffic through the day.

A uniform 'congestion 'tax' on the other hand has the potential to affect peak versus off peak driving. This could take the form of a single uniform charge for access to a freeway in peak hours. It makes peak hour freeway travel expensive relative to other modes and times of travel. But it cannot

influence the allocation of freeway space between users with different values of time within the peak period. A single priority lane toll can do this.

Depending on the initial traffic share of the various transport modes, the ease of substituting among them and the cost of delays to travellers, a picture of the optimum combination of taxes and subsidies will vary. But a uniform congestion tax is an essential ingredient if maximum efficiency gains are to be made. Parry finds that it alone can capture 90 percent of the improvement of an ideal combination of policies. Rail subsidies alone, by contrast, will typically capture less than a quarter of these gains. Only if rail is carrying a two thirds share of all traffic to begin with will a rail subsidy be even half as efficient as a congestion tax. One of the problems is of course the rail subsidy's ineffectiveness in influencing peak versus off peak travel. And as Parry points out (p. 17) it 'has the additional drawback that it increases the overall demand for travel'.

However, there is reason to believe that while public transport subsidies may be considerably less efficient than ideal road congestion charging, they may be *relatively* more effective in Sydney than in typical American situations if public transport's share is the critical factor. As Hensher (1998, p. 193) points out, public transport in Australia has a substantial market share 'where there is a concentration of activity'. It is worth noting that while a two thirds initial share of traffic carried by public transport (rail in Parry's model) is considered an extreme case for the US, 78 per cent of *commuting* traffic to Sydney's CBD is carried by public transport, even though only 11 percent of *all* journeys in Sydney are made by public transport.

There are clear limitations to analyses of this kind. The exclusion from consideration of other transport externalities is one. But the relative importance of congestion costs can justify this. More critically, only congestion of *freeways* and their associated costs is addressed. The use of local roads as a transport alternative is recognised and modelled but not the possibly significant costs of increased peak hour congestion through traffic shifted from freeways to back roads. Adding subsidised bus travel to the modelling would, as the author recognises, (p. 21) increase the potential efficiency gains of a general public transport subsidy (rather than as previously a rail only subsidy) would offer greater efficiency gains.

Few studies of this kind attempt to define gains in social welfare in a broader sense that includes distributional effects. Parry however does consider the implications of defining efficiency gains more widely to allow for high and low income travellers. But explicitly weighting the gains to low income travellers higher than the gains for wealthier ones has little

effect on the relative efficiency of the different policies. Parry also considers, but does not attempt to quantify, the implications of the popular notion that those on higher incomes are bigger users of the peak hour freeway while lower income commuters rely more heavily on rail. This would mean that high income earners would bear a relatively higher proportion of a congestion tax and the relative performance of the public transport subsidy would improve.

The omission of spillover effects from freeway congestion pricing to local road congestion is a serious limitation on the usefulness of these results. The opposition to explicit congestion charging is strong and part of the explanation is the justified concern of those living near and using alternate road routes. The widespread use of 'traffic calming' regulations and devices to reduce speeds and traffic volumes on local roads has often been claimed to have had little overall impact on the main problem – the *total* volume of road traffic (Goodwin 1998).

Implementing congestion charges

Singapore is one of the few large cities to implement a congestion charging regime.

Singapore's approach has varied over the years. The early attempts were through artificially raising the cost of car purchase and registration. Later direct vehicle control schemes using 'entry charges' were introduced in 1975. These consisted of licences which had to be purchased for entry into the city during the morning peak (later extended to the evening as well). Levied on top of existing parking charges, these 'effectively doubled the cost of driving into town' (The Economist, 5 September 1998). The annual road tax was doubled.

While significant road speed improvements occurred during the peak, there was increased congestion either side of the three hour time zone and on local roads as drivers sought to avoid the toll.

By 1998 electronic tolling for all cars had been introduced with the capacity to vary tolls by day and time.

An attraction of road user charges: the double dividend effect.

As discussed earlier the efficiency effects of any particular tax or subsidy cannot be fully judged without taking into account its implications for other taxes and the flow on effects of this. This is one reason why road

charges have proved so attractive to policy analysts. Not only do they directly target and reduce a major contributor to the estimated unpriced social costs of road use. They also create scope for reducing some other distorting taxes that are reducing economic performance but have been regarded as a necessary evil from a revenue raising point of view. For this reason there is reference to the 'double dividend' effect.

What should be the basis for comparison when judging policy effectiveness?

In judging the effectiveness of different instruments to deal with transport externalities, analysts have had to first specify the 'base case' or reference situation with which they are making a comparison. This is important because the *ideal* taxes and subsidies are set at a level that will close the gap between private and social costs and benefits (after allowing for any 'double dividend' effect). They will fully 'price in' the externalities. But these externalities themselves, and the size of the gap, depend on the level and type of transport activity to begin with. And this in turn depends on what is assumed about the level of taxes and subsidies facing the public *before any change is made*.

One accepted method is to look at the economy 5 to 10 years ahead and build in the levels of transport activity and externalities that we would expect to encounter if nothing is done to change today's policy settings. This gives the base case with which comparisons are made. If formal economic modelling is used then the prices and quantities of transport services are often assumed to be ones which balance supply and demand.

The results of different policy mixes: a Belgian study

A recent example of this approach is provided by simulation modelling of outcomes for Belgium, comparing outcomes in 2005 using current policies and those that would be implied by the use of optimal road charges combined with public transport subsidies and fuel taxes (de Borger and Swysen 1999). The modelling allows for the flow through of effects of current regulations on vehicle emissions and for projections on traffic growth and mode use. Both passenger transport and freight are included. The transport tasks modelled are 'interregional', but, being for intensely settled and urbanised Belgium, the implications would seem to have relevance for the urban corridor of NSW.

Like metropolitan NSW, the Belgian market share of public transport is relatively low (projected at 15 per cent of passenger kilometres in 2005

under current arrangements but with a bus-rail share that favours rail – 9 per cent versus 6 per cent).

The *shadow cost of public funds* is the term used to recognise that revenue raised from transport taxes and charges reduces the need for some other tax burden. Alternatively, any transport subsidy has to be financed with additional taxes on other sectors. The Belgian simulation study sets this at an additional 5 cents in the dollar for every ‘subsidy dollar’ raised and also examines the results if any such cost are ignored. (Australian estimates put this social cost of taxation much higher. Han (1996) puts them as high as 60 cents for payroll tax, the pre-eminent state tax but the author concedes that such high estimates are likely to be the result of his specific modelling assumptions.). Small (1998) suggests 25 cents in the dollar as reasonable for the US.

The Belgian study assumes that full electronic pricing of road use, including time of day pricing (peak-off peak discrimination) is feasible. This assumption is then removed and the authors look at more limited pricing options for dealing with transport externalities, including the case where the introduction of increased road user charges is infeasible and altered public transport subsidies are used as the sole pricing instrument to get optimal transport flows and mixes. Transport ‘prices’ are generalised prices defined to include the time cost of travel per kilometre (which differs in peak and off peak periods).

The results show that big welfare gains are theoretically obtainable, but

- they rely for their size on being able to implement big imposts on private road users, especially in peak periods. The main gains are from reduced congestion and the scope for tax relief in other areas;
- when such charges are feasible they are also best accompanied by public transport charges that slightly *exceed* the marginal resource costs of public transport (ie. subsidies in this sense are not advised); and
- the implied increases in private road use ‘prices’ is very large, more than doubling base levels but the pay off is to reduce transport social costs to little more than one third of their base level.

If optimal road pricing is not feasible, either for political or technical reasons, the results change dramatically, especially if fuel tax manipulation is ruled out.

- in most situations, the use of public transport subsidies (charging prices less than the marginal resource cost of the service) are justified;

- the results become highly dependent on the degree of substitutability between private and public transport;
- the greater the substitutability the bigger the optimal subsidies on public transport; and
- while there are gains from reducing social costs including congestion impacts through public transport subsidies, they are at best 5 percent of what they might be with optimal road pricing. With the assumption of little responsiveness of car travel to subsidised public transport this falls to 1.4 per cent or roughly \$45 million annually.

Road price modelling for London: targeting congestion through cordon charging

A slightly earlier attempt at modelling the likely impact of road pricing alone is reported in Bates (1998, p. 183) where the so called APRIL model of congestion charging for London, developed in the early 1990s, is employed. (The capacity to analyse various congestion charges was developed through this model but charges have never been implemented.) The charging concept used is that of *point based cordon charging* with a vehicle incurring different charges as it passes points nearer and nearer the centre of London in the peak period. This reflects the reality that congestion only becomes a major source of social cost in the region for Inner and Central London. Simultaneous changes in transport prices are not considered.

Rather than estimating optimal charges the study focuses on the effect on car and other mode use and the externalities created for several arbitrary charge levels (£2, £4 etc). Nevertheless, accompanying calculations show that the overall economic benefits could be substantial and are sensitive to whether charging in both directions is adopted. Overall benefits between £277 million and £446 million annually (in 1991 values) were identified.

The modelling predicted significant mode shifts in response to these highly targeted congestion charges, despite relatively low responsiveness of public transport travel to motoring costs. Rail travel patronage would benefit from switching by longer distance travellers while bus travel would increase for short journeys. The model predicted these shifts, notwithstanding the fact that the generalised price of public transport journeys was adjusted to capture the effects of peak period overcrowding by increasing the value of travel time incorporated in the price.

Modelling optimal road tolls for Sydney

Modelling of the effects of *optimal* road tolls for Sydney has been performed by ARRB for the BTCE (1996b). This modelling found that if differential charges could be applied on different road types during peak periods, congestion charges could yield net benefits in Sydney of \$521 million annually. This figure allows for a significant reduction of car user benefits as car users are diverted from their preferred mode to others by the change in relative prices that would disadvantage road use. Optimal charges were estimated to vary from 62 cents per vehicle kilometre in the CBD to 21 cents on inner arterial roads and seven cents on outer arterials. It is not clear what the implementation costs would be although BTCE (1996b, p. 313) report that they have been included (as costs of smart card readers, intersection readers etc.) at \$150 per vehicle.

Economies of scale, externalities and the case for subsidies

The prospect of changes in the relative price of different means of transport shifting demand onto other modes that already have capacity problems raises questions about the role of subsidies (and of road charges) in the longer term when pricing decisions must be linked to decisions about capacity and capacity enhancement through investment.

Peirson and Vickerman (1998a) claim (pp. 62–63) that there are two critical analytical points in the economics of transport. One is scale economies and associated lumpy investments. The other is the role of congestion. Interaction between the two is important for the direction that policies on subsidies and charges might take. As they point out

‘ scale economies could, on the one hand, be used as a justification for maintaining modes of transport with large external effects because the scale economy effect reduces the full social costs to the community. On the other hand, if environmentally less damaging modes have higher internal costs making them expensive to provide but with the potential for securing substantial scale economies, can this be used to justify public subsidy in the interests of exploiting the scale economies?’

Pricing at short run or long run marginal social cost? The importance of economies of scale

Once infrastructure has been installed many of its costs are sunk. From one point of view these costs are irrelevant for the purpose of arriving at an efficient price for accessing that infrastructure. Marginal costs are what matter, so long as these include not only internal (operations and mainte-

nance) but also external costs of additional pollution, accidents, congestion etc. But the *average* cost (eg. per person kilometre) of meeting customer demand will include those costs that do not vary with output.

If a new public transport facility for instance has average costs which fall with increased patronage and price is set only to cover short term *marginal social costs*, a financial deficit may result. Infrastructure costs are ignored in such pricing decisions in order to get the optimal utilisation of *existing* capacity while allowing for the differing external costs of different modes. Thus while unwanted externalities are *taxed* as part of the pricing decision it may still be that a subsidy in the sense of a financial cost deficit is implied and has to be funded.

If such pricing induces a switch from, say, congested roads and this lowers the adverse externalities sufficiently, this may cancel out the deficit in a full cost sense. But will the taxes on externalities that become part of this approach to pricing be sufficient to cover the financial deficit for the transport sector? And will increased public transport capacity be required and if so how should this be related to the pricing issue? And how should augmentation of road infrastructure be linked to congestion charges? Such considerations have been explored by Peirson and Vickerman (op. cit.) by modelling transport pricing for peak and off peak London and interurban travel in the U.K.

This study shows what a big difference economies of scale in any of the main transport modes can make to conclusions about optimal taxes or subsidies to tackle transport externalities. By estimating optimal prices for travel (and consequent demand for travel by car bus train and underground) that recover both the long run *internal* costs of additional travel (long run marginal costs) and the externalities including congestion, Peirson and Vickerman report efficient price results that vary greatly for most transport modes depending on whether internal unit costs are constant (constant returns) or are decreasing (increasing returns) in response to increased travel over the longer term (10 years).

One major objective of their study was to allow for the possibility that the use of efficient prices that attempted to include marginal social costs might nevertheless fail to bring about significant redistribution of the transport task because of capacity constraints on modes experiencing higher demands. To do this required long run capacity expansion (investment) to be modelled.

Table A.3 in the appendix gives selected results from this study which builds in assumptions about long term relationships between income

growth and the responsiveness of demand for different types of travel to *income* growth as well as responsiveness to changes in *prices*. Price settings have to cope with the fact that as incomes grow the demand for transport modes expands at different rates. Congestion on different modes is an external cost which both influences (tax inclusive) price and is influenced by it. The Peirson and Vickerman study, however only allows for 'optimal' congestion, and that only on roads. (Optimal congestion means that the congestion level is such that the additional congestion cost from extra traffic is just equal to the cost of avoiding that extra congestion by expanding infrastructure.)

Where scale economies are absent tax inclusive prices which are set to reflect the different levels of externalities imposed by the different modes differ widely from their present levels.

Long run efficient prices, combined with the investment required to satisfy long run demand, imply long term subsidies to public transport and rail in particular. Car travel in London would see its marginal social costs taxed at levels that would yield a substantial financial surplus.

But a major conclusion from this London based study is that 'efficient pricing and taxation of externalities is not sufficient to give substantial shifts to modes of transport with lower external costs' (p.73). In other words the use of 'user prices' that include taxes on external effects will not cause significant shifts from car to public transport.

These results are not altogether surprising. Much depends on what is assumed about price responsiveness compared with income responsiveness of travel demands for different modes. Based on the available evidence price responsiveness of travel demand is low – whether it be car travel in response to car travel costs or car travel in response to public transport prices.

If long run internal marginal costs are well below average costs, as they will be with significantly increasing scale economies, investment in transport will help to lower internal costs per additional passenger kilometre and the tax component of price becomes part of a pricing 'package' with the price being a combination of internal costs and taxes on externalities. But if investment in transport infrastructure – both roads and non-road – occurs in tandem with price adjustments to meet long term demands, mode shares may be little changed according to this study.

Elasticities and the role of subsidies

The effectiveness of public transport subsidies in controlling transport externalities depends partly on the influence they have on fares, and, through these, on the relative price of travel by these modes compared with car. The influence is only partial because subsidies can also be used to change the quality of service at a given fare – through expenditures that change journey speed, frequency, reliability, comfort and safety. The EPA and NCOSS have emphasised that these factors play a significant role in inhibiting public transport patronage. Mees (2000, p. 86) also points out that '...public transport is already cheaper than owning and operating a car. It is flexibility, convenience and door to door travel times that count most'.

It has been emphasised that what matters in travel choice decisions is not just the fare but the 'generalised price'. This includes the monetary value of the cost of travel time (including waiting time). Subsidies that have a bearing on either fares or frequency and speed both affect this generalised price. But the starting point for measuring the sensitivity of public transport usage to 'price' is usually fares.

Most of the available evidence is that these sensitivities (elasticities) are low. Luk et al. in a 1994 study of responsiveness of demand to bus pricing, for instance found that overall fare elasticities were between -0.27 and -0.35. There were important differences between peak and off peak travel however with the latter being twice as price sensitive. This pattern is broadly true for rail travel as well.

The peak-off peak difference in elasticities has a potentially important implication for the use of subsidies. It suggests that there is likely to be a greater proportionate loss of public transport patronage in off peak if subsidies were reduced, for instance, than if the same resulting price rise were imposed on peak time travellers.

Conclusions based on fare elasticities require caution. When the *generalised* price of travel (including access time, waiting time, transfers etc) is the subject of change, elasticities are found to be considerably higher.

This concern on the part of stakeholders was reported by IPART (1999, p. 34) in its discussion of the likely effects on revenue and patronage of a weighted fare increase for CityRail services in the Sydney metropolitan region.

Recent work by Hensher (1998) estimates the responsiveness of CBD commuter trips to fare changes and car travel costs for a variety of ticket types (weekly, single, travel pass etc.) for Sydney train, bus and car travel.

An interesting outcome of this work is the finding that while the responsiveness of travel by one mode to another's price is invariably low – in line with international research – the effects are asymmetrical. The highest 'cross elasticity' is the responsiveness of demand for train travel passes to an increase in car travel costs. The estimated corresponding response of car travel to a change in travel pass price is negligible. This suggests that the use of increased train subsidies to target altered behaviour by car commuters will have negligible effect. Increased costs of car travel on the other hand will engender a somewhat bigger switch to travel pass train commuting.

Another result to emerge from this commuter study is the estimated value of travel time savings for different kinds of traveller. The average value was \$3.36 per person hour for train, \$4.60 for car and \$4.75 for bus. Since we expect the value of time to increase with income this provides some indirect support for the redistributive benefits of *rail* subsidies at least.

The growth in non-commuter travel is becoming relatively more important. Work undertaken for the Tribunal by the Institute of Transport studies in 1996 (IPART 1996) used both stated preference (what people chose in hypothetical choice experiments) and revealed preference (what was observed) techniques to estimate public transport demand elasticities for both commuters and non commuters. While there is not a consistent pattern, fare elasticities for some kinds of train tickets (eg. travel passes) are considerably higher for non commuters. Similarly CBD–non CBD travel elasticities reported by the SRA to the Tribunal show higher values for non CBD travel.

The use of price to influence travel demand may have its strongest prospects in the non commuting market. The elasticity of concession versus 'full fare' travel is an issue that merits further investigation given the importance of concession travel in total demand.

Parking charges and availability

As it is the generalised price of door to door travel that ultimately enters travel calculations and mode choice the price and availability of parking is a component that has potential influence. While road charging is rare parking charges and rationing of parking space (increasing time costs) is a much used device. What is its potential for influencing total travel, mode choice and road use externalities?

BTCE (1996b) developed a model of six Australian capital cities in which the possible impact of introducing uniform parking charges on commuting

was explored. The modeling was equivalent to introducing a 'trip charge' on road commuters on top of any costs they might already face. Very conservative responsiveness of the demand for car travel to parking charges was assumed (-0.03). Not surprisingly the overall impact was slight.

The equity implications of this modelling are again of interest. BTCE reports (p.120) that in the base case (the current situation before introducing such a charge) the low income households pay much less proportionately than high income ones reflecting the lower proportion of these households commuting by car. The charge is regressive with the burden increasing relatively more for low income households.

A more recent paper by Hensher and King (1999) uses the stated preferences of drivers to investigate the likely impact of both price and supply of parking in Sydney's CBD. One of the key questions asked was whether drivers would switch to public transport in the face of adverse (from their point of view) changes.

The results stand in sharp contrast to the earlier BTCE work where elasticities were assumed rather than estimated. The authors find that 'In general there is high sensitivity to parking prices, far higher than one finds for in-vehicle cost and even travel time in modal choice' (p. 1). Hours of operation of parking were also varied. It was found that there was much greater sensitivity in the potential switch to public transport in response to parking price than in response to hours.

Hensher and King conclude

The evidence suggests that the imposition of a curtailment of hours of operation at specific locations will lead to a relocation of parking and some small switch to public transport, but essentially a continuation of driving into the CBD. Increases in (parking) tariffs however will secure significantly greater use of public transport. There is virtually no loss in travel to the CBD.

Road pricing in practice: the phantom policy

Despite the theoretical evidence pointing to the efficiency gains to be had through road pricing, and the relative ineffectiveness of public transport subsidies in dealing with externalities 'the main real world experience of road pricing is of its continual non-implementation' (Goodwin 1998, p.127). Public transport subsidies, on the other hand, are virtually universal.

Work conducted in New South Wales points to an expected resistance to the introduction of road charging and the recent experiences with tollways reinforces the conclusions of those such as ACIL (1996) and the NRMA (1997). In discussing the results of the NRMA survey which addressed measures to tackle Sydney's air quality, Adam (1998) makes the point that not more than a quarter of those surveyed favoured anything 'restricting driver behaviour or penalising drivers'.

By one view, road pricing is neither necessary nor sufficient for a successful transport policy. But what is meant by 'successful'? Should it be measured against the potential efficiency of a policy mix that ignores implementation problems such as those facing the inclusion of road pricing? Or should it be gauged against the estimated outcomes that would have occurred without the real world policies that have been adopted?

The first approach is the one illustrated by the cited work of Parry, Peirson and Vickerman and others. Borger and Swysen look at 'what might be' in Belgium five years hence under the status quo policies and alternatives that could include road pricing.

There is little analysis that tries to measure the 'what would have been' or 'what might be' outcomes of, say, removing the general subsidies to rail while still avoiding road pricing measures. Nevertheless, there is a body of evidence that points to the limitations on fares and fare subsidies as an effective tool for effecting mode switching. NSW Treasury, in its submission to the Tribunal (May 2000) reasons that in view of the low fare elasticities of demand for public transport, any changes in fares that might result from changes in subsidies are likely to be swamped by long term trend growth in car based transport.

Changes to the generalised price of bus and train travel however, may be capable of effecting change. Adam (1998) in reviewing survey evidence on the likely patronage of the new Parramatta Chatswood rail link, puts the view that 'overall, people tend to assess and be most sensitive in selecting a (travel) mode on the basis of the door-to door travel time in their choice', including walking time.

Two important conclusions emerge from this. One is that successful mode switch policies can be influenced by at least one implementable road price related variable – the availability and cost of *parking*. The second is that we may have to look increasingly to investments that modify access, availability, frequency and reliability of public transport rather than to 'lower than otherwise' fares to achieve switching goals. This is taken up in the

next section, along with consideration of other ‘non-price’ approaches, including land use planning.

We turn to these issues in the next chapter.

Summing up on second best subsidies

Many of the marginal external costs of road use are measurable but estimates vary widely depending on whether peak or non peak conditions are relevant, depending on the value of time, and on whether a short or long run perspective is taken.

‘First best’ remedies would involve charging for these externalities directly. The Western Sydney Regional Organisation of Councils submission has called for the government to consider road user charges. Congestion charging in particular is a theoretically attractive way of signalling one of the major external costs of private road use to motorists. Some modelling suggests the efficiency gains could be large. (But even with congestion pricing mode shifting in response to relative price changes may not be large if infrastructure investment in *both* road and public transport is occurring.)

If congestion charging is considered impractical, there are some changes to the generalised price of car travel that may have an impact. CBD car parking charges are one such possibility.

Public transport subsidies on the other hand appear to have a limited role in bringing about change in commuting behaviour. Very low own and cross price elasticities for peak commuter travel have been estimated, limiting the likely effectiveness of subsidies in dealing with peak hour congestion. These elasticities may be higher for off peak, non work, non education related travel, which is becoming a more important part of the total transport task. Subsidies may be somewhat more relevant to this kind of travel choice – *provided the choice is there to be had*. But how should any such subsidy relate to externalities?

If the marginal external costs of road use can be estimated, it would be a good indication of what to charge road users. It does not follow that this same amount is what should be deducted from a public transport passenger fare if the road charge is not feasible.

An optimal tax on one activity does not equate to an equivalent optimal subsidy on a substitute. And non price solutions may have more to offer.

5

Non price approaches and compatibility with subsidies

THE AVAILABLE EVIDENCE ON THE ABILITY of public transport subsidies to influence travel behaviour through reducing the relative cost of travel suggests they have a limited effect. One reason for this is because fare subsidies only effect one component of the 'generalised price'. But government funding of 'lower than otherwise' fares is only one way in which tax payer money can be used to influence travel outcomes. Investment in Public transport Infrastructure (unaccompanied by *general* fare subsidies) is one way. The effectiveness of either subsidies or government investment may depend on accompanying land use planning restrictions.

Urban planning

In its document 'shaping our cities' the NSW Department of Urban Affairs and Planning (DUAP 1998) set out an urban design planning strategy which listed the following as one of its basic principles.

'Shaping the distribution of land uses and designing developments to support viable alternatives to car use'. (p. 9)

In doing so DUAP noted that between 1981 and 1991 population in the Sydney region grew by 9 per cent while car use grew by 20 per cent, that the Government's Action for Air program viewed this as unsustainable and targets zero growth in *road* kilometre travelled by 2021. It suggests that

'One critical long-term means to improve and maintain the region's air quality is to make our cities more compact and distribute land uses to manage travel demand.' (p. 10)

Some progress has been made in this direction with DUAP reporting that 'reliance on the urban fringe for new housing has been reduced from 42 per cent in 1993-94 to around 30 per cent in recent years and touching a low of 27 per cent'. There is reference to affordable housing initiatives in Ultimo-Pyrmont and Newcastle.

But despite this, as DUAP recognises, 'new residential estates in outer areas are often the only real choice for many people purchasing a new home' (p. 13). This affects the kind of changes required to eventually limit growth in car kms travelled in the Sydney region. Successful policies may have to face the fact that a significant proportion of new household formation will continue to be distant from the CBD and further from established public transport networks. Along with this, travel patterns are increasing in complexity and the ratio of trips to work to all trips continues to slowly decline. This has (possibly different) implications for handling 'total travel' 'congestion creating travel' and 'pollution creating travel'.

Urban design

DUAP (1998) has argued that there are a number of ways in which urban structure can contribute to travel minimisation and a shift towards public transport. These include:

- encouragement of mixed use centres which have the advantage of focusing trip destinations maximising public transport use;
- early planning stages of new transport corridors to take account of land uses that will benefit from public transport; and
- further integrating services and mode changes while improving cross regional public transport to cater for diversifying trip patterns.

Other cities have tried to encourage substitution away from the car using planning instruments.

Hensher, (1999) examining the case for bus transitways in preference to light rail, cites the contribution of planning restrictions and investment prioritisation in Ottawa's successful public transit development. In Ottawa a land use and transportation plan which legislates precedence for public transport over all forms of road construction and road widening is in place. According to Hensher, planning regulations require developers to concentrate development near public transport, to orient buildings and private access to transit stops, to provide walkways and transit only roadways through developments, and to enter into agreements with the municipality on matters such as staging construction to accommodate transit' (p. 13).

Public transport accessibility, urban form and public transport use

The interrelationship between public transport and urban planning and development has some 'chicken and egg' aspects. Transport links help to

shape the urban form and the urban form can influence the demands for transport. Headicar and Curtis (1998) have examined the way in which the siting and form of new residential estates in Oxfordshire, England might influence car travel. Their studies were however based on surveys of residents of fringe developments with varying access to *existing* motorways and intercity rail services. They concluded (p. 237) that 'As a general rule public transport has little or no significance for new estates regardless of the transport opportunities available.' They argue that authorities should act to 'locate development not so much where it offers the *choice* (emphasis added) of public transport but where it is likely to discourage extensive car use.' (p. 240)

The question posed by this kind of research is about where and in what form to encourage new development *given* a public transport network and whether such decisions will make a difference to modal shares. Different answers may be obtained where urban development and transport links are proceeding more or less simultaneously.

In Brazil, Hensher (1999) has observed the contrasting experiences of several different cities. In Curitiba an integrated transport-urban development plan has been consistently implemented over 30 years. It has seen high density development confined to within short distances of five radial transportation axes with median strip bus transitways. An efficient transport system has emerged. This contrasts with cities such as Sao Paulo where bus based transitways have been implemented 'in isolation from coherent planning and land use strategies.' (p. 14)

In seeking tools other than price to manage transport demand, its composition and its social costs, there are clearly ways in which urban planning can help but the limitations are related to the maturity of the urban environment in question. The same consideration applies to the ability of the transportation system to shape the urban form and through this, shape future transport demand.

On the latter, Hensher (1998, p. 196) points out that in Australian cities the transport systems are already highly developed, the built environment has a very long life, (thereby limiting the pace and influence of beneficial *redevelopment*) transport tends to be a falling rather than a rising cost share of commercial activity and information based firms are location flexible. All of these highlight the limitations on transport's influence.

The extent to which future land use planning can contribute to transport demand management is the other side of this issue. The Ottawa experience suggests that strong regulatory control can have an impact but of course

this comes at a cost (unknown) as property rights are attenuated and commercial and private choices are limited by the effects of the legislation

Whatever the ability of deliberate policy action through urban land use and transport planning to affect transport demand, the changes in urban economies that occur over time have an effect on public transport's share.

Concern about the long term struggle to turn around urban rail travel's falling share of the total has repeatedly drawn attention to the fact that rail's comparative advantage is restricted to the high density corridors linking ribbon development to a major work generating terminus like Sydney's CBD. Rail commuters typically live within one kilometre (walking distance) of the stations. But as the urban form slowly evolves away from this CBD orientation in Sydney the circumstances for rail's highest density operations are under threat.

Increasingly the development of major regional job centres like Parramatta and Chatswood will diminish the proportion of total rail travel that is CBD commuting. This raises issues about not only the best pricing (and subsidy) response but also the appropriate *investment* responses to deal with these urban dynamics.

Part of the change in urban economies is the change to more flexible work practices. This can have conflicting effects. On the one hand it can mean people living further away from traditional work centres because of a reduced need to travel as often. This can lead to longer but fewer trips. On the other hand as Brewer (1998) has discussed in the US context, it can lead to a more even spreading of highway traffic loads, easing capacity constraints and deferring expensive capacity augmenting investments.

Public funding at the infrastructure stage

In its *Action for Transport 2010* the NSW Government outlined an extensive program for addressing Sydney's transport infrastructure needs over the next decade. An estimated \$300 million per year for new and improved rail infrastructure and \$70 million for bus transitways was foreshadowed.

Direct expenditures of this kind are usually not considered by public transport advocates as a substitute for fare subsidies. Nevertheless, where there are social costs associated with raising tax revenue to fund either, the relative effectiveness of investment and general fare subsidies becomes an issue.

Government funding is typically involved at both the infrastructure construction stage and the ongoing operations stage for new transport infrastructure. Its effectiveness in delivering net social gains may depend on the split between the two.

Subsidies which target price, and through price, patronage, can only contribute to the correction of the external costs of road use if they have pronounced effects in constraining increased road use. They will have no such effect where choice of a public transport alternative is not an option. As the Tribunal has recognised (Report no. 3, 1999) this has been an issue in Sydney for other than radial journeys.

Cost benefit analysis of investment alternatives for enhancing transport infrastructure networks such as the Parramatta Chatswood rail link and the Liverpool bus transitway require the inclusion of the avoided social costs of future road use in the calculation of the present value of future benefits. Such project evaluation weighs up the total social benefits of the project against the total social cost. Of course, a major element in the benefit calculation is the *private* benefits that accrue to future users measured ideally through their willingness to pay. But there are also benefits to current users of both road and rail who will have their travel efficiency enhanced. For existing users there is the equivalent of a fare or journey cost reduction.

If subsidy -inclusive prices are used in cost benefit analyses the subsidy must be deducted to calculate the net benefits. The social cost of the subsidy also needs to be deducted. The social cost of the subsidy is created through the efficiency losses of the tax burden or of any crowding out effects of additional government borrowing. However, this is omitted in most studies.

There is merit in building estimates of any avoided road externalities into the benefit component of public transport investment appraisal. The economic rate of return on such investments and the present value of incremental benefits are appropriate aids to decision making. Both will be influenced by inclusion of these external benefits. And the lower the price the larger are these and other consumer benefits. If subsidised prices are used to calculate benefits in these infrastructure investment appraisals, care must be taken to recognise that the subsidy is a transfer of benefits from the rest of the community. The difficult issue of the appropriate size of any such subsidy remains. An analytical illustration is provided in appendix C.

There are two main dangers in this approach of trying to capture externalities at the infrastructure choice stage. One is only indirectly related to the

measurement of externalities. It is the tendency to grossly over-estimate patronage for new public transport infrastructure. Recent experience with Sydney's airport link is replicated elsewhere. Small (1998) reports that of 10 rail transit systems recently built in the US, ridership was overestimated in every case and the errors were very large. Such errors will give inflated estimates of avoided road externalities.

Second, there is a good deal of uncertainty in the measurement of these externalities. This will inject further uncertainty into the cost-benefit analysis. But given the magnitude of patronage estimation errors, this may be a second order issue.

6

Summary and conclusions

THE BIGGER THE DEMAND for road use for travel purposes, the bigger are certain external costs borne not by the individual road user, but by others. Public transport also generates some, but not all, of these externalities and typically at much lower levels per passenger carried. Stakeholders have submitted arguments that the full social costs of road use are a relevant consideration in setting transport fares and subsidies. Some have called for Government to give consideration to road user charges.

Which costs comprise social costs?

The full social costs of road use include both the private costs of vehicle ownership and operation (including time costs) borne by the individual motorist and those borne by the wider community. They include the resource costs (the operating and maintenance costs of vehicles and road systems, the opportunity cost of capital embedded in land and structures) and the noise amenity and pollution costs and any costs to safety or congestion that are not already accounted for by the individual motorist.

Different costs are relevant for different policy purposes

Any performance comparison of the *cost effectiveness* of existing different transport modes (cost per passenger kilometre for example) should include all of these social costs. These *total* social costs are not, however, of direct use in either investment appraisal or pricing to manage externalities. The costs and benefits that are relevant for cost-benefit appraisal of alternative transport projects are the *incremental* social costs and benefits associated with each option.

Because the full social costs of road use are not faced by road users, road use is higher than it would otherwise be. It grows faster, as does the demand for additional road infrastructure. Ideally, the price faced by the user of each mode would include *all* of the costs that vary with greater use of that mode – *the marginal social costs*, comprising both marginal private costs and marginal external costs.

Australian and overseas attempts to measure these additional costs vary widely in their results even when broadly comparable definitions of externalities are adopted. For most studies, however, congestion costs dominate others (which include air pollution, external accident costs, greenhouse and noise effects etc.) The exception is American work that includes controversial external parking and land use costs which, when included, exceed congestion costs and result in estimates of the external costs that are more than double those reached under the narrower definition. If this broader definition of external costs is adopted, such costs per vehicle kilometre exceed the variable *private* costs of road use – those costs to the motorist that vary with kilometres travelled – for urban peak hour road use. They are clearly significant costs. How should they be incorporated into transport pricing and investment decisions?

When performing economic cost benefit analysis of how best to service changing transport demand, infrastructure investment decisions about additions to the road network should include these costs. They are also relevant to infrastructure investment decisions in deciding between different public transport options. The avoided external costs of road use become relevant in such choices.

Cost benefit analysis of a bus transit way versus light or heavy rail extension, for example, would legitimately include the avoided costs of road travel that each could deliver as part of the social benefits of the options under consideration. If these costs were already priced into road use no such adjustment to the social benefits would be warranted.

Marginal, not total externalities are relevant for pricing

The appropriate signal to road users to get them to moderate use would be the *marginal* external cost they impose. *Total* costs are not relevant to achieving this.

Road user charging, if practical, would need to include long run marginal external costs to achieve efficient pricing and timing of new road infrastructure investment.

But it is not straightforward to decide which definition of external road user costs should be used for these purposes. Marginal external costs are different for peak hour urban roads than for off peak and are different again for rural roads, for example.

Political and practical implementation obstacles continue to hold back the use of road charges that might target these externalities directly and help to

bring private and social costs of car use closer together. International examples of attempts to control congestion through road use charging are limited and have had some unwanted accompanying local effects.

Subsidies are a very second best means of pricing for externalities

In the absence of efficient road pricing, subsidisation of public transport is a second best means of bringing external road usage costs to account in transport pricing and investment decisions.

The international attempts to *model* the likely impacts of road use charging have in a number of instances included public transport subsidies as a complementary or alternative instrument for modifying road use to more efficient levels. These studies point to significant potential gains where road user charges are part of a larger policy package. CBD parking charges have been shown to hold promise in Australian studies. Public transport subsidies on their own seem capable of delivering only a fraction of the benefits of these more direct methods, particularly when the social costs (efficiency losses) of tax funding of subsidies is taken into account.

Subsidies to achieve transport demand management depend critically on price responsiveness. Evidence suggests this is low in Sydney at least. However, differences have emerged for commuter and non commuter travel which may have some relevance to fare setting.

Overall the evidence suggests that manipulation of the relative price of car travel and public transport via general public transport subsidies have a weak, even negligible effect on mode switching by existing travellers and therefore on the demand for road use at any point in time. However, their reduction from current levels would reduce the economic welfare (consumer surplus) enjoyed by *all* fare paying customers on public transport whose fares increase as a result. The severest consequences would be for those who have no (or very limited) mode choice. Subsidy reduction would arguably worsen equity to the extent that it is the poorer citizens who have poorer car access.

Some other grounds for subsidies remain valid

Although, fare subsidies are not the most effective instrument to change transport mode choice they can be used to achieve other objectives. There are reasons why government will wish to subsidise travel on public transport by targeted groups. These objectives are typically only incidentally related to achieving more efficient road use. These motives

include the delivery of identified social program objectives and community service obligations through fare concessions. The purchase of public transport services by departments of education on behalf of the families of school children is an example.

General fare subsidies may also be argued for on equity grounds, but this may be an expensive and questionably targeted means of delivering greater equity given the benefits it simultaneously confers on better-off travellers. Certain routes in Sydney for instance have a concentration of subsidised peak hour train and ferry traffic where patronage is drawn heavily from better off sections of the community. Distributive justice may be improved by such subsidies if this is judged to have improved simply by making poorer travellers better off regardless of the windfall enjoyed by the more affluent users. But lower fares to all come at a price elsewhere.

Taxation cost of transport subsidies should not be ignored

Efficiency losses created by the need to support subsidies with higher taxation have to be taken into account. Some studies suggest that a conservative estimate of such costs would be 25 cents in the dollar (again a distinction between average and marginal costs may be important here). State taxes which fund public transport subsidies in Australia include payroll tax which has been cited elsewhere as distorting labour markets and others like gambling taxes which have been argued to be regressive, with the burden falling relatively heavily on low income households. One of the attractions of road user charges is the scope they provide for reducing other distortive taxes.

Externalities are not being factored into fare subsidies

This review could find no evidence that estimated road cost externalities have been *quantitatively* linked to finding the level of fare subsidies that are then applied *in practice*. While various states have acknowledged the potential environmental benefits from expanded public transport use, none have explicitly attempted to work these into fare setting.

An estimate of marginal road use externalities is not the optimal subsidy to apply

Calculation of an optimal subsidy needs to take account of price elasticities which vary from mode to mode and across markets (commuter–non commuter etc.) But that leaves the current level of general fare subsidies open to the criticism that they are largely unrelated in any way to avoided

road use externalities. The European studies discussed in this review produce modelling results that show that some degree of subsidisation is usually warranted. But no modelling has been undertaken for Australian cities that tries to solve for the optimal subsidy level in the absence of hypothetical road charges.

Non price instruments, including urban planning, have a role

Whilst road user charging is the ‘first best’ way of using *price* to moderate and manage road based externalities, it may be of limited effectiveness given low price responsiveness, unless accompanied by other non price tools. Urban planning restrictions have a role to play in shaping the choices facing travellers. They have been shown to work to good effect in new urban developments in conjunction with the provision of transit facilities and urban design that deliberately limits the choice of the car option.

Public funds to provide enhanced services rather than to provide general fare subsidies?

Researchers have drawn attention to the fact that *accessibility* and *quality of service* may have a stronger impact on public transport patronage than the price effects of subsidies. This may be most important in newly serviced urban development areas where the level of access to public transport can condition future behaviour. The scarcity and cost of raising public funds underlines the need to consider the net benefits of subsidising new or improved infrastructure rather than subsidising fares on environmental grounds. By building the incremental benefits of avoided road use externalities into cost-benefit appraisal, this gives more benign options enhanced chances of adoption.

Some will argue that significant subsidies (‘affordable fares’) are also a necessary accompaniment to investment in improved interchanges, new transitways and the like so that adequate patronage can develop and become habituated. It may be that consideration of the relative price of car travel and public transport is more important in influencing *initial* choices than in changing existing and possibly entrenched travel patterns, particularly for commuters. It has implications for the justification of subsidies and the way in which they are used. More quantitative evidence is needed before this conclusion can be drawn. But calibrating any such subsidies to avoided road use costs once the investment has been made is difficult to implement and justify.

Appendices

A

Estimated externalities: international and Australian studies

International Studies

Belgium

An extensive body of work has developed which looks at the estimation of transport externalities using data for Belgium. That country has been the subject of a number of recent attempts to explore policy changes that might bring efficiency gains by correcting for road use externalities. A first step has been the need to offer quantified value for the main externalities of interest. While there are acknowledged problems with the estimates given, as was discussed above, such attempts still provide a useful reference in two important ways. First, they allow a concrete discussion as to the magnitude of any corrective measures that might be required. Second, by demonstrating the relative importance of each type of externality there is a guide for policy makers as to the potential gains from adopting measures to mitigate the individual costs..

Mayeres (2000) has brought together many of the important external costs estimated for Belgium. Table A.1 presents the values obtained for the external costs of various transport modes and the relative importance of each.

An important point to note in these results is the high percentage of the marginal external costs of cars attributed to congestion. For a petrol car being driven in a peak period, 83 per cent of the external cost generated is congestion costs. By comparison that same figure is 41 per cent for buses. In off peak periods congestion is still the largest single component of the marginal external costs of car transport. Given that rail travel does not generate this externality (rail networks are not congested in the sense used here), a switch in travel mode may have the beneficial effect of reducing the overall marginal external costs of urban transport.

A.1 Road transport: the marginal external costs for Belgium

	<i>Marginal external costs</i> (ECU/vkm)	<i>Share in marginal external costs</i>		
		<i>Congestion</i>	<i>Air pollution</i>	<i>Accidents</i>
		%	%	%
Passenger transport				
▪ Petrol car — peak	0.22	83	7	10
▪ Petrol car — off peak	0.07	48	21	31
▪ Diesel car — peak	0.27	69	22	9
▪ Diesel car — off peak	0.12	30	50	20
▪ Tram, metro — peak	0.37	100	0	0
▪ Tram, metro — off peak	0.07	100	0	0
▪ Bus — peak	0.90	41	49	10
▪ Bus — off peak	0.60	12	73	15
▪ Rail — electric	0	-	-	-
▪ Rail — diesel	0.20	0	100	0

Source: Mayeres (2000).

Turning to the other external costs generated in the provision of transport, we find that both the air and accident costs of the petrol car in Belgium exceed that generated by electric rail. However, in both these categories the external costs of bus use in both peak and off-peak periods is higher than that for the petrol car.

This highlights the care needed for interpretation of external cost measures. Those presented for Belgium are measured in European currency units *per vehicle kilometre*. The costs that are most relevant for policy measures designed to improve mode sharing from an efficiency perspective are costs per passenger kilometre.

The European Union

The European Commission has released a green paper dealing with the issue of transport externalities in which estimates of the resulting costs are given. A particular point of note in the paper is the conclusion that 'congestion represents a major external cost, which is largely concentrated in road transport' (European Commission 1995, p. 14).

The paper cites a survey by the OECD which puts road congestion costs for the European Union at approximately two per cent of GDP. It is not clear whether this figure includes internal as well as external costs of congestion. There is some suggestion that the given congestion cost is overestimated (*The Economist* 1998).

Table A.2 gives a comparison of the volume of pollutants released by cars and trains in Germany, Switzerland and Belgium. The results indicate that in both Germany and Belgium the air pollution generated by cars is higher than for trains for all pollutants except sulfur dioxide and aerosols. In fact for carbon monoxide in Germany cars produce approximately 85 times the amount produced by trains. That same number for Belgium is approximately 130 times.

A.2 Specific emissions by mode Grams per passenger kilometre

	<i>Unit</i>	<i>Car</i>			<i>Train</i>		
		<i>Germany</i>	<i>Switzerland</i>	<i>Belgium</i>	<i>Germany</i>	<i>Switzerland</i>	<i>Belgium</i>
CO ₂	Gram	180	-	126.4	78	-	48.7
CO	Gram	11	3.1	1.038	0.13	-	0.008
NO _x	Gram	2.1	1.4	1.367	0.46	-	0.120
C _x H _y	Gram	2.3	0.75	0.168	0.30	-	0.003
SO ₂	Gram	-	-	0.084	-	-	0.209
AER ¹	Gram	-	-	0.046	-	-	0.074

Source: European Commission.

Table A.3 provides estimated external costs for London in a study of optimal transport pricing discussed in detail below. The results are of interest because they help to put in perspective the relative size of marginal external costs (MEC) compared with the marginal resource costs (LRMC) of the various modes. By far the largest marginal external cost is the congestion cost generated by car transport in the peak period. Further, the total marginal costs of car travel exceed the aggregated marginal costs of the underground, rail and bus at the peak travel time. This seems to suggest that by inducing consumers to use public transport rather than cars in peak periods would create benefits by reducing the total transport costs generated. In this case a public transport subsidy would be part of an optimal pricing package.

A.3 Marginal internal and external costs and prices of passenger transport in London pence/passenger – kilometre^a

	<i>Global warming</i>	<i>Air pollution</i>	<i>Noise pollution</i>	<i>Conges- tion</i>	<i>Accidents</i>	<i>Total MEC</i>	<i>LRMC^b</i>	<i>Efficient price with CRS^{b,c}</i>	<i>Efficient price with EOS^{c,d}</i>	<i>Current price</i>
	Pence	Pence	Pence	Pence	Pence	Pence	Pence	Pence	Pence	Pence
Inter urban										
▪ Rail	0.01	0.12	0.02	0.04	0.03	0.22	9.67	9.89	5.05	7.11
▪ Car	0.02	0.35	0.08	0.85	0.15	1.45	5.15	6.60	6.08	7.78
▪ Coach	0.01	0.39	0.01	0.15	0.01	0.57	3.00	3.57	2.67	3.09
London										
▪ Underground										
– Peak	0.01	0.13	0.09	0.72	0.03	0.98	45.18	46.16	10.02	10.12
– Off peak	0.01	0.13	0.09	0.00	0.03	0.26	15.80	16.06	8.16	8.94
▪ Rail										
– Peak	0.01	0.13	0.09	0.80	0.03	1.06	20.11	21.17	11.12	6.88
– Off peak	0.01	0.13	0.09	0.07	0.03	0.32	12.55	12.87	6.59	6.88
▪ Car										
– Peak	0.03	4.34	0.39	15.06	1.50	21.32	7.12	28.44	7.73	11.28
– Off peak	0.02	2.89	0.39	1.65	1.50	6.45	6.54	12.99	12.34	10.04
▪ Bus										
– Peak	0.01	7.21	0.09	3.73	0.88	11.92	15.27	27.19	22.61	10.63
– Off peak	0.01	5.41	0.09	1.76	0.88	8.15	13.00	21.15	17.25	10.63

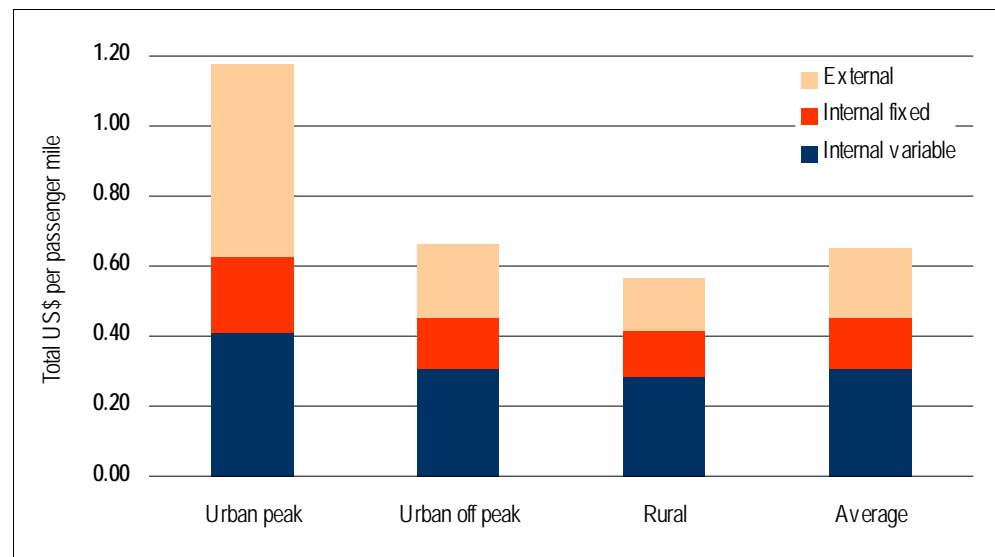
^a GB£0.01 = US\$0.015 = ECU0.012. ^b Assuming constant returns to scale. ^c Efficient price is defined as LRMC + MEC. ^d Assuming maximum returns to scale.

Source: Peirson and Vickerman (1998).

The US

Litman (1999a) has produced a compendium of road use costs for the US as a whole. He argues for the inclusion of the opportunity costs of road in lands. The results of doing this have been discussed in chapter 3. Figure A.4 shows the relative importance of different cost categories according to travel conditions and the significant differences between peak and off peak travel in particular.

A.4 US automobile cost distribution by travel conditions



Note: External costs are broadly defined and are average, not marginal costs.

Data source: Litman, T., 'Transportation Cost Analysis' 1999.

Australia

For air pollution, Table A.5 indicates that the volume of pollutants generated by cars is greater than that produced by trains except in the case of sulfur dioxide. A report by the BTCE (1996) contains estimates of the costs of such emissions with the exception of carbon dioxide. Using these estimates we find that the cost of air pollution for cars is approximately 0.06c/km while for trains the figure is 0.01c/km.

A.5 Air emissions from passenger transport Grams per passenger kilometre

	VOC	NO _x	CO	SO ₂	TSP	CO ₂
	Grams	Grams	Grams	Grams	Grams	Grams
Cars	1.73	1.27	13.87	0.02	0.03	208
Buses (diesel)	0.34	1.67	0.93	0.06	0.22	140
Trains (electric)	0.0008	0.08	0.01	0.15	0.01	112

Source: IPART and EPA 1996.

Table A.6 indicates that there is a wide discrepancy in the figures available from attempts to measure congestion costs. This is a reflection of the problems of estimation and in particular the problems that arise in placing a value on the time lost in delay. Despite these differences, the numbers indicate that congestion, as in the other countries discussed, is a significant cost of road transport. Further, the table indicates that Sydney has relatively high congestion costs as compared with most other states' capitals.

A.6 Congestion costs in Australia

Source	Year of estimate	Sydney	Melbourne	Brisbane	Adelaide	Perth	Canberra
		\$/ vehicle km	\$/ vehicle km	\$/ vehicle km	\$/ vehicle km	\$/ vehicle km	\$/ vehicle km
EPA (Vic) (1994)	1980–84	1.04	0.48	0.6	0.19	na	na
BTCE (1996)	1995	0.208	0.103	0.214	0.086	0.049	0.022

Source: EPA Vic (1994) and BTCE (1996).

Finally, Table A.7 indicates that in NSW congestion costs account for approximately 81 per cent of the external costs of road transport. This is in line with international studies other than those which use a broader definition of externalities.

A.7 External road transport costs for NSW (per vehicle kilometre)

External cost	Source	Cost \$/km
Accidents	BTCE (1996)	0.037
Noise pollution	Institute of Transport Studies (1994)	0.003
Air pollution	Institute of Transport Studies (1994)	0.007
Congestion	BTCE (1996)	0.208
Total external cost		0.255

Source: Institute of Transport Studies (1994) and BTCE (1996).

B *Views of stakeholders on transport externalities and the role of subsidies*

Council of Social Service of New South Wales (NCOSS)

NCOSS (27 April, 2000) stressed the need for *an investigation of pricing policies of all modes of transport, including road pricing* for ‘establishing a firmer base for passenger transport funding, with performance standards and assessment being managed independently of bids for fare increases.’

As part of this new approach, NCOSS called for an investigation of all modes of transport including road pricing and the consideration of all social and environmental impacts of these pricing policies.

NCOSS was concerned that existing estimates of externalities put forward by CityRail may be seriously understated. It states that ‘It is extremely difficult for a fair estimation of how much government and passengers should both pay without an estimation of externalities costs which is able to be responsive to Sydney’s rapidly changing environmental and social context.

NCOSS was also concerned that an increased dependence on fare box revenue may well thwart other government objectives such as those outlined in *Action for Air*.

It also drew attention to what it saw as the many gaps in the targeted concession program. ‘Thus those who have poor access to transport concessions are disadvantaged by fare increases’ that would follow any subsidy reduction.

NCOSS also responded to the draft of this report. It emphasised non price factors that inhibit public transport usage. These factors included access and service standards. NCOSS highlighted that it is often those most in need of low cost, efficient public transport that have the least access to it.

NCOSS appreciated the political and practical implementation obstacles that prevent the use of road charges and stated that 'in the absence of adequate road charges, those that choose to use road public transport should be subsidised'. In terms of the degree of subsidisation, NCOSS suggested that an estimate of the theoretical road charges would be a reasonable starting point. NCOSS preferred the model and definition of externalities, that includes external parking and land use costs, employed by Litman (1999).

The University of New South Wales Transport Program

The University of New South Wales Transport Program (18 April, 2000) supported an increase in government funding for NSW public transport rather than an increase in fare box revenue. The Transport Program's submission states that 'the continuing expectation for an increasing proportion of the fare box is misconceived and inconsistent with the goal of Ecologically Sustainable Development.'

The submission contends that the leading economic beneficiaries of public transport are landholders located close to stations or interchanges, followed by car drivers and lastly people travelling on public transport. (This raises the prospect of using means other than the fare box to capture the value of public transport.)

The submission points to the work of Litman in the US which includes a much broader definition of social costs than is often included in appraisals of transport externalities. Current practices, the submission claims, tend to skew decisions towards car transport.

The Western Sydney Community Forum

The Western Sydney Community Forum called for public transport subsidisation to be considered in a wider context. This would involve treating as public transport benefits the avoided external costs of car use.

Western Sydney Regional Organisation of Councils

Western Sydney Regional Organisation of Councils called for a wider inquiry into the costs and subsidy levels of all modes of transport and referred to 'the inherent subsidies to private vehicle users'. Referring to the documented rationale for recent fare increases, WSROC expressed its belief that 'the Government should also consider introducing similar changes on private car users who are also being heavily subsidised.'

State Rail Authority April 1999

In its submission to the 1999-2000, CityRail Fare Review the SRA/CityRail listed the avoided costs of congestion, accidents, air and noise pollution as the social benefits of the rail network. It cited a 1995-96 study which puts the aggregate value of these at \$350 million per year. It suggested that these are roughly equal to the below rail costs (access charges) levied by the Rail Access Corporation).

The submission reiterated the position put by the State Rail Authority in 1993 to the Industry Commission Inquiry that:

... if it is not feasible for government to change the true cost of road usage, it must continue providing a similar financial support to rail users as a second best alternative to put them on equal footing with road users.

NSW Treasury (May 1999)

Treasury argued that whilst the management of road congestion and transport related environmental outcomes are import objectives, rail fares have little impact on these objectives and that a similar conclusion could be reached for bus and ferry fares.

Changes in demographics and land use have, according to Treasury, weakened the relevance of public transport in its traditional role as a commuters' service. This helps to explain the small proportion of the total transport task carried out by public transport. But those getting the highest use value from public transport, it is argued, may well be those travelling for work or education.

On the relationship between externalities and fare levels, Treasury was of the view that 'valuations of the rail externality in *aggregate are not a great help*. ... If we want to use rail fares to help manage road congestion and environmental outcomes, we have to investigate what happens *at the margin* when fares are raised or lowered.'

Treasury point to very low estimates of demand responsiveness to fare changes *by commuters* and the continuing trend growth in car travel which is likely to swamp any switching effect between public transport and car use that might be induced by fare changes.

Commuter Council of New South Wales (2001)

The Commuter Council of NSW responded to the draft of this report. The Council commended the report for its attention to the unseen costs and hidden subsidies of private transport. It provided examples in Sydney's transport history to show the importance of accessibility and quality of service in influencing public transport patronage.

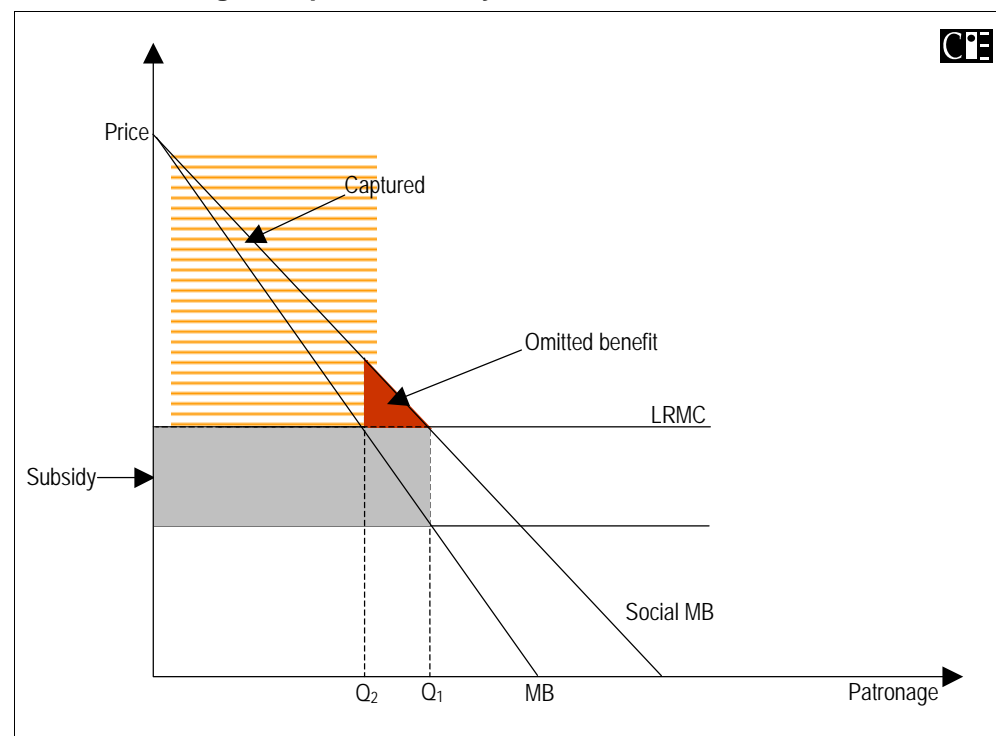
The Commuter Council of NSW is also concerned with the air pollution externality from congestion. It draws attention to the case of South-West Sydney where asthma rates are the highest. In relation to this the Council raises the issue of a greater use of electric transport.

C

The efficiency costs and benefits of subsidies: an illustration

SOCIAL BENEFITS OF PUBLIC TRANSPORT diverge from private ones. When external net benefits of public transport projects can be quantified, and related to levels of patronage, the optimal level of public transport patronage is where the social marginal benefit equals the long run marginal cost (LRMC). This is shown as Q_1 on the diagram below. However, because the individual does not bear all social costs and benefits directly, they will not form a part of his or her decision making process. Unless fares are subsidized users will respond to fares in such a way that the private marginal benefit (MB) will equate with the LRMC at a lower level of patronage (Q_2). The community captures some of the available external benefits but some are sacrificed. The omitted benefit – shown on the diagram – is the cost of this lower level of patronage.

C.1 Determining and optimal subsidy



To achieve the optimal level of patronage (Q_1) the fare could be subsidized to equal the MB at Q_1 , the optimal level of patronage. The subsidy is a transfer of benefits from the community at large to fare paying customers. However there is a cost involved with providing the subsidy (shown by the shaded rectangle on the diagram). The subsidy must be financed in some way – either by higher taxes, which may involve efficiency losses, or by reductions in other government expenditure.

If the cost of the subsidy is greater than the omitted benefit then it is not efficient to provide the subsidy. The cost of achieving the higher level of patronage outweighs the benefits received from it. The relationship between the two will depend on the price responsiveness of patronage and the deadweight costs of financing the subsidy.

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