ROAD PRICING AND COST RECOVERY

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ABSTRACT: *Road pricing can be a method to ration the use of what is a very expensive asset; it can also be used to generate funds which can be used for road works. This paper applies principles of economic theory to examine the impact of a road pricing system based on economic efficiency. An application of these principles indicates that both the form and level of charge are important in rationalising road use and optimising the role of road transport in our modern economy.*

Estimates are made of the costs of road use, effective road prices and level of cost recovery by class of road user. The calculations focus on avoidable road costs, largely the damage caused to road pavements by heavy vehicles. Alternative approaches to the allocation of costs in excess of avoidable costs are discussed. The results show that while there is considerable over recovery of costs from private motorists, operators of heavy vehicles pay only a small proportion (34 percent in the case of six axle articulated vehicles), in terms of effective road user charges, of the costs incurred by their use of roads.

The current imbalance in road cost recovery between motorists and operators of heavy vehicles is shown to be largely the result of the increasing reliance on fuel taxes as a source of revenue for roadworks. This is because the rate of vehicle fuel consumption is not closely related to the damage caused to roads for the wide range of vehicle types. The paper concludes with a discussion of the effects on both road investment and the economy in general, of moving away from fuel taxes towards a road pricing system based on principles of economic efficiency.

ROAD PRICING AND COST RECOVERY

INTRODUCTION

Road damage has been a problem in Australia since the time of the first roads. At various times throughout this century and the previous one, attempts have been made to restrict road damage both by restricting weights of vehicles, axles and tyres and by charging for road damage, usually on the basis of the load carried or some other indicator of the potential for damage (DMR 1976). These approaches have met with mixed success.

Currently the Australian road asset is worth over $40 billion. In use it depreciates by more than $2 billion per annum which is roughly equal to the cost of the maintenance effort required each year to maintain the value of the asset. Maintenance work is due in large measure to the damage in use caused by vehicle loads, especially heavy vehicles.

With such an expensive asset and one which is so costly to maintain, there is a need for a mechanism to ensure that any decline in value caused by road use is at least matched by the benefits to road users (and society in general) from that road use.

This paper applies the principles of economic theory to examine the implications of adopting a road pricing system based on principles of economic efficiency. The paper also examines the consequential implications for generation of funds for both maintenance and new works to upgrade the asset and increase its value.

ROAD PRICING

Road pricing is the mechanism for charging road users for their use of roads and for recovering the costs of providing roads. There are various road pricing arrangements which may be applied, based on either, or a combination of, economic efficiency or equity criteria. The efficiency criterion is based on two principal requirements, that the most appropriate road network be provided and that the existing road network be used to its best advantage. An integral part of both of these principles is a concern that, where there is a substitute for roads, the most appropriate mode be chosen. Equity based pricing mechanisms on the other hand, attempt to charge road users on some measure of equity, such as road use, the value of the vehicle or road space taken.

Efficiency Approach

There are two levels at which road pricing has an impact on road funding and financing; by rationing road use and road provision and by raising funds. The first consideration is that by charging road users for their use of roads, prices act as a mechanism for rationing road use as well as encouraging appropriate investment decisions based on correctly established demand patterns for road use. These rationalising aspects control the total annual cost of providing and maintaining roads. For this to occur properly, prices must be set equal to short run marginal cost (SRMC) which is, practically speaking, the cost which occurs directly as a result of a (marginal) decision to use the road. In addition, to ensure that appropriate demand signals are obtained, the charge for road use should be clearly identified as such and should vary as closely as possible with the costs of road use.

The main road cost to vary with road use is pavement damage cost. For a given road, damage increases largely with vehicle mass and distance travelled, but decreases as the mass is spread over more axles. (Engineering studies have shown that damage increases, on average, with the fourth power of the axle loads of a vehicle.) An efficient charge should vary with these three factors in line with the fourth power rule.

Of the currently available road pricing mechanisms the most efficient one for recovering road damage costs is a mass-distance charge appropriately structured for vehicles with different numbers of axles. Fuel excise is an inefficient mechanism since fuel consumption does not vary with road damage. A fully laden articulated truck may consume around four times as much fuel as a motor car for a given distance travelled but may cause 10 000 times more damage. Replacing fuel excise by a correctly structured mass-distance charge would not only encourage better decisions concerning the overall use of road transport, but also concerning the type of vehicles used for various tasks (for example, the use of vehicles with more axles).

It is also important that, in order for prices to appropriately influence the level and form of road use, that they reflect short run marginal cost (SRMC) and not long run marginal cost (LRMC). Variation in infrastructure costs due to a decision to use the road are entirely captured by SRMC. The LRMC indicates the cost of providing an additional unit of output when capacity can be varied continously. As such it has no bearing on the day-to-day decisions to use (or overuse) a road. Setting price equal to LRMC will cause overuse or under use of the asset because only by coincidence would the LRMC be optimal for the current level of demand. The 'fallacy' of using long run cost for marginal cost based pricing is discussed in a recent article on airport pricing by William Vickrey (1985).

Apart from its use in efficiently rationing resources, the second impact of road pricing is that charging road users for road use raises funds for ongoing investment or for general revenue. Generally, the purpose to which the funds are applied is a policy decision, although ideally they should be applied to the areas which generate the greatest net returns (which may or may not be roads).

The two considerations may conflict. Setting prices equal to SRMC may not raise sufficient revenue to meet the policy designs of government. For instance, pricing at SRMC will generally not raise sufficient revenue to cover the total annual level of road expenditure.

If full road cost recovery is a requirement, and it frequently is, additional revenue can be raised most efficiently by setting prices in excess of SRMC according to the demand for road use, particularly by setting prices in inverse proportion to the price elasticities of demand for road use. This simply ensures that those users with the most elastic demand, that is those users whose use would decrease most with a given increase in road price, are charged proportionally less. Those users with the most inelastic demand would be charged proportionally more. In this way, for a given level of revenue, there will be a minimum reduction in demand.

Pricing on the basis of demand elasticities, or Ramsey pricing (after Ramsey, 1927), minimises the loss in net benefits to the community from not charging a price equal to SRMC.

Pricing in excess of SRMC has significant equity and administrative implications, especially as different users are charged different increments. In some areas these considerations may be so substantial that some trade-off is required between equity and administration on the one hand and efficiency on the other hand.

Equity Approaches

While the economic efficiency approach attempts to maximise the net welfare of society, it nevertheless ignores income distribution effects. Governments may be concerned to account for these through some notion of equity.

There are a number of alternative equity methods for allocating costs. In the United States of America, Federal road expenditure is funded through a 'cost occasioned' pricing system. Also called the incremental method, this approach seeks to attribute as much road expenditure, including fixed costs such as road construction, to particular vehicle types. For example, heavy trucks require stronger pavements than do cars and so are allocated a greater share of road pavement construction costs. Under the efficiency approach, these costs are allocated on a demand basis, whereas in the United States they are allocated on a cost basis.

Other methods adopted in some Australian studies have used arbitrary allocation rules such as allocation based on vehicle kilometres travelled. While the United States methodology has a rationale (USA DoT 1981 and 1984), these arbitrary rules do not.

Modal Competition

As part of an integral land transport pricing scheme, road pricing has an impact on the choice of mode of transport and the allocation of the transport task between modes.

The Ramsey pricing rules outlined above also assume that there are no substitutes for the good or service being priced (or taxed). Where there is an alternative in competition with road transport, such as rail transport, allowance must be made in the pricing rule. If an increase in the price of road freight above SRMC causes a shift of customers to rail, there may be a distortion in modal demand patterns with a consequent loss in net welfare. This situation can be exacerbated where the competitive rail service does not follow a similar pricing rule.

Taplin (1980) has shown that the extent of adjustment required to the Ramsey pricing rule depends on how much traffic is competitive, the degree of competition and the deviation of price from marginal cost for rail.

As noted above, it is short run marginal cost that is important for road and rail. From an examination of the results of the recent Inter-State Commission's study of interstate road cost recovery, which found that, on the whole, interstate rail freight fully covered its 'long run avoidable cost') (ISC 1986, p. 356), it is likely that rail does cover its short run marginal cost for most freight traffics that are competitive with road.

Rather than concentrating initially on the problem of intermodal competition, it may be more appropriate to ensure an efficient road pricing system is introduced. Rail authorities may then increase their rates. In this situation, the argument for continued subsidies of rail freight operations will be considerably reduced.

In summary, each of the rationing and funding considerations has important equity and efficiency implications. Road pricing is therefore an important instrument of governments in providing the required level of roads and road funds. It is also potentially an important device to encourage efficient use of expensive assets and to rationalise the choice between vehicles and transport modes.

ROAD COSTS

An economic measure of costs would take into account all resources tied up in the road system plus a change in the value of the system (through depreciaiton). This would include the opportunity cost of the road system; the best return that could be obtained from investing the funds spent on roads elsewhere.

In addition to government expenditure on road infrastructure, there are other government expenditures and social costs associated with road use such as traffic management expenditures, and externalities such as accident, pollution and congestion costs. Addressing these costs may involve some road expenditure. In addition there are the costs of vehicles including vehicle operating costs.

The publicly perceived annual cost of providing roads is, however, generally taken to be the annual expenditure on road works which is estimated to be about $4 200 million in 1986-87. This is the cost recovery target considered in this paper. Both the economic cost and the total financial cost to the whole community are likely to be significantly higher than this.

In order to develop a pricing/cost recovery system based on economic efficiency principles, short run marginal cost has firstly to be identified.

Marginal cost is the cost of providing an additional unit of output. In practice this is difficult to identify and measure in the case of roads. It is simpler to measure the costs that can be avoided if a given unit of output, say a given tonne-kilometre, was not produced. This avoidable cost (short run) is a useful approximation for the range of output levels close to the capacity of the system.

Calculation of Total Avoidable Pavement Costs

There are two broad approaches that could be taken to calculate the total level of avoidable cost. At one level it could be aggregated from individual calculations of the damage caused by different vehicle types travelling over different road surfaces. The avoidable cost can be calculated as the life-cycle costs in terms of maintenance, resealing and restoration required to repair this damage.

Pavement Life-Cycle Cost Approach

Figure 1 shows a stylised profile of the roughness of a road. At initial construction the road is fairly smooth (RO). As heavy axle loads pass over the road its roughness increases. Routine annual maintenance will reduce some surface roughness although deformation of the pavement also occurs. Gradually more and more maintenance is required and pavement deformation becomes unacceptable. Normal levels of routine maintenance may not be sufficient to restore the level of roughness to below the maximum acceptable level (RA). Resealing the road becomes a more economic proposition. This will fill surface cracks and, if thick enough, considerably reduce pavement deformation.

Overall roughness may be returned to a level close to RO. However, pavement and subgrade deformation are continuing to increase and eventually the whole road reaches a point where even resealing is not an efficient proposition. The rate of deterioration through rutting, spalling, cracking and general failure increases rapidly, requiring major rehabilitation or reconstruction of the pavement and perhaps the base and sub-base. The road has come to the end of its service life.

At this point it may also be upgraded or improved to cater for the increased level of traffic and axle load passes now occurring. This upgrading is not an element of the avoidable cost of an additional unit of output but the rehabilitation component is.

In essence all these road works (apart from upgrading) are substitutes for each other but with differing cost effectiveness in addressing the various manifestations of road damage (for example surface cracking, pot holes or rutting).

One further significant point about the life-cycle costs is that the road damage is not repaired as it occurs. Some damage is repaired with annual maintenance but some structural damage is not repaired until the road is reconstructed. In effect, some element of the damage caused by heavy axles can be considered as the need to bring forward further roadworks, or as a reduction in the life of the road.

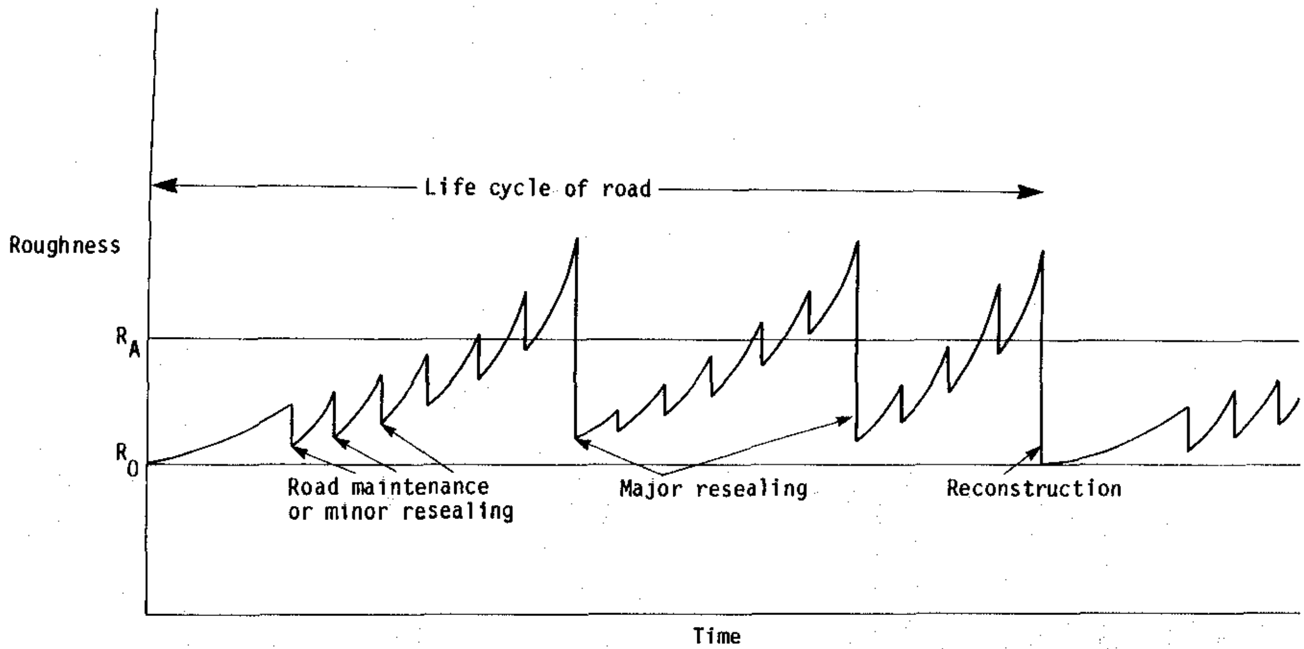

Figure 1 Stylised roughness profile of a road

As noted above engineering studies have shown that, on average, damage caused to a road is proportional to the fourth power of the axle loads of the vehicle. Damage can thus be allocated among vehicles on the basis of axle loads, using this fourth power rule, and distance travelled. In practice these are combined into a single unit -equivalent standard axle load (ESAL) kilometres.

Some element of routine maintenance is due to the effects of weather or is independent of traffic (for example, mowing median strips). In general however, the bulk of routine maintenance and all of resealing and reconstruction costs of roads and bridges (excluding upgrading) can be attributed to heavy axle passes over the life of the road.

A study of pavement life-cycle costs has not as yet been attempted in a systematic manner in this country, although aspects of the problem have been studied. Detailed studies have been undertaken in the United States however, by the Department of Transportation's Federal Highway Administration (1984) and by the World Bank (1985). The key information, for which little research has been undertaken, is the establishment of roughness relationships for traffic on various road types. This information is important as roughness is an approximate measure of the damage done.

The area of pavement life-cycle costs is one in which the Federal Bureau of Transport Economics is currently undertaking research. Until this and other related research is completed, and the relevant relationships are known, avoidable pavement cost estimates are reliable only within a fairly broad range.

Avoidable Annual Expenditure Approach

The alternative approach, which is less theoretically sound, is to estimate the current level of road expenditure being directed towards fixing up damage done to the road system by previous vehicle travel. Of course, as shown earlier, damage done today may not be repaired until some future time so this method will involve a number of approximations and is likely to produce only a rough estimate of avoidable pavement cost.

Recent work for the BTE Roads Study suggests that currently up to 80 per cent of current road expenditure is required to restore roads to an acceptable level. The Australian Roads Outlook Report (TAROR), not yet published, has found that about 65 per cent of arterial road expenditure and almost all local road expenditure is required to restore roads to an acceptable level. If an allowance is made for damage which is due to weather and other damage not attributable to the effect of axle load passes (which has been estimated at about half the current level of annual routine maintenance), the TAROR figure of 65 per cent can be reduced to about 47 per cent of current road expenditure. This estimate of the level of avoidable cost is about the average estimate of avoidable cost shown for the various Australian studies compared in the recent Inter-State Commission's (ISC) report on Cost Recovery Arrangements for Interstate Land Transport (ISC 1986). It is also the proportion established in an earlier BTE study (BTE 1985) which assessed avoidable costs from a bottom-up method using data from the Economics of Road Vehicle Limits Study in the mid 1970s (NAASRA 1976).

On this basis, the avoidable pavement cost estimate is approximately \$2 000 million for 1986-87. The calculations allocating this amount among vehicle types are presented in Table 1. The calculations are based on distributing costs on the basis of annual ESAL kilometres for each vehicle type. Information on average ESALs per vehicle was obtained from a survey conducted by the recent Review of Road Vehicle Limits (RORVL) study team (NAASRA 1985). This survey took account of all vehicles whether empty, partially loaded, fully laoded or even overloaded.

Allocation of Expenditure greater than Avoidable Cost

If it is desired to recover total annual road expenditure from road users rather than from income taxation and local government rates, then a method is required for allocating the remaining \$2 200 million among road users.

An allocation based on Ramsey pricing requires information on the price elasticities of demand of various road users. Ideally elasticities should be those which apply at the point where price equals marginal cost or the arc elasticity between that point and the level of demand at the new price. However, it is usually not the case that price equals marginal cost and so the prices and elasticities estimated are the current actual levels.

The prices used are, in the case of trucks, a broad estimate of the average marginal cost of carrying a tonne kilometre of freight and, in the case of cars, the short run marginal cost of operating a car (mainly petrol costs). The elasticities are short run estimates based on a range of studies, including the 1981 study by the Transport Economics Centre of the University of Tasmania (TEC 1981). The estimates used are:

Cars - private	elasticity = -0.13	price = 7 cents/km
- business	-0.19	7 cents/km
Rigid trucks	-0.15	6 cents/tonne km
Articulated trucks	-0.12	5 cents/tonne km

TABLE 1 CALCULATION OF SHORT RUN AVOIDABLE PAVEMENT COST ATTRIBUTABLE TO VARIOUS VEHICLE TYPES, 1986-87

Vehicle type	*Vehicle travel (million km)*	*Average ESALs*	*Total ESAL kms (million)*	*Allocated avoidable cost ($ million)*	*Number of vehicles ('000)*	*Average cost per vehicle ($ per vehicle)*
Cars	126 695	0.0003	38	5.8	8 015.6	0.73
Rigid trucks						
2-axles	6 311	0.39	2 461	377.1	388.5	971
3-axles	950	1.22	1 159	177.6	39.4	4 507
>3-axles	530	1.93	1 023	156.7	17.2	9 112
Total rigid trucks	7 791	..	4 643	711.4	445.1	..
Articulated trucks						
<5-axles	566	1.56	883	135.3	15.8	8 562
5-axles	655	2.37	1 552	237.8	11.7	20 328
6-axles	2 217	2.24	4 966	760.9	22.3	34 119
Total articulated trucks	3 438	..	7 402	1 134.0	49.8	..
Other trucks	228	4.26	971	148.8	2.1	..
Total	138 152	..	13 054	2 000.0	8 512.6	..

.. Not applicable.

Note Owing to rounding, figures may not add to totals.

Sources BTE estimates. Australian Bureau of Statistics (ABS) Survey of Motor Vehicle Usage (SMVU) (1987). Review of Road Vehicle Limits (RoRVL) Commercial Vehicle Survey (on computer tape) (NAASRA 1985).

The simple formula used in this paper to identify appropriate revenue contributions greater than marginal cost for each vehicle class is:

$$FAC_i - MC_i = \frac{-k.P_i}{E_i}$$

where FAC_i is the fully allocated road cost for road use i;
MC_i is the marginal cost of road use i;
k is a constant which is set to achieve the recovery target;
P_i is the price of road use i; and
E_i is the price elasticity of demand for road use i (which is normally negative)[1].

Given the broad assumptions about the values of these parameters, a Ramsey pricing allocation is shown in Table 2. For comparative purposes three other allocations are also shown. One of these is an allocation based on the US incremental method of allocating costs. The other two allocations shown, are those implied by the payments that would be made by the various vehicle types from a fuel excise, where the level of excise on motor spirit and distillate were the same and also where the excise level on distillate was twice that on motor spirit. Current excise arrangements are, nationally, very close to the former case although the total revenue raised from fuel excise is much larger than $2 200 million.

Table 2 indicates that, while fuel excise may not be a good mechanism to recover avoidable pavement cost, it can be structured so as to be a reasonable mechanism to recover the balance of the revenue target.

In practice the information required to conduct a detailed Ramsey pricing allocation is not readily available, so broad assumptions would have to be made. Given these problems, the alternative methods could be employed, although at the cost of not maximising economic efficiency.

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1. The elasticity of supply is not considered since the expenditure to be allocated is the expenditure on the supply of infrastructure; that is only road users, not suppliers, are to be charged. A further assumption is that P_i and E_i, the initial, or existing, prices and elasticities are in the same ratio as the final, or post Ramsey allocation, prices and elasticities.

TABLE 2 ALLOCATION OF ROAD EXPENDITURE IN EXCESS OF SHORT RUN AVOIDABLE PAVEMENT COST, 1986-87
($ million)

	Fuel excise allocation			
Vehicle type	*Existing excise arrange-ments*	*Motor spirit excise equals one-half of diesel excise*	*Ramsey pricing*[a]	*Incremental pavement construction*[b]
Cars, business use	880.0	761.0	864.4	638.0
Cars, domestic use	880.0	757.0	591.3	638.0
Total cars	1 760.0	1 518.0	1 455.7	1 276.0
Rigid trucks				
2 axle	171.6	239.8	99.1	356.4
3 axle	28.6	41.8	48.7	53.7
> 3 axle	19.8	33.0	40.5	29.9
Total rigid	220.0	314.6	188.2	440.0
Articulated trucks				
< 5 axle	33.0	55.0	44.6	74.7
5 axle	39.6	66.0	80.1	86.5
6 axle	132.0	224.4	359.8	292.7
Total articulated	204.6	345.4	484.5	453.9
Other trucks	13.2	22.0	71.5	30.1
Total trucks	437.8	682.0	744.2	924.0
Total	2 200.0	2 200.0	2 200.0	2 200.0

a. Based on assumed demand elasticities and prices.
b. These are broad illustrative figures based on the United States' Department of Transportation, 'Capital Cost Allocations and User Charge Structure Options'.

Note Owing to rounding, figures may not add to totals.

Sources BTE estimates. US Department of Transportation, Federal Highway Administration (1981).

The United States' Federal Highway Administration method is, as noted earlier, based on cost rather than demand. The overall method has a number of problems, is very complex and requires a great deal of information. Refinements to the basic method have been suggested recently in the literature (Fwa and Sinha 1986). What is surprising perhaps is that the results of the various methods suggested are reasonably similar. Heavy vehicles are allocated a significant share of total costs under both the Ramsey pricing approach and the incremental approach. The fuel excise can also be structured to achieve a similar allocation to heavy vehicles.

In many recent Australian studies very simple methods have been used to allocate expenditure above avoidable cost, for example allocations based on vehicle distance travelled, perhaps with a weighting on heavy vehicles to represent space taken up. These methods, which are quite arbitrary, have generally resulted in a much smaller allocation of costs to heavy vehicles.

Fully Allocated Expenditure

Table 3 shows fully allocated expenditure for the financial year 1986-87. The allocation of costs above avoidable cost is based on the Ramsey pricing allocation and the assumptions therein.

It should be stressed that the results are indicative only. As noted earlier, much more research needs to be undertaken on vehicle traffic and road damage relationships and to refine road demand elasticity estimates. Given the assumptions made, the results do, however, indicate the magnitude of the charges required if the current level of annual road expenditure were to be raised from road users in an efficient manner. They also indicate that reliance on fuel taxes as a road pricing mechanism considerably under prices truck road usage and over recovers costs from operators of motor cars.

EXISTING ROAD USER PRICES

The three main forms of road pricing which occur in Australia are fuel excises, petroleum franchise licence fees and vehicle registration fees.

Other charges on road users such as drivers' licence fees, parking fees and insurance payments are not specifically charges for road use but for other services associated with this, such as traffic management, parking and accident risk coverage. However, these charges and the services supplied also have an effect on the level of road use.

TABLE 3 FULLY ALLOCATED ARTERIAL ROAD EXPENDITURE, 1986-87

Vehicle type	*Avoidable cost* *($m)*	*Ramsey allocation*[a] *($m)*	*Fully allocated arterial road expenditure* *($m)*	*($ per vehicle)*
Cars				
Business use	3	864	867)	182
Domestic use	3	591	594)	
Rigid trucks				
2 axle	377	99	476	1 225
3 axle	178	49	226	5 743
> 3 axle	157	41	197	11 466
Articulated trucks				
< 5 axle	135	45	180	11 385
5 axle	238	80	318	27 174
6 axle	761	360	1 121	50 254
Other trucks	149	72	220	104 910
Total	2 000	2 200	4 200	..

a. Based on assumed demand elasticity values and prices.
.. Not applicable.

Note Owing to rounding, figures may not add to totals.

Source BTE estimates.

Road users also pay other charges such as sales taxes and customs duties, but as these types of charges also apply to non-road users, they may be regarded as contributions to consolidated revenue rather than road user charges. Indeed, in the 1986-87 budget speech, the Federal Treasurer indicated that at least a part of the revenue from fuel excise fees may be regarded as a contribution to general revenue rather than being a specific charge for road use.

Stamp duties fall on a range of financial transactions but only on a few physical assets (eg houses and cars) and so could perhaps be considered more as a road user charge. However, like sales taxes and customs duties they are not annual charges related to road use.

Expenditure Recovery Payments

The level of recovery of government expenditure on road infrastructure is indicated by a matching of relevant revenues with the level of expenditure. There is little consensus, however, over what are relevant revenues from road user payments. Not all government revenue from road users can be automatically considered as arising from charges for road use.

The Federal Goverment has three main types of revenue source. These are:

- economic rents from the ownership and control of resources;
- general taxation revenue raised from the broad community; and
- revenue from specific charges for specific services provided.

Various definitions of road user payments may be outlined to include payments made by road users on road use related activities from all of these sources. The definition adopted by the Bureau in a recent study of road cost recovery (BTE 1985) includes only revenue from annual charges which are unique to road users. It excludes general taxation revenue and economic rents. A narrower definition would include only the part of revenue which is hypothecated to road expenditure.

Hypothecation is the tying of funds from a particular source to a particular, usually related, expenditure. Although hypothecation does not have an economic basis it is often applied in areas where the expenditure is of particular significance, such as in road funding.[2]

2. Economic theory holds that revenue should be raised from efficient charges and investment decisions (spending) should be based on benefit-cost analysis. There is no particular reason why the level of revenue raised should equal the level of investment. Arguments that road users are not getting a fair deal if they pay more in road taxes than they receive in the form of road expenditure are equally invalid. Kindleberger (1986) claims that this thesis violates the distinction between a budget and a market. 'In a market equal values are exchanged. A budget, on the other hand, is a device expressing the cohesion of a sharing group with monies raised according to one standard, perhaps ability to pay, and expenditure distributed according to another, some combination of efficiency and need.' (Kindleberger 1986, p. 6). An increase in fuel excise as part of the budget process therefore, does not automatically oblige an increase in road expenditure.

Estimates of revenue received from various activities related to road use in 1986-87, are shown in Table 4.

TABLE 4 ESTIMATED GOVERNMENT REVENUE FROM ROAD USE, BY RECOVERY DEFINITION, 1986-87

($ million)

Type of tax or charge	*All revenue from road use related charges*	*Revenue from annual charges unique to road users*	*Revenue hypothecated to road works*
Charges on sale of petroleum			
Excise on motor spirit and diesel	4 640	4 640	1 245
Petroleum franchise licence fees	670	670	300
Sub-total	5 310	5 310	1 545
Customs duties			
Motor vehicles and parts	270	..	..
Petroleum	26	..	..
Sub-total	296	..	..
Sales taxes			
Motor vehicles	1 260	..	..
Parts and tyres	640	..	..
Sub-total	1 900	..	..
State motoring charges			
Vehicle registration fees	1 070	1 070	1 070
Drivers' licence fees	170	170	..
Road transport and miscellaneous taxes	10	10	..
Stamp duty on registration	440	..	..
Sub-total	1 690	1 250	1 070
Total	9 196	6 560	2 615

.. Not applicable.

Note Owing to rounding, figures may not add to totals.

Sources BTE estimates. ABS (1986). Australian Institute of Petroleum (1986).

The total payments to government made through road use related activities in 1986-87 are estimated to total $9 196 million. Of this about $6 560 million arises from specific charges which were levied annually only on road users. From this amount, revenue from charges such as drivers' licence fees, parking fees and so on, which can be regarded as charges for traffic administration service rather than for the provision of road system infrastructure, would need to be netted out. The remaining charges, which include residual and miscellaneous road transport taxes, total $6 390 million. This amount can be considered as the total level of payment by road users for the use of the infrastructure. However, it must be stressed that the definition of a road user charge is an arbitrary one.

Road User Cost Recovery

On the basis of the assumptions made, the cost recovery comparison in Table 5 shows that in aggregate, road users are easily recovering annual expenditure by governments on roadworks. Whether or not they are also recovering the annual cost to society of their use of the road system has not been determined here.

The allocation of costs and revenues among various vehicle categories indicates that the operators of motor cars are over-recovering their share of fully allocated pavement (or infrastructure) costs while the revenue paid by operators of heavy vehicles falls well short of, not only their share of fully allocated costs, but also their share of avoidable costs.

The concluding section will discuss some of the main implications of an efficient system of road user charges and the economic costs of having some sectors not contributing an amount at least equal to their avoidable cost.

CONCLUSION: RATIONALISING ROAD PROVISION AND ROAD USE

The immense value of the road resource and the high cost of maintaining it make it imperative that the appropriate level of road provision be maintained and that this be used to its greatest advantage. This is the problem of efficient road pricing.

The above analysis suggest that the current level and form of road prices encourages non-efficient use of our road system. The extent of the deviation from optimal demand levels depends on the actual elasticity of deamnd of road use. The annual pavement damage cost, which currently is in the order of $2 000 million, could undoubtedly be reduced by a system of pricing based on economic efficiency considerations.

A recent study of road prices in the United States (Small and Winston 1986) estimated that the deadweight cost to the United States economy of an inefficient road pricing system was over US$1 000 million. A measurement of the loss in Australia depends crucially on the elasticity of demand for road use. However, even using the low elasticity estimates adopted above, a similar calculation for Australia, based on measuring net loss of consumer surplus, puts the absolute cost of inefficient road pricing at over $60 million for 1986-87.

This figure represents only the loss from the failure of truck operators to meet their marginal cost of road use. To this would have to be added the loss from over-recovery by private motorists although this must be weighed against the social costs of collecting the same revenue through general taxation. Nor does the estimate include the other social costs such as increased vehicle operating costs due to rougher roads and cost of items such as congestion, accidents, pollution and so on.

Indeed, the estimate is probably significantly lower than the total deadweight loss to the community. The deadweight loss is in contrast to any over or under payments by some sectors to other sectors, which are, from the point of view of the whole community, transfer payments.

The figures also indicate that there is a large cross subsidisation of truck operators by private and business motor car operators.

An interesting comparison can be made between road expenditure and fuel expenditure. The high cost of fuel has encouraged a high degree of fuel efficiency both in respect of choice of vehicle and the use to which the vehicle is put. Although the amount spent on fuel in Australia is of a similar magnitude in aggregate, to the amount the community spends on roads, there is not the incentive to use roads efficiently as there is to use fuel efficiently.

Indeed, by recovering road costs by excises on fuel, we are encouraging greater fuel efficiency, and thereby decreasing that revenue base, but doing little to encourage road use efficiency. The difference is that in fuel provision the costs are internalised to users whereas in road provision they are not directly internalised. This demonstrates that not only do road charges need to be directly related to costs but they also have to be seen to be directly related if demand patterns are to be correctly established.

TABLE 5 COMPARISON OF FULLY ALLOCATED ARTERIAL ROAD EXPENDITURE AND COST RECOVERY CONTRIBUTIONS, 1986-87

	Fully allocated expenditure		*Cost recovery contributions*[a]		*Over or under recovery*[b]	
Vehicle type	*($m)*	*($/veh)*	*($m)*	*($/veh)*	*($m)*	*($/veh)*
Cars						
Business use	867)	182	2 402)	601	1 535)	419
Domestic use	594)		2 416)		1 822)	
Rigid trucks						
2 axle	476	1 225	718	1 848	242	623
3 axle	226	5 743	128	3 249	(98)	(2 494)
> 3 axle	197	11 466	80	4 651	(117)	(6 815)
Articulated trucks						
< 5 axle	180	11 385	108	6 835	(72)	(4 550)
5 axle	318	27 174	122	10 427	(196)	(16 747)
6 axle	1 121	50 254	381	17 085	(740)	(33 169)
Other trucks	220	104 910	37	17 524	(183)	(87 396)
Total	4 200	..	6 390	..	2 190	..

a. Based on the second definition of road user charge in Table 4. Using the first definition constributions will be on average 40 per cent higher with a consequent change to the level of over or under recovery shown.
b. Under recovery shown in brackets.
.. Not applicable.

Note Owing to rounding, figures may not add to totals.

Source BTE estimates.

The main conclusions reached by Small and Winston, are that US revenue instruments are inadequate and that in the US current recovery from operations of trucks is below that required for economic efficiency. Average charges levied on truck operations are nevertheless much greater than those in Australia.

A further conclusion reached by Small and Winston, is that current US design practice leads to serious under investment in pavement durability. More durable pavements would result in lower damage costs and so lower road charges. This is an issue which also needs to be investigated in Australia.

Generally, even if efficient road pricing were instituted, then there is still a requirement that roads be provided which are best suited for the task required of them; roads which minimise their life-cycle costs, minimise the amounts which are required to be recovered from road users. In a competitive system, the firms which make the best investments, have the lowest cost structure and can offer the lowest prices. These firms will be the ones most likely to survive in the long run, thus ensuring that, over the long run, the lowest cost systems are maintained.

The nature of road provision, however, is such that roads are provided by a single authority in each State. While there are some pressures upon authorities to provide the most suitable roads for the purposes required of them, the most appropriate pressure will come from road users when they are required to pay for road use in proportion to the costs they cause. In the absence of a competitive system of road provision, suitable input from road users to the road investment decision may occur if there is suitable road user representation within each of the State Road Authorities.

To summarise, road prices based on economic efficiency considerations (and prices on a similar basis for other modes of transport) would encourage the most appropriate use and provision of Australia's extensive transport system.

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