# Review of Road Pricing in Australia and Overseas

## Occasional Paper

The main purpose of the work presented in this Paper was to examine the nature of road pricing in Australia and identify potential areas for improvement. The approach adopted was to consider the relevant aspects of economic theory underpinning road pricing and then to examine how different road pricing strategies have been implemented in a number of overseas countries; specifically the United States, New Zealand, Singapore and Hong Kong.

Occasional Paper 73

# Review of Road Pricing in Australia and Overseas

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## FOREWORD

The main purpose of the work presented in this Paper was to examine the nature of road pricing in Australia and identify potential areas for improvement. The approach adopted was to consider the relevant aspects of economic theory underpinning road pricing and then to examine how different road pricing strategies have been implemented in a number of overseas countries; specifically the United States, New Zealand, Singapore and Hong Kong. Options for improving the Australian road pricing system are discussed in the light of overseas experience.

Amongst the issues explored in the Paper are the possible road pricing objectives, the potential conflicts between these objectives and the pricing strategies which may be available to meet them. The case studies presented provide examples of how these issues and problems have been addressed in practice.

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## SUMMARY

This Paper addresses the question of road pricing in Australia. Attention is directed at assessing the performance of the pricing system in terms of satisfying specific pricing objectives and examining alternative pricing strategies to the current system.

The approach adopted in the Paper was to examine the theoretical aspects of road pricing and how specific road pricing strategies have been implemented in a number of overseas countries. The United States, New Zealand, Singapore and Hong Kong were selected as case studies. These countries were chosen on the basis of differences in road pricing objectives pursued. The United States pricing scheme is equity based while the New Zealand scheme has some regard to economic efficiency criteria. The Singapore and Hong Kong pricing schemes are concerned with the effects of congestion.

Economic theory suggests that road users should pay for the provision of road services. Roads possess some of the characteristics of public goods but they also retain some private good characteristics. Hence, while their provision by the public sector is justified no rationale exists for providing roads free of charge.

As roads possess both public and private good characteristics, road pricing may be used to pursue a number of different objectives. Three broad objectives of government pricing of roads are identified in the Paper:

- economic efficiency;
- income distribution; and
- financial goals (for example, cost recovery).

Conflicts between these objectives exist and while, in theory, pricing strategies can be designed to satisfy each of these objectives it is unlikely that all three can be satisfied simultaneously by any one pricing strategy. Hence, it is necessary that decisions be made concerning the relative importance of alternative pricing objectives

and the extent to which each should be pursued. In practice, compromises may need to be made.

The case studies examined in the Paper provide examples of how the conflict between objectives has been resolved in other countries.

The chief objective of the United States pricing scheme is the maintenance of equity between different classes of road users. However, cost recovery is also an important consideration. In attempting to achieve these objectives two major charges are imposed; namely fuel taxation and a heavy vehicle use tax. This later charge is an annual fixed fee levied on the basis of average distances travelled by different classes of vehicles. It is argued in the Paper that this averaging method results in vertical equity between different classes of vehicles being maintained, but it adversely affects horizontal equity between similar vehicles. Economic efficiency criteria are also not satisfied by this charging structure.

The principles which underly the New Zealand road pricing scheme are similar to those underlying the United States scheme. The fundamental principle underlying the New Zealand system is the recovery of all road costs from road users. The system is, in essence, based on a particular strategy for achieving equity, the cost occasioned methodology. However, unlike the United States scheme, the New Zealand scheme has elements of efficiency built into it through the imposition of weight-distance taxation incorporating the use of hubodometers. To the extent that the distance averaging factor present in charges levied is not as great as that in the United States charging structure, the New Zealand pricing system is likely to achieve higher levels of efficiency and also horizontal equity, while recovering all road costs.

Unlike the United States and New Zealand road pricing schemes those implemented in Singapore and Hong Kong are directed at reducing congestion levels within inner-urban areas. The two approaches adopted in pursuing this objective are, however, considerably different. The Singapore scheme employs a system of licencing whereas the Hong Kong scheme uses on-vehicle electronic metering. In terms of simplicity the Singapore scheme offers distinct advantages over the Hong Kong scheme, but in terms of the maintenance of efficiency and equity the Hong Kong scheme would seem to be superior.

The assessment of the Australian road pricing scheme indicates that

significant deficiencies exist within its structure. Heavy vehicles are generally considered to underpay in relation to the costs that they impose on the road system while lighter vehicles, in particular passenger vehicles, overpay. Hence, while the current system may raise sufficient revenue to recover the total costs attributable to all road users, improvements in efficiency and equity can be made.

It is argued that the satisfaction of efficiency and equity criteria requires that the avoidable costs of road use by different vehicles be recovered from those responsible for them. By implication, this requires the imposition of charges which vary with distance travelled and vehicle type. The only charge that can fully meet these criteria is a weight-distance tax. However, there are a number of problems associated with the imposition of such a tax, in particular, acceptance on the part of road users and constitutional constraints.

Given a weight-distance tax for recovery of avoidable cost, there are a number of other charges which could be used, either singly or in combination, to achieve any additional revenue target. From an efficiency point of view, the choice of the best charge or combination of charges will depend on expected user reactions to the charges. Annual registration fees and fuel taxes are two types of charges which would probably best perform any additional revenue raising function from an efficiency viewpoint.

Registration fees and fuel taxes will, however, have very different equity implications - particularly with regard to the burdens imposed on private motorists compared with heavy vehicle operators. These implications should be fully considered in designing an appropriate system of road user charges.

## CHAPTER 1-INTRODUCTION

Road pricing has been an important issue in Australia and other countries because of the key role of the price mechanism in the resource allocation process and concerns about the fairness of charges to particular road user groups.

The main purpose of the work reported in this Paper was to examine the nature of road pricing in Australia and to assess its effectiveness in meeting specific objectives. This examination was made against the background of the basic theoretical concepts underlying road pricing and the road pricing experience in a number of overseas countries.

In earlier Bureau of Transport Economics (BTE) research into the road financing policies of a number of overseas countries, reported in BTE Occasional Paper 49 (BTE 1982a), it was found that the United States and New Zealand had developed road pricing schemes with specific, well defined objectives. The United States has adopted an equity based pricing scheme while the New Zealand scheme contains both equity and efficiency elements within its structure. Both these countries were included as case studies in this study to illustrate the practical considerations involved in adopting a system of road user charges to meet specific objectives. In addition, the Singapore and Hong Kong road pricing schemes were examined as they provide examples of pricing schemes specifically designed to meet another objective; the control of traffic congestion.

The structure of this Paper takes the following form. Chapter 2 presents theoretical aspects of road pricing, including the economic rationale for pricing road use. Possible road pricing objectives are outlined and strategies designed to satisfy these objectives.

Chapters 3 to 6 are devoted to the country case studies referred to above and the Australian road pricing system. The current system of road user charges is described for each country and then assessed in terms of the framework developed in Chapter 2.

The various options for changing the Australian road pricing stucture are discussed in Chapter 7. These options are assessed in light of the pricing considerations evident in the overseas countries examined and the pricing constraints present within Australia. Chapter 8 contains a summary of the main issues identified in the Paper.

## CHAPTER 2-ROAD PRICING PRINCIPLES: CONCEPTS AND ISSUES

The economic principles underlying road pricing are well documented in economic literature. This chapter provides a summary of these principles and a discussion of the more important contemporary road pricing issues. It also contains details of the possible objectives for pricing roads and how the choice between road pricing strategies depends on the primary objectives being sought.

The discussion in this chapter begins with a short explanation of why road use should be priced. This is followed by an analysis of the current economic theory of road pricing, including some theoretical and practical problems. Alternative pricing objectives are then presented along with alternative road pricing strategies designed to achieve these objectives. Finally, some current road pricing issues are examined.

The discussion has been kept as non-technical as possible but some economic terms and concepts are required to accurately explain pricing principles. Further amplification of these concepts can be found in most micro-economic textbooks.

### RATIONALE FOR ROAD PRICING

If roads were owned and supplied by private firms there would be little question that motorists would be charged for using them. In this situation prices would generally be determined by market forces.

For various reasons roads are not usually provided by private firms but by governments. These reasons include the difficulties of excluding people who are unwilling to pay, the limited charging mechanisms available to private firms (for example, tolls) and the high costs of collecting these charges. A further characteristic of roads favouring public supply is the existence of externalities; benefits or costs not accruing wholly to users (for example, benefits to shop owners, costs of noise and pollution to nearby residents). In the case of benefits to non-users, it may be desirable to expand road capacity to take advantage of them. However, there would be no

incentive for a private firm to do so if it could not charge for these benefits.

Equally, there would be no incentive for a private firm to improve the safety features of roads if it did not have to bear the cost of accidents.

The provision of roads by the public sector means that it may not be necessary to directly price their use, since governments have available to them a range of revenue sources from which to fund roads expenditure (or other areas of expenditure). Roads could, for example, be funded from income taxation receipts. However, there are a number of reasons why governments may choose to impose charges on the use of roads. In general there are three main objectives for pricing roads; economic efficiency, equity and revenue raising (a financial objective).

The main economic rationale for directly pricing the use of publicly provided roads, in a way similar to the situation if they were provided by a private firm, is the desirability of achieving an economically efficient allocation of the scarce resources of society.

The price charged for road use affects the level of usage. When an 'appropriate' price is charged, the resulting level of road use provides a signal as to whether more or less resources should be directed to the road system. In the absence of prices, road users will be encouraged to demand a higher than 'optimal' level of services.

The pricing of road use may also assist in obtaining an efficient allocation of resources among road and other transport modes. In the absence of road pricing, demand may be attracted away from lower cost rail or air services. This may lead to the consumption of more resources in undertaking a given transport task.

A further aspect of the efficiency argument for directly pricing road use rests on the fact that, in many instances, road transport is an intermediate good, or a further input into other productive processes, and not a final good. As a result, appropriate road user charges are an important element in maximising the total productive effort of the economy.

Governments may wish to pursue objectives apart from economic efficiency through the provision and pricing of road transport infrastructure. For example, governments may provide to a particular

area road infrastructure of a quality for which the construction and maintenance costs cannot possibly be recovered from potential road users and justify this on the basis of defence, fiscal equalisation, regional development, equity or other social grounds. Such a decision results in a redistribution of resources or income within the community.

Finally, road pricing may also be adopted by governments because of its potential use as a general taxation measure. For example, road pricing may be used to raise revenue over and above the amount necessary to recover the costs incurred in providing the road infrastructure, or simply to recover a particular amount which the government decides is an appropriate contribution by road users towards road costs.

These three goals; economic efficiency, revenue raising and equity (income distribution) are discussed in turn. The conclusion reached is that each of the available road pricing stategies is unlikely to achieve all three objectives simultaneously and a decision must therefore be made about the relative importance of the alternative goals.

## ECONOMIC EFFICIENCY

Economic efficiency is concerned with the optimal allocation of resources among competing needs. Using a number of assumptions about the behaviour of firms and consumers, precise conditions can be established from micro-economic theory for maximising economic efficiency. The process of achieving maximum economic efficiency is seen in the theory as one of maximising the utility or satisfaction of all individuals in their consumption of goods.

The simple micro-economic model demonstrates that economic efficiency is maximised when the price charged for each good or service is equal to the marginal cost of producing the good, that is, the cost of producing the final unit of output. In the case of a firm operating in a competitive market it represents the lowest price at which an additional unit of output of the good will be supplied.

Economic theory suggests that it is efficient for a government to fund production of a good from income taxation only when the marginal cost of providing the good is zero[1]. In special cases, such

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1. This special case, where marginal cost is zero, is referred to by Samuelson (1954) and other economists as a 'pure public good'.

as defence, this may be applicable because the extra cost of providing defence to one extra individual is zero (or very close to zero). However, the marginal cost associated with a vehicle being used on a road is usually not zero. For example, the use of a vehicle on a road causes damage to the road surface resulting in maintenance costs being incurred. There are also social costs associated with road usage such as pollution and congestion costs.

The marginal cost of road use (which includes social costs) is, however, generally recognised to be a small proportion of total costs. Therefore, the adoption of the marginal cost pricing principle, while maximising economic efficiency under the assumptions of the simple micro-economic model, may not recover all the costs of road provision and thus require subsidisation from general taxation. The main reason why the revenue collected from a road pricing strategy based on marginal costs will fall short of the total cost of road provision is the existence of joint or common costs. Joint costs include the fixed costs of providing the basic road system which are required before even one vehicle can travel on the road (for example, right of way and a minimum standard of road). Common costs include those which vary as the level of traffic varies (for example, extra lanes and traffic lights). These costs, which can be either variable or fixed, cannot be attributed to one individual user and are not affected by the use of the road by one additional vehicle.

The term avoidable cost is often used in discussions on road pricing. The term refers to the costs that could be avoided if a particular vehicle did not use the road system, whereas marginal cost refers to the cost of providing an additional unit of output (for example road use). The latter can be difficult to measure, whereas avoidable cost is, at least in theory, much easier to calculate. The two concepts are generally used inter-changeably although they are technically different.

## FINANCIAL GOAL

The nature of road costs means that the application of the simple economically efficient (marginal cost) pricing rule to roads will result in a shortfall in the recovery of the total costs of road provision. Therefore, the recovery of all road costs, or the use of road pricing to raise general revenue over and above the cost of providing roads, requires the adoption of an alternative strategy to marginal cost pricing.

The appropriate pricing strategies to provide desired revenue levels while still preserving the key elements of economic efficiency have been of interest to micro-economists since early this century. The most succinct early work on the subject was presented by Ramsey in 1927. The model developed by Ramsey (1927) has been refined by a number of researchers including Baumol and Bradford (1970). The Ramsey model sought to establish conditions under which charges greater than marginal cost might be levied that would minimise the consequent losses in efficiency.

The Ramsey model demonstrates that to achieve a specific revenue target, and minimise the welfare loss from not setting prices equal to marginal cost, prices should be set so that the level of use of roads by each road user is in the same proportion as would be the case if prices were set at marginal cost. It is argued that when this condition is fulfilled distortions in the demand patterns of road users will be minimised.

In practice this requires that higher prices are set for those road users who are least deterred by high prices. These users are said to have a low price elasticity of demand for road use. Users with a high price elasticity, or a strong sensitivity to price, should be charged closer to marginal cost. Technically, Ramsey pricing means pricing according to the inverse price elasticity of demand for road use for each individual.

The above pricing rule is applicable whether a government (or private firm) wishes to recover all costs (including common and joint costs), a lesser amount (but still above marginal cost) or a greater amount. However, it is dependent on a number of assumptions, the most important of which is that there are no close substitutes for road use (which in technical terms means that the cross elasticities of demand are zero).

If, for example, the application of this rule resulted in a significant number of road users switching to, say, rail then this situation can give rise to distortions in the demand for both transport services. In this case it has been shown (see Kolsen 1968) that prices should be set for both road and rail such that

$$\frac{\text{road price}}{\text{road marginal cost}} = \frac{\text{rail price}}{\text{rail marginal cost}}$$

To generalise this statement, wherever there are close substitutes in the economy and one or all are taxed, then taxes should be set such

that the final price is a constant proportion of marginal cost for all substitutes.

These pricing rules represent what economists term 'second-best' options which, in theory, are not as efficient as marginal cost pricing. In choosing between them it is necessary to decide whether there are close substitutes for road use. On this point there is some disagreement.

It is clear that only some forms of road use are currently in competition with rail transport services, most notably long distance road freight. Thus one major issue in applying the above pricing rules is the setting of prices for long distance heavy road vehicles. It is often argued that some rail freight services in Australia fail to meet marginal costs (see National Road Freight Industry Inquiry (NRFII) 1984). Where this is the case, heavy road vehicles in direct competition with rail freight should not pay more than marginal cost; on both equity and efficiency grounds both modes should always at least cover their marginal costs. Alternatively rail freight rates could be increased above marginal cost in line with the price/marginal cost ratio of heavy road vehicles, that is, both modes should be treated equally. For those heavy road vehicles not in competition with rail, and for all other road users, prices above marginal cost should be related to demand elasticities if welfare losses are to be minimised.

A further point to note is that to be strictly correct the Ramsey pricing rules should apply to all 'complements' of road use. For example, purchase of motor vehicles and parts, such as tyres, should also be reduced pro rata to the levels that would result from marginal cost pricing. In practice this may be difficult or impossible to achieve since the demand for these 'complements' will differ from that for road use. Although there are no clear rules for action in this case, possible effects on the demand for complementary goods should be taken into account in assessing appropriate charges.

On the other hand, some complements may be less sensitive than road use to taxation. If so, it might be better to tax these complements than to tax road use, since this could result in a smaller loss of efficiency. For example, it may be that demand for vehicle ownership is fairly inelastic with respect to higher registration charges. Some road users may choose to dispose of their vehicles when faced with a large tax on ownership, or decide not to purchase a vehicle (or a second vehicle), but these individuals may be small in number. In

addition, taxation on vehicle ownership may have little impact on the road use of the remaining vehicle fleets.

A decision on the appropriate item(s) to tax requires information about the demand elasticities for these complements as does the appropriate level of taxation for individual road users.

In practice demand elasticities, and therefore Ramsey prices, are difficult to measure and some simple approximate charges may have to be determined if this approach is adopted. Studies of demand elasticities have yielded widely varying results (see, for example, Taplin's discussion of the subject (Transport Economics Centre (TEC) 1981). In each situation (for example, different countries and different road categories) separate studies may need to be undertaken to determine elasticity values.

A point worth emphasising is that Ramsey pricing rules only show how to minimise the loss of efficiency from charging road users more than avoidable costs. There is no intrinsic merit from an economic efficiency viewpoint in achieving any particular cost recovery target above avoidable cost (although the potential to cover total costs over the life of an asset may be an important consideration for investment decisions). Hence a more efficient approach may be to obtain revenue above avoidable costs from the community at large rather than from road users (for example, through income taxation).

## EQUITY GOALS (INCOME DISTRIBUTION)

The economically efficient approach and the adoption of Ramsey pricing rules for revenue raising from road use may produce results which are unacceptable from the point of view of income distribution in society. The inverse elasticity rules, as well as most micro-economic principles, were originally based on concepts of utility functions where it was assumed that the marginal utility of money was constant for all individuals. Further, they were premised on a proposition (known as the Kaldor-Hicks criterion) that society's welfare can be said to improve if the sum of utility gains by some individuals exceed the sum of utility losses of all other individuals. In other words, welfare will be improved if losers can be compensated by those who gain, whether or not compensation is actually made.

A more restrictive approach has been developed in modern welfare economic theory whereby welfare is said to improve if no consumer loses but some gain (see discussions of Pareto optimality in most

modern micro-economic textbooks, for example, George & Shorey 1978). However, current welfare economic theory still ignores the fact that income distribution in society may be adversely affected from some individuals' perspectives under conditions of Pareto optimality or under Ramsey pricing. For example, more wealthy individuals may be made relatively better off even though poorer people may also gain. This may be viewed by some individuals as an inferior result.

The micro-economic approach to the problem of income distribution is to address it through income taxation or subsidies (cash grants) which do not distort the pattern of demand for road use.

The use of measures such as income taxation to address a specific problem such as the income effects arising from road pricing are, however, rather 'blunt' and appear to be generally unacceptable to governments. The preferred alternative usually involves the adoption of a pricing policy which explicitly (or implicitly) takes distributional considerations into account (for example, concessions on bus fares for low income groups).

In contrast with economic efficiency pricing rules no unique, unambiguous analysis has been developed to provide pricing rules that would ensure income distribution will be 'improved'. Lansing (1966, p. 5) comments that considerations of income distribution lie on the boundary between economics and politics. What constitutes an equitable allocation of resources can be determined by a number of factors but cannot be uniquely defined.

Three different approaches have been identified as possible ways to address the problem of attaining an equitable distribution of costs among road users. These are:

- the cost occasioned approach
- the benefits approach
- the ability to pay approach.

**Cost occasioned approach**

The basis of the cost occasioned approach is founded on the principle of horizontal equity. This principle suggests that individuals in equal positions should be subject to the same levels of taxation. This implies that road users who impose the same levels of cost on the road system should be confronted with similar charges.

The cost occasioned approach is, like the economic efficiency

approach, cost based but open to the level of costs attributed to individual users. As applied in practice, the cost occasioned methodology entails attributing all costs (or as much as possible) to individual road users. Thus it attempts to attribute common costs to individual users using criteria usually based on engineering aspects of roads. For example, because roads are often built to a higher standard than required for cars alone, in order to cater for heavy trucks, the additional construction costs of pavements and bridges required for truck use are allocated to trucks. The basis of such an allocation is usually some formula derived by engineering research such as the 'fourth power rule'. This rule holds that pavement damage is proportional to the fourth power of the axle load of the vehicle. Thus the pavement thickness required varies with the number of unit axle (raised to the fourth power) passes over the surface. Other factors usually considered include distance travelled and, in the case of bridges, gross vehicle mass.

All remaining costs, including joint costs, which cannot be attributed in some way among vehicles are usually allocated by some generally accepted but arbitrary method such as dividing them equally among all vehicles or on a vehicle kilometre basis.

Thus almost all costs other than marginal costs are allocated among road users on a causal basis. This compares with Ramsey pricing which allocates these costs on the basis of demand. The difference in practice between these two methods is impossible to ascertain *a priori* and would depend on many factors, such as the types and overall design standards of roads. This also means that the results in one country may not be applicable in another.

**Benefits approach**

This approach is based on the proposition that the level of taxes levied on individuals should reflect the benefits they derive from consumption.

A major difficulty with this approach is the necessity of measuring the benefits enjoyed by all road users from using the roads. This is a large task and involves considerable subjectivity. For this reason the approach is generally not considered practical.

**Ability to pay approach**

This concept is also derived from principles of income taxation. In general, it is based on the proposition that individuals should be taxed in accordance with their financial or economic ability to pay

such taxes. However, these abilities are difficult to measure. It has been argued that the concept of ability to pay has its foundations in the notion of a utility function, suggesting that individuals should accept equal reductions in utility as a result of taxation.

### Comparison of equity approaches

It is important to note that the three equity approaches outlined are mutually exclusive. The charges resulting from implementation of each of the approaches will be different. They are also most unlikely to be consistent with marginal cost pricing or Ramsey pricing rules.

The choice of a preferred equity approach to road pricing is likely to depend on data availability and administrative practicability. Most equity based studies have employed the cost occasioned approach because of the measurement difficulties involved with the benefits approach and the ability to pay approach.

## PROBLEMS AND ISSUES IN ROAD PRICING

The discussion above has outlined in general terms the broad types of approaches that can be followed in determining suitable road pricing schemes to satisfy different pricing objectives. The broad objectives which might be pursued have been specified, along with the appropriate strategies to achieve these objectives. Some of the problems associated with developing mechanisms and rules to meet the objectives have also been identified. However, there are a number of other problems and issues which must be addressed before any of these schemes can be implemented; some relating to individual schemes and some of a more general character. Two of these are discussed below:

- congestion pricing
- hypothecation.

### Congestion pricing

One particular cost of road use that has attracted special attention from economists has been the cost of road congestion. Congestion imposes costs on other road users rather than on the road system. These include longer travel times and higher vehicle operating costs.

Since these costs are attributable to individual road users and vary with each trip made, they should, on economic efficiency grounds, be priced in the same way as for all other costs.

Charging road users for congestion costs can, however, be difficult

for at least two reasons; the problems in measuring the congestion costs caused by each and every use of the road and political considerations.

The first problem arises from the fact that congestion varies with location and time of day as well as certain characteristics of each vehicle (for example, size, acceleration and braking distance). Efficient congestion charges should reflect all these variables.

Recent developments in electronics and micro-processors have the potential to solve these problems. In fact an electronic pricing scheme has been recently introduced in Hong Kong. Details of this scheme are discussed in Chapter 5. Such schemes have potential problems, however, including cost and public acceptability. It is also possible that they might not be effective in some cities but simply shift the congestion elsewhere.

The political consideration is concerned with the levying of congestion charges on motorists to raise considerable revenue when governments are unable or unwilling to spend the revenue on improving the road system.

While these difficulties may be serious there is, nevertheless, merit in adopting at least some system of congestion charges to deter those who place least value on use of the road system in heavily congested areas. However, in most countries governments have not adopted effective pricing schemes but, by default, have left congestion to ration itself. Thus on congested roads there is a physical rationing of road space with little regard for the efficient use of resources. The design criteria for new roads tends to reflect this situation.

**Hypothecation**

In discussions on road pricing and cost recovery many commentators have advocated the tying of revenue raised from road pricing to expenditure on roads. Hypothecation policies have been adopted in many countries and there are specific examples in Australia (for example, the Australian Bicentennial Road Development Program and the new Australian Land Transport Program).

Economic theory does not provide a basis on which hypothecation may be justified. By and large, expenditure decisions should be made on the basis of benefit-cost analysis and pricing decisions on the basis of marginal cost pricing. There is no *a priori* reason why the revenue collected from road users over a specified time period should be equal

to expenditure, except perhaps over the total life of a particular project and only then in special circumstances.

The costs imposed on the road system by road users should not be confused with the expenditure incurred in constructing and maintaining roads. It is possible that if a particular road is never improved but is maintained constantly at a certain standard over its lifetime, total costs imposed on it by road users will equate with expenditures. However, for the road system as a whole, sections are constantly being improved while others are deteriorating. Overall capacity has also been expanding. In addition, apart from the actual construction and maintenance expenditure, the opportunity cost of road investments, (that is the benefits that could be obtained by investing the funds spent on roads in other productive areas) should also be taken into account in cost recovery calculations.

There are, however, advantages in the pay-as-you-go approach to cost recovery. One argument advanced in its favour is that it helps create financial discipline because expenditure must be kept in line with revenue raised. On the other hand, the pay-as-you-go approach can pose problems, particularly during inflationary periods when road costs are increasing more rapidly than hypothecated revenue.

Other advantages may include the possibility that road users may be more amenable to increased road user charges if the revenue generated is seen to be going to improve roads and not siphoned into general revenue. Road authorities also benefit by not having to argue their case against other areas of government expenditure. However, treasury departments appear to be reluctant to see their scope for budget management reduced by the tying of any revenue source to a particular item of expenditure. It is also argued that such a practice reduces a government's ability to implement priority programs.

## CHAPTER 3-ROAD PRICING IN THE UNITED STATES

The predominant feature of the road pricing system in the United States is its focus on equity considerations. The methodology on which the pricing system is based has been developed over the past 28 years. The latest modification to the structure of charges was the result of the promulgation of the provisions of the Surface Transportation Assistance Act 1982 (STAA 1982) on 6 January 1983. The provisions of this Act represented a watershed in Federal Government road financing arrangements in the United States. Prior to this, the structure of road user charges had remained substantially unaltered since 1956.

This chapter examines the impact of the provisions of the STAA 1982 on road pricing arrangements in the United States. In particular, the central concern is focussed on the structure of charges that arose from the provisions of the Act and how they correspond to the various objectives of road pricing outlined in Chapter 2.

The chapter begins with details of the role that each level of government in the United States plays in road financing. The background to the 1982 Act is then discussed and the current system of road user charges outlined. This system is then assessed in terms of both the framework presented in Chapter 2 and the specific objectives of road pricing which have been expressed in the American literature. Some comments concerning the effectiveness of the United States pricing system are also presented.

### RESPONSIBILITY FOR ROADS

The system of government in the United States is comprised of three elements: Federal, State and local government. In this respect, it is similar to the Australian Federal system of government where there is a shared responsibility of governmental functions.

The United States Constitution provides the basis for the role of Federal and State governments in the provision of road services.

There is no provision made for local government. However, as noted in BTE (1982a, p. 88), the State governments have to a large degree delegated their roads responsibility to local government authorities. Hence, there is a sharing of roads responsibility among different levels of government in the United States.

**Federal government responsibility for roads**

The Federal Government has limited *de jure* responsibilities for roads emanating from provisions in the United States Constitution. However, when financing and pricing considerations are fully accounted for, it is possible to identify a more extensive Federal Government *de facto* role.

The Federal Highway Administration (FHWA) is responsible for the management of the Federal roads program. The financial basis for this program is derived from revenues provided under the Federal-Aid Highways Act 1916 and amending Acts.

While the funding requirements for this program are met partially by the Federal Government, it is, in effect, a State government administered scheme. The State governments are responsible for the initiation of road projects to be considered for the road program, while it is the Federal Government's role to decide which projects should receive Federal funds.

The degree of control that the Federal Government exercises over the disbursement of its funds may vary according to road category. For example, a strong Federal involvement has been assumed over the interstate highway system. Federal funds comprise the majority of all funds spent on roads in this system and the Federal Government undertakes a dominant role in defining the composition of the system, both physically and financially. However, for other categories of roads the degree of Federal supervision is substantially lower.

**State government responsibility for roads**

A requirement of the initial Federal-Aid Highways Act 1916 was that State governments be required to set up State transport departments. One of the functions of these organisations is to formulate State road expenditure programs for evaluation by the FHWA. In total, the State governments maintain financial and administrative responsibility for approximately 20 per cent of the total road system (BTE 1982a, p. 97).

In addition to these responsibilities, the State governments also assist local government authorities in the maintenance of their road

expenditure programs. This is accomplished by a system of grants to local government authorities.

The various State governments raise revenue for roads from a variety of sources in conjunction with that raised by the Federal government. These sources include excises on fuel, heavy vehicle taxes, motor vehicle registration fees and drivers' licence fees. The State governments also receive additional revenue in the form of payments by local government authorities where the responsibility of these levels of government for roads overlap.

### Local government responsibility for roads

In the United States local government authorities are responsible for the administration of the largest proportion of the total road network (BTE 1982a). Local government authorities have access to their own revenue sources. These include road user charges such as tolls, parking charges and traffic fines and other charges such as property taxes.

It is evident, therefore, that each level of government in the United States exercises a significant degree of responsibility in making decisions concerning road finance and expenditure. Thus, a detailed examination of the road pricing system in the United States must include the charging structures of all levels of government. Such an extensive examination is not attempted here; rather the intention of the Paper is to focus on particular charging schemes, while the discussion in this chapter is restricted to the Federal road user charges.

## THE SYSTEM OF ROAD USER CHARGES PRIOR TO 1982 AND THE 1982 UNITED STATES FEDERAL HIGHWAY COST ALLOCATION STUDY

The rationale for the current system of Federal road user charges emanated from the findings of the 1982 United States Federal Highway Cost Allocation Study. Before describing the United States pricing system in detail it is worthwhile examining the findings of this study, and the reasons why it was instigated, to gain an appreciation of the objectives behind the current pricing scheme.

### Major changes in road pricing arrangements prior to 1982

The basis of the current system of charges was laid in 1956 when specific Federal road user charges were first introduced.

Prior to this time road expenditure was financed from revenue

collected from general taxation sources. As a consequence, no formal link existed between road revenue and road expenditure.

The Highway Revenue Act 1956 introduced a link between specific charges and road expenditure. The Act adopted a 'pay-as-you-go' philosophy to road financing in establishing the Highway Trust Fund. This fund received revenue from a number of taxes levied on road users which were earmarked for expenditure on roads. User charges accrued firstly to a General Fund, administered by the US Treasury, and were then transferred to the Trust Fund. Withdrawals from the Fund were only made for projects approved by Congress. The chief objective was to ensure that expenditures from the fund were balanced against revenues.

With the introduction of the 1956 Act a number of existing charges were tied to road expenditure and their rates of taxation increased. In addition, two new hypothecated charges were introduced. These were a tax on tread rubber (per unit weight of retread) and a heavy vehicle use tax. The introduction of these taxes was directed at preserving equity between road user classes, reflecting the major objective of the Act. Their specific aim was to ensure heavy vehicles paid a 'fair' share of road costs.

However, despite these changes, there was some concern that the distribution of costs and benefits of road use were not adequately reflected in the charging system (FHWA 1983, pII-3). In response, Congress initiated a study to examine the benefits derived by various classes of road users from road expenditure. The Study, completed in 1961, recommended changes to the charging structure to preserve equity between vehicle classes. As a consequence, the taxation levels on tyres, inner tubes, tread rubber and new trucks were increased and the heavy vehicle use tax was also raised. In addition, the existing sales taxes levied on new trucks, buses and trailers were earmarked for allocation to the Highway Trust Fund. These recommendations were incorporated in the Federal-Aid Highways Act 1961.

Subsequent to the passage of the 1961 Act no other major changes were made to the system of road user charges in the United States until 1982. However, during the period from 1961 to 1982 a number of attempts were made to raise the level of taxation imposed on heavy vehicles. In 1965 a supplementary report to the 1961 cost allocation study indicated that the distribution of the tax burden among different road users did not reflect the costs that they imposed upon the road system. Specifically, there was some concern that heavy vehicles, as a class, were underpaying in comparison to their cost

responsibility. Higher rates of taxation on distillate and increases in the rate of tax on tyres and the heavy vehicle use tax were proposed. However, these were not accepted by Congress.

Similarly, in 1966, changes to heavy vehicle taxation levels were proposed but again rejected. However, all Federal taxes on fuel, tyres, new trucks, truck parts, lubricating oils and heavy vehicles were hypothecated and transferred to the Trust Fund.

A further cost allocation study undertaken in 1970 reinforced past observations that a disparity existed between the level of tax payments and the cost responsibilities of heavy vehicles. Despite this, little of consequence was done to ameliorate this anomaly and no further changes were made to the system of road user charges until 1982. One likely reason for this is contained in the financial data presented in BTE (1982a). These data indicate that over time revenue had accumulated in the Trust Fund. On these grounds it may have been politically difficult to increase the rates of road taxation on trucks when surplus revenue existed.

**The requirement for a further cost allocation study**

With the passage of the Surface Transportation Assistance Act 1978, there was growing concern that Federal and State government road revenues were not sufficient to meet road expenditure requirements which had risen as a result of inflation.

While the demand for road services had moderated, increases in road construction and maintenance costs meant that receipts from road taxation were considered insufficient to maintain an adequate road program. In addition, there had been a shift over a number of years in demand towards more fuel efficient vehicles, resulting in a reduction in fuel excise collections.

Apart from these financial considerations, there were other factors which demonstrated the need for a further cost allocation study. First, the legislation providing for the Highway Trust Fund was due to expire in 1984 and there was a perceived need to renew the legislation. Second, there had been a change in the road expenditure pattern as the Interstate Highway System was nearing completion. There had been a shift in emphasis from construction expenditure to maintenance expenditure. Hence it was thought that the benefits of road use accruing to different user classes had also changed as a consequence. Finally, there was also a need to update current cost data and maintain data reliability (BTE 1983, p. 5).

Section 506 of the Surface Transportation Assistance Act 1978 (1978 STAA) directed the Department of Transport to undertake a further cost allocation study to be completed by 1982. The Department was directed to:

- examine the allocation of Federal highway program costs among user classes;
- assess the current charging system and recommend more *equitable* alternatives; and
- evaluate the need for long-term monitoring of roadway deterioration.

It is significant that the explicit objective of the study, as it had been for all previous studies, was the preservation of equity. The Study Team interpreted this requirement as not totally precluding consideration of efficiency issues. Nevertheless, it rejected adopting a system of charges based on efficiency because of three considerations. First, it was suggested that a prime requirement of the Highway Trust Fund was that expenditure balance the revenue received and that marginal cost pricing may be in conflict with this requirement, insofar as it may lead to an under- or over-recovery of road expenditure. Second, it was argued that, as State and local government charges did not reflect efficiency considerations, the adoption of an efficient Federal charging scheme would not of itself promote total efficiency in the roads sector of the economy. Third, it was considered that efficient user charges would be more difficult to implement.

In addition to these considerations, the concept of congestion pricing was also rejected by the Study Team as it was believed that the imposition of congestion charges would recover excessive revenue and so be politically unacceptable.

**Methodology adopted to allocate costs**

In previous cost allocation studies undertaken in the United States the cost-occasioned approach to equity pricing was adopted. Specifically, incremental cost methodology was used to allocate costs among road users. The 1982 Study also adopted the incremental method, but there are significant differences in this methodology from that adopted in earlier studies. One example is the allocation of construction costs.

The studies conducted prior to 1982 examined the potential differences in construction costs arising from the necessity to provide different

infrastructure for heavier vehicles. It was considered in the 1982 Study that this method did not distribute pavement costs on an equitable basis among vehicle classes (Bunting 1983, Working Paper 2, p. 2). In particular, there was some concern that the allocation of economies of scale in road pavement construction was inappropriate.

In previous studies the methodology adopted was to build pavement costs up in increments beginning with the lightest vehicles. Hence, in allocating costs, the approach assigned the resultant economies of scale in pavement costs to the heaviest vehicles. To avoid this problem the 1982 Study allocated costs to vehicle classes (grouped on the basis of weight) thereby distributing the benefits of economies of scale to all user classes.

In allocating costs among road users the following cost categories were identified:

- pavement costs
- structure costs
- geometric costs
- residual, common, costs.

*Pavement costs*

Included in this cost category are the so-called 4R costs, comprising pavement resurfacing, restoration, rehabilitation, and reconstruction costs. In previous studies no separate account had been taken of these costs. It was considered in the preparation of the 1982 Study that these costs would form an increasing proportion of total costs and therefore should be given explicit attention.

The costs of the new pavements were assigned to vehicle classes on an incremental basis. The cost of a minimum thickness of pavement was assigned to all classes of vehicles. Additional increments of pavement were then allocated among vehicles on the basis of equivalent single axle loads (ESALs). This method was adopted because information compiled by the American Association of State Highway Officials (AASHO) suggested that pavement damage was a function of axle weight.

While a similar methodology had been adopted in previous studies there were some differences in the way that it was implemented in the 1982 Study. The main difference was in the number of increments of pavement thickness that were used in assigning costs among user classes. In the 1965 Study six increments of pavement thickess were

applied. However, in the 1982 Study this was increased to 15 increments. By adopting this approach a higher proportion of total costs were assigned to heavy vehicles. Indeed, it was found that only 35 per cent of total pavement costs were assigned to common costs, a smaller amount compared with that assigned in earlier studies.

The method of allocating costs for existing pavement differed somewhat from that for new pavement. These were assigned on the basis of pavement stress relationships. This was found to include an interactive relationship between axle weight and environmental factors.

*Structure costs*

The costs of new or replaced structures (for example bridges) were assigned on an incremental basis. This involved identifying the costs associated with the incremental removal of vehicle classes from use of the structure in question (BTE 1983, p. 19). Each increment was assigned in proportion to the degree to which the structure in concern was deficient in load-bearing capacity.

The costs of rehabilitation, however, were treated as common costs and assigned equally to all vehicles.

*Geometric costs*

Costs arising from some geometric features required to satisfy the specific requirements of particular classes of vehicles were also assigned on an incremental basis. These costs include road width and steepness of grade. The costs of road width were allocated on the basis of vehicle width while the costs of providing road grades for particular classes of vehicles were allocated on the basis of the power to weight ratio of each vehicle class.

*Common costs*

The remaining costs (or residual costs) were treated in the Study as common costs. It was decided that a use-related measure, vehicle miles travelled (VMT), was the most equitable means of allocating this cost. In previous studies, however, vehicle axle miles had been used to assign pavement costs between vehicle classes.

The cost allocation methodology adopted in the 1982 Study is summarised in Table 3.1.

## Findings and recommendations of the 1982 Study

The examination undertaken in the 1982 Study involved the selection of

base year and forecast periods. The base year taken was 1977 and the forecast period began in 1980 and ended in 1990. The year 1985 was chosen to represent the forecast period.

The Study attempted to assess the likely distribution of road expenditure in the forecast period. This was made on the basis of the anticipated requirements of user classes for this period. Costs for the forecast year were assigned to vehicle classes and were compared with the revenue levels generated from alternative charging schemes.

In order to facilitate this comparison, vehicles were categorised into 38 vehicle types and then grouped into twelve classes. The structure of these classes is outlined in Table 3.2.

Table 3.3 provides details of the average annual payments made for each vehicle in a vehicle class in the base and forecast years under the current user charges structure. A number of pertinent features are contained in these data. First, the payments made by passenger vehicle owners were predicted to decline in real terms over time.

TABLE 3.1-COST ALLOCATION METHODOLOGY ADOPTED IN THE 1982 US FEDERAL HIGHWAY COST ALLOCATION STUDY

| *Cost component* | *Allocation method recommended by study* |
|---|---|
| Pavement | |
| New construction | Design approach-minimum thickness, uniform removal technique |
| Resurfacing, restoration, rehabilitation and reconstruction | Consumption approach-weighted deterioration functions |
| Bridges | |
| New construction | Incremental method |
| Replacement | Incremental method plus partially on basis of structural deficiencies |
| Repair | Common cost (see below) |
| Geometric | |
| Road width | Common cost (see below) |
| Grading | Incremental as a function of power to weight ratio |
| Common cost | Vehicle miles travelled |

*Source:* US DoT (1982, p. II-6), cited in BTE (1983, p. 18).

TABLE 3.2-1982 COST ALLOCATION STUDY; VEHICLE CATEGORIES

| *12 vehicle group summary* | *38 vehicle group* | *Description* | *Gross registered weight (1000 pounds)* |
|---|---|---|---|
| 1 | 1 | Standard compact autos | |
| 2 | 2 | Subcompact autos | |
| 3 | 3 | Motorcycles | |
| 4 | 4 | Intercity buses | |
| 5 | 5 | Transit buses | |
| 5 | 6 | School and other buses | |
| | 7 | Single unit 2-axle 4-tyred | <6 |
| 6 | 8 | Single unit 2-axle 4-tyred | 6-10 |
| | 9 | Single unit 2-axle 4-tyred | >10 |
| 7 | 10 | Single unit 2-axle 6-tyred | <19.5 |
| 7 | 11 | Single unit 2-axle 6-tyred | 19.5-26 |
| 8 | 12 | Single unit 2-axle 6-tyred | >26 |
| 7 | 13 | Single unit 3-axle | <26 |
| 8 | 14 | Single unit 3-axle | 26-33 |
| 8 | 15 | Single unit 3-axle | 33-40 |
| 8 | 16 | Single unit 3-axle | 40-50 |
| 8 | 17 | Single unit 3-axle | >50 |
| 9 | 18 | Combination 3-axle | <26 |
| 9 | 19 | Combination 3-axle | 26-50 |
| 10 | 20 | Combination 3-axle | >50 |
| 9 | 21 | Combination 4-axle 2S2 | <50 |
| 10 | 22 | Combination 4-axle 2S2 | 50-60 |
| 10 | 23 | Combination 4-axle 2S2 | >60 |
| 9 | 24 | Combination 4-axle other | <50 |
| 10 | 25 | Combination 4-axle other | 50-60 |
| 10 | 26 | Combination 4-axle other | >60 |
| 9 | 27 | Combination 5-axle 3S2 | <50 |
| 10 | 28 | Combination 5-axle 3S2 | 50-70 |
| 11 | 29 | Combination 5-axle 3S2 | 70-75 |
| 12 | 30 | Combination 5-axle 3S2 | >75 |

TABLE 3.2 (Cont)-1982 COST ALLOCATION STUDY; VEHICLE CATEGORIES

| *12 vehicle group summary* | *38 vehicle group* | *Description* | *Gross registered weight (1000 pounds)* |
|---|---|---|---|
| 9 | 31 | Combination 5-axle other | <50 |
| 10 | 32 | Combination 5-axle other | 50-70 |
| 11 | 33 | Combination 5-axle other | 70-75 |
| 12 | 34 | Combination 5-axle other | >75 |
| 9 | 35 | Combination 6 or more axles | <50 |
| 10 | 36 | Combination 6 or more axles | 50-70 |
| 11 | 37 | Combination 6 or more axles | 70-75 |
| 12 | 38 | Combination 6 or more axles | >70 |

*Source:* US DoT (1982, p. IV-19).

Conversely, payments made by truck owners were expected to rise within the ten year period by more than 50 per cent.

One reason cited for this was the reliance of the current charging structure on fuel excise as a major source of road revenue. It was anticipated in the study that there would be an improvement in the fuel efficiency of passenger vehicles and that this would be reflected in lower fuel consumption levels. Similar improvements in heavy vehicle fuel consumption were not expected. In addition, it was considered that the revenues collected from *ad valorem* taxes levied on heavy vehicles would not decline in significance, largely as a result of the expected impact of inflation on taxation receipts.

It was concluded in the study that the owners of passenger vehicles would contribute significantly less than the owners of heavy vehicles in terms of average user charge payments. However, it was evident that in spite of this the owners of heavy vehicles were paying charges that were less than the costs associated with their road use while the owners of lighter vehicles were over-paying. This is demonstrated by the data provided in Table 3.4, which show the ratios of user charges collected from each vehicle class to the allocated costs of those classes. A ratio greater than one indicates an overpayment by a vehicle class, while a ratio less than one indicates an underpayment. These data emphasise the relative advantage enjoyed by the owners of the heaviest vehicles and small passenger cars.

It is evident that single unit trucks overpay relative to other vehicles. Similarly, large passenger motor vehicles overpay relative to small passenger motor vehicles (as a result of greater fuel consumption levels). However, the greatest concern was that

TABLE 3.3-ANNUAL USER CHARGE PAYMENTS PER VEHICLE UNDER CURRENT USER CHARGE STRUCTURE

*(US$)*

| *Vehicle type* | *Base year (1977)* | *Forecast year (1985)* |
|---|---|---|
| Passenger cars | | |
| Large | 40 | 31 |
| Small | 23 | 18 |
| Average | 37 | 25 |
| Motorcycles | 3 | 3 |
| Buses | | |
| Intercity | 1 015 | 145 |
| Other | 46 | 0 |
| Average | 86 | 6 |
| Vans | 49 | 40 |
| Total passenger vehicles (average) | 38 | 27 |
| Single unit trucks | | |
| Less than 26 000 lbs | 105 | 132 |
| Greater than 26 000 lbs | 405 | 554 |
| Average | 175 | 253 |
| Combination trucks | | |
| Less than 50 000 lbs | 569 | 798 |
| 50 000 - 70 000 lbs | 889 | 1 292 |
| 70 000 - 75 000 lbs | 1 331 | 1 663 |
| Greater than 75 000 lbs | 1 452 | 1 819 |
| Average | 1 057 | 1 411 |
| Total trucks (average) | 347 | 522 |
| Total vehicles (average) | 50 | 46 |

Note: 1 tonne approximately equals 2200 pounds.

*Source:* US DoT (1982, p. I-11).

combination trucks of all weights significantly underpay in comparison to other vehicles. It was considered that if the user charges existing in the base year continued in the forecast period the disparity between heavy combination trucks and other vehicles would continue.

TABLE 3.4-RATIOS OF USER CHARGE PAYMENTS TO ALLOCATED COSTS BY VEHICLE CLASS UNDER CURRENT USER CHARGE STRUCTURE

| *Vehicle type* | *Base year (1977)* | *Forecast year (1985)* |
|---|---|---|
| Passenger cars | | |
| Large | 1.2 | 1.2 |
| Small | 0.7 | 0.7 |
| Average | 1.1 | 1.0 |
| Motorcycles | 0.5 | 0.6 |
| Buses | | |
| Intercity | 1.2 | 0.2 |
| Other | 0.3 | 0.0 |
| Average | 0.5 | 0.0 |
| Vans | 1.2 | 1.1 |
| Total passenger vehicles | 1.1 | 1.0 |
| Single unit trucks | | |
| Less than 26 000 lbs | 1.3 | 1.7 |
| Greater than 26 000 lbs | 1.7 | 2.2 |
| Average | 1.5 | 2.0 |
| Combination trucks | | |
| Less than 50 000 lbs | 0.8 | 1.2 |
| 50 000 - 70 000 lbs | 0.9 | 1.3 |
| 70 000 - 75 000 lbs | 0.6 | 0.8 |
| Greater than 75 000 lbs | 0.5 | 0.6 |
| Average | 0.6 | 0.8 |
| Total trucks (average) | 0.8 | 1.0 |
| Total vehicles (average) | 1.0 | 1.0 |

*Source:* US DoT (1982, p. I-13).

This disparity was explained in the Study as emanating from the structure of the user charges system. In particular, the main concern was that heavy vehicle user charges were not graduated according to vehicle weight. For example, the heavy vehicle use tax was levied on the basis of a flat rate of three dollars per thousand pounds of vehicle weight for all trucks weighing over 26 000 pounds. Sales taxes on trucks and parts and accessories were also flat rate charges.

A number of alternative charging structures were examined in the Study and were analysed in terms of their effectiveness in matching the cost responsibilities of different user classes with the amount of revenue generated from charges levied on those classes.

Six alternative charging schemes were assessed. These alternatives are presented in Table 3.5. The first option consisted of rates of taxation which were applicable under the current charging scheme. This option was rejected on the grounds outlined above. Options 2A to 2D were designed to encourage a more systematic relationship between user charges and costs but they did not include any of the existing user charge exemptions. Option 3 had the same objective as options 2A, 2B, 2C and 2D but retained all existing exemptions.

In general, the following pricing options were considered. First, increases in the rates of excise on petrol and diesel were recommended. In addition, it was argued that a differential excise rate be levied on petrol and diesel fuel, with a higher rate imposed on diesel consumption. This was because it was thought that diesel powered vehicles were more efficient than petrol powered vehicles and, therefore, would contribute less revenue per mile to the construction and maintenance of the road system.

Second, the imposition of flat rate taxation on tyres, as under the existing charging scheme, was rejected. In its place a graduated fee schedule was recommended. In each of the five pricing options examined, three rates of taxation were prescribed: for tyres weighing up to 50 pounds (22.7kg); between 50 and 100 pounds (45.4kg); and over 100 pounds. However, in each of the five options, different rates of excise were recommended.

Similar alternatives were proposed for the heavy vehicle use tax. As with the tyre tax, the heavy vehicle use tax was levied on a flat rate basis. Before the 1982 Cost Allocation Study was completed the excise rate was set at three dollars per thousand pounds of gross vehicle weight. Under the new schemes a graduated scale of fees was applied

TABLE 3.5-USER CHARGE ALTERNATIVES PROPOSED IN THE 1982 COST ALLOCATION STUDY

*(per $ billion of 1985 Federal Highway Program expenditure)*[a]

| *Charges* | *Current system* | *Options excluding current exemptions* | | | | *Option retaining current exemptions* |
|---|---|---|---|---|---|---|
| | *1* | *2A* | *2B* | *2C* | *2D* | *3* |
| Motor spirit (cents/gallon) | 0.55 | 0.6 | 0.6 | 0.59 | 0.6 | 0.6 |
| Diesel (cents/gallon) | 0.55 | 0.8 | 0.6 | 0.8 | 2.5 (with rebates) | 0.8 |
| Lubricating oil (cents/gallon) | 0.82 | 0 | 0 | 0 | 0 | 0 |
| Tyres (cents/pound) | 1.33 | 0.33 (<50lbs)<br>1.0 (>50<100)<br>2.0 (>100) | 0.43 (<50lbs)<br>1.5 (>50<100)<br>3.0 (>100) | 0.5 (<50lbs)<br>1.0 (>50<100)<br>2.0 (>100) | 0.2 (<50lbs)<br>1.0 (>50<100)<br>2.5 (>100) | 1.0 (<50lbs)<br>2.0 (>50<100)<br>3.0 (>100) |
| Tubes (cents/lb) | 1.47 | 0 | 0 | 0 | 0 | 0 |
| Tread rubber (cents/lb) | 0.68 | 2 | 3 | 2 | 2.5 | 3 |
| New vehicles (per cent wholesale price) | 1.37 (for SU[b] trucks, tractors, trailers >5 ton GVW) | 0.55 (for SU trucks, tractors, trailers >16.5 ton GVW)<br>0.55 (buses >14 ton GVW) | 0.65 (for SU trucks, tractors, trailers >16.5 ton GVW)<br>0.9 (bus >14 ton GVW) | 0.4 (tractors >16.5 ton GVW)<br>0.4 (buses >14 ton GVW) | 1.0 (tractors >16.5 ton GVW) | 0.82 (SU trucks, tractors, trailers >16.5 ton GVW) |

TABLE 3.5 (Cont)-USER CHARGE ALTERNATIVES PROPOSED IN THE 1982 COST ALLOCATION STUDY

*(per $ billion of 1985 Federal Highway Program expenditure)*[a]

| *Charges* | *Current system* 1 | *Options excluding current exemptions* 2A | 2B | 2C | 2D | *Option retaining current exemptions* 3 |
|---|---|---|---|---|---|---|
| Parts and accessories (per cent wholsesale price) | 1.09 (for SU trucks, tractors, trailers) | 0.55 (all vehicles >16.5 ton GVW) | 0.65 (all vehicles >16.5 ton GVW) | 0 | 0 | 0.82 (SU trucks, tractors, trailers >16.5 ton GVW) |
| Heavy vehicle use tax ($/1000 lb GVW) | 0.41 (for SU trucks, combinations and intercity buses) | All vehicles 0.86 (>30<35 ton) 2.28 (>35<37.5) 3.93 (>37.5) | All vehicles 1.00 (>30<35 ton) 2.39 (>35<37.5) 4.75 (>37.5) | All vehicles 1.18 (>16.5<35 ton) 2.83 (>35<37.5) 4.46 (>37.5) | | SU trucks, combinations and intercity buses 0.18 (>30<35 ton 1.86 (>35<37.5) 3.61 (>37.5) |

a. Tax rates are those required to make each alternative yield $1 billion annually in 1985. To convert to actual tax rates, multiply the amounts by the number of billions of dollars in the 1985 Federal Highway Program.
b. SU stands for single unit.

*Source:* US DoT (1982, p. I-16).

to vehicles between 30 and 35 tons (30.5 to 35.6 tonnes), and between 35 and 37.5 tons (38.1 tonnes). The only variation was in option 3 where the rates only applied to single-unit trucks, combination trucks and intercity buses. It was considered that under a graduated schedule of charges heavier trucks would pay progressively more, reflecting the greater costs that these vehicles impose upon the road system.

In considering changes to the system of sales taxes on new trucks and parts and accessories, two possible modifications were suggested as having the potential to improve the equity of the charging system. The first was that of increasing the threshold weight at which payment of the tax became liable. Under the existing scheme the threshold level was set at 10 000 pounds (4.5 tonnes). However, in the alternatives considered this was raised to 33 000 pounds (15 tonnes).

With the raising of the threshold level, the other change considered was to reduce the rates of sales taxation on new trucks and to remove all sales taxation on parts and accessories for vehicles weighing less than 33 000 pounds.

Included in the revised structure of charges were a number of cases where the removal of all taxation on some items was recommended, for example on lubricating oil and tyre tubes. It was thought that there were considerable benefits to be gained by these changes as they would simplify the taxation structure without unduly affecting the equity of the charging system.

In concluding, it was considered in the study that the alternatives examined moved the charging system closer to a position where the charges imposed upon road users more closely approximated the cost responsibilities of different user classes. This is demonstrated by the data provided in Table 3.6. In this table the ratios of user charge payments to cost responsibilities for each of the alternatives considered in the study are presented.

The most significant improvements brought by the alternative charging structures are in terms of the payments made by heavy vehicles. As was noted previously, an inequity existed in the charging structure where single-unit trucks overpaid relative to other vehicles and heavy combination trucks underpaid. Under the alternative structures considered this inequity is reduced. The payments that would have to be made by all single unit trucks would be significantly reduced. Conversely, the payments made by the heavier combination trucks are brought into line with their high level of cost responsibility, by

TABLE 3.6-RATIOS OF USER CHARGE PAYMENTS TO COST RESPONSIBILITIES FOR ALTERNATIVE USER CHARGE STRUCTURES BY VEHICLE CLASS; FORECAST YEAR

| *Vehicle type* | *Current system* 1 | *Options excluding current exemptions* 2A | 2B | 2C | 2D | *Option retaining current exemptions* 3 |
|---|---|---|---|---|---|---|
| Passenger cars | | | | | | |
| Large | 1.16 | 1.18 | 1.19 | 1.10 | 1.18 | 1.22 |
| Small | 0.71 | 0.75 | 0.74 | 0.74 | 0.75 | 0.74 |
| Average | 0.97 | 1.00 | 1.01 | 1.00 | 1.00 | 1.02 |
| Motorcycles | 0.58 | 0.50 | 0.50 | 0.52 | 0.48 | 0.54 |
| Buses | | | | | | |
| Intercity | 0.15 | 1.04 | 1.19 | 0.92 | 1.00 | 0.12 |
| Other | 0.00 | 0.90 | 0.94 | 1.02 | 1.00 | 0.00 |
| Average | 0.04 | 0.93 | 0.99 | 1.00 | 1.00 | 0.02 |
| Vans | 1.08 | 1.02 | 1.03 | 1.02 | 1.01 | 1.06 |
| Total passenger vehicles | 0.98 | 1.00 | 1.01 | 1.00 | 1.00 | 1.01 |
| Single unit trucks | | | | | | |
| Less than 26 000 lbs | 1.71 | 1.08 | 1.08 | 1.07 | 1.13 | 0.95 |
| Greater than 26 000 lbs | 2.21 | 0.96 | 0.96 | 0.97 | 0.91 | 1.04 |
| Average | 1.99 | 1.01 | 1.01 | 1.01 | 1.01 | 1.00 |

TABLE 3.6 (Cont)-RATIOS OF USER CHARGE PAYMENTS TO COST RESPONSIBILITIES ALTERNATIVE USER CHARGE STRUCTURES BY VEHICLE CLASS; FORECAST YEAR

| *Vehicle type* | *Current system* 1 | *Options excluding current exemptions* 2A | 2B | 2C | 2D | *Option retaining current exemptions* 3 |
|---|---|---|---|---|---|---|
| Combination trucks | | | | | | |
| Less than 50 000 lbs | 1.24 | 0.84 | 0.81 | 0.90 | 0.99 | 0.97 |
| 50 000-70 000 lbs | 1.25 | 1.00 | 1.02 | 1.00 | 1.03 | 1.00 |
| 70 000-75 000 lbs | 0.78 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Greater than 75 000 lbs | 0.59 | 1.00 | 1.01 | 1.00 | 1.00 | 1.00 |
| Average | 0.80 | 0.99 | 0.99 | 0.99 | 1.00 | 1.00 |
| Total trucks (average) | 1.03 | 0.99 | 0.99 | 1.00 | 1.00 | 1.00 |
| Total vehicles (average) | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

*Source:* US DoT (1982 p. I-19).

increasing the level of their annual payments. However, combination trucks weighing less than 50 000 pounds (22.7 tonnes) still underpay in comparison to other vehicles within this vehicle class.

**Congressional response to the 1982 Cost Allocation Study**

As was noted previously, the findings and recommendations of previous cost allocation studies brought little in the way of changes to the road user charges structure. The 1982 Study was different insofar as its findings encouraged Congress to make substantial changes to the road taxation structure. In December 1982, Congress passed legislation altering the provisions governing operation of the Highway Trust Fund. Table 3.7 provides a comparison of the user charges structure that existed before the 1982 Cost Allocation Study and the charging structure that was implemented by the STAA 1982.

*Petrol tax*

Under the provisions of the STAA 1982 excise rates on petrol increased from four cents per gallon to nine cents per gallon, an increase of 125 per cent. Prior to this, rates had remained unchanged since 1959.

Under the excise scheme a number of exemptions are made. First, the Act provides an exemption for methanol or ethanol fuels. To qualify for the exemption the chief constituents of the fuel in question must consist of at least 85 per cent methanol or ethanol. The 1978 STAA also provided an exemption for gasohol fuels. However, this exemption has since been removed and gasohol fuels are now subject to a rate of taxation of four cents per gallon.

The 1982 STAA currently also allows for the exemption of off-highway business use from the imposition of the excise on petrol. In this case a rebate of the excise is payable to the consumers concerned. Exemptions are also available for State and local government bodies.

In addition, all buses are granted a full exemption from Federal fuel taxes.

*Diesel and special fuels*

Accompanying the excise tax on petrol is a similar tax on diesel fuel. Similar conditions to those applying to the petrol excise also apply to the excise on diesel fuels. A differential levy was not placed on petrol and diesel consumption.

*Lubricating oil*

Under the 1978 STAA, lubricating oil was subject to a manufacturers'

excise tax of six cents per gallon. In the 1982 Act the tax on lubricating oil was abolished.

*Tyre taxes*

The 1978 STAA made allowance for taxes to be levied on tyres. A flat rate of tax of 9.75 cents per pound of total tyre weight was imposed.

TABLE 3.7-COMPARISON OF FEDERAL USER CHARGE STRUCTURE; PRE- AND POST-1982

| *Tax structure* | *Pre-STAA 1982* | *Enacted in STAA 1982* |
|---|---|---|
| Petrol | 4 cents per gallon | 9 cents per gallon |
| Diesel and special motor fuels | 4 cents per gallon | 9 cents per gallon |
| Lubricating oil | 6 cents per gallon | Nil |
| Tyres | 9.75 cents per pound | Nil first 40 lbs of tyre weight, 15 cents/lb next 30 lbs, 30 cents/lb next 20 lbs, 50 cents/lb balance of tyre weight |
| Tread rubber | 5 cents per pound | Nil |
| Inner tubes | 10 cents per pound | Nil |
| | 10 per cent at manufacturers level for vehicles over 10 000 pounds | 12 per cent at retail level for trucks over 33 000 lbs; trailers over 26 000 lbs |
| Truck parts | 8 per cent for parts used on all trucks | Nil |
| Heavy vehicle use tax | $3 per 1000 pounds over 26 000 pounds | Nil for vehicles less than 33 000 lbs $50 + $25/1000 lbs for vehicles 33 000- 55 000 lbs $600 + $52/1000 lbs for vehicles 55 000- 88 000 lbs $1900 for vehicles 80 000 lbs and above (Top rate $1600 on 1 July 1984, $1700 on 1 July 1986 and $1900 on 1 July 1988) |

*Source:* FHWA (1983 p. V-6).

In place of the flat rate of taxation, the 1982 Act implemented a multi-part charging system. Within this structure tyres weighing less than 40 pounds (18.1kg) are not subject to taxation. However, the next 30 pounds (13.6kg) are charged a rate of 15 cents per pound, the rate then doubles to 30 cents per pound for the next 20 pounds and thereafter a charge of 50 cents per pound is levied.

*Tread rubber and inner tubes*
Taxes on tread rubber and inner tubes were abolished in the 1982 STAA.

*Sales taxes on new trucks and trailers and parts and accessories*
The 1982 Act modified the structure of sales taxes on both new trucks and trailers and parts and accessories. The prevailing taxation rates under the 1978 Act were 10 per cent of the value of trucks and trailers weighing over 10 000 pounds (4.5 tonnes). Under the provisions of the 1982 Act the rate of tax was increased to 12 per cent and the threshold level was raised to 33 000 pounds (15 tonnes). The threshold level for trailers was raised to 26 000 pounds (11.8 tonnes).

Provisions for the imposition of sales taxes on parts and accessories were repealed. Previously, excise taxes had been levied at a rate of 8 per cent on the value of parts and accessories used on vehicles weighing more than 10 000 pounds.

*Heavy vehicle use tax*
The tax subject to the greatest revision was the heavy vehicle use tax. The rate prescribed in the 1978 Act was a flat fee of three dollars per 1000 pounds (454kg) for trucks in excess of 26 000 pounds. The revised rates in the 1982 Act consisted of a graduated schedule beginning at $50 for trucks weighing less than 33 000 pounds and culminating at a maximum level of $1600 for trucks weighing over 80 000 pounds (36.3 tonnes).

The new rates for trucks weighing over 55 000 pounds are to be revised periodically up to 1988. For example, on 1 July 1984 a truck weighing 80 000 pounds was charged $1600, this will increase to $1900 on 1 July 1988. Heavy vehicles travelling less than 5000 miles each year are exempt from the heavy vehicle use tax.

## ASSESSMENT OF THE UNITED STATES FEDERAL ROAD PRICING SCHEME

As noted in Chapter 2, road pricing may serve three broad objectives; economic efficiency, revenue raising and equity. The purpose of this

section is to compare the nature and structure of the United States' Federal road user charges structure with these pricing criteria.

**Economic efficiency**

Economic efficiency was explicitly rejected as a primary pricing objective in the 1982 Cost Allocation Study. Nevertheless, there is merit in examining the charging structure from an efficiency viewpoint to determine which aspects are at variance, and to what extent, with the efficiency criteria outlined in Chapter 2. While economic efficiency may have been of only secondary importance in formulating the charging structure it is possible that minor modifications to the structure may result in improved efficiency while leaving equity aspects largely unaffected.

In this respect, three observations are made. First, the variable charges imposed under the scheme are designed to recover all costs (that is, it is a cost occasioned approach) and not simply the marginal costs as required under a strict efficiency approach. Second, there exists a heavy reliance on fuel excise as a means of recovering road costs and associated with this are a number of deficiencies. Finally, the heavy vehicle use tax is levied on average road use rather than marginal road use. If the heavy vehicle use tax was levied on marginal road use and recovered only marginal cost then it would be an efficient charge. A discussion on these observations follows.

As explained in Chapter 2, economic efficiency is concerned with ensuring that resources are allocated in an optimal manner. This will be achieved, *ceteris paribus*, when prices are set equal to marginal cost, where marginal cost is defined as the additional cost incurred to produce an additional unit of output. This rule may vary depending on how road transport's substitutes are priced. In some circumstances it may be necessary to set prices either above or below marginal cost so as not to distort resource allocation between modes.

The marginal cost of road use is a function of a number of factors including vehicle miles travelled (VMT), road construction characteristics, vehicle weight and axle loadings, vehicle composition, terrain and climate. The extent to which each of these factors are taken into account within the charging structure will determine the degree to which efficiency will be achieved. However, it would be necessary to know the relationship between variations in these factors and cost levels for maximum efficiency to be achieved.

Most of these factors are taken into account within the current charging structure. Hence, there exists a potential within this structure for efficiency criteria to be satisfied. For example, distance related cost factors are accounted for in a number of ways. First, fuel consumption varies with distance travelled. Hence, a fuel excise tax takes account of distance related costs. The heavy vehicle use tax also takes account of the distance related costs imposed on the road system by heavy vehicles because it is levied on the basis of vehicle weight and the average annual distance travelled by each class of vehicle. In addition, the amount collected by the tyre taxes partially reflects distance travelled.

Some variation in charges between vehicles of different classes is also provided for within the structure of charges. As noted above, the heavy vehicle use tax is based on a graduated scale of charges which distinguishes between vehicles of different weights. Tyre taxes and taxes on inner tubes would increase with vehicle weight and size to a limited extent. No differentiation is made between the excise rates levied on the consumption of diesel and petrol. However, since heavy vehicles will generally consume more fuel over a given distance than lighter vehicles, some disaggregation of charges for heavy and light vehicles will automatically occur, although not explicitly.

From the foregoing it is clear that there is sufficient scope within the current US charging structure to build in efficiency elements. However, there is doubt as to the ability of the current structure to accurately reflect purely marginal variations in the cost responsibility of individual road users.

For example, the focus of the heavy vehicle use tax is on vehicle classes rather than on individual road users. The rate of charge is based on the average annual distance travelled by all vehicles in the class and is independent of the distance travelled by a particular vehicle.

It is unlikely that vehicles grouped within the same class will travel a similar distance annually. It follows, therefore, that each vehicle within a particular class will be responsible for a different level of cost. Charging the same amount for each vehicle class in these circumstances must result in a degree of cross-subsidisation between vehicles, which is a departure from the optimal conditions of resource allocation. This departure is of concern because those vehicles which pay less than marginal cost will be encouraged to over-consume road resources and so lead to a reduction in efficiency.

In the 1982 Cost Allocation Study the use of hubodometers as an element of road pricing was rejected. This led to the rejection of weight-distance taxes similar to those in New Zealand (see Chapter 4). The type of scheme which is employed in the United States is a second-best solution compared with the weight-distance tax option. If the charges are set at levels to recover only marginal cost then the class as a whole would pay the same amount as under a true marginal cost pricing scheme. However, the allocation of resources that results from this scheme will not mirror that which would exist under a true marginal cost pricing scheme.

A different problem arises with the imposition of excises on fuel consumption. A close relationship between cost responsibility and fuel consumption does not exist. Pavement damage is primarily a function of axle loadings and this relationship is believed to be essentially exponential in form. Hence, while heavier vehicles travelling longer distances will consume more fuel than other vehicles, by perhaps four to 10 times, the additional damage to pavement incurred by heavy vehicle road use exceeds that of lighter vehicles by a much greater amount (assessed in the US Study as an average of 1000 times). Therefore, while there will be some variation in taxation liabilities, a degree of cross-subsidisation between articulated vehicles and other vehicles will still arise.

All the above considerations indicate that the current US road pricing structure departs from the narrowest principles of marginal cost pricing in a number of areas. Strict marginal cost pricing requires that the road user be confronted with charges that reflect the marginal costs that are imposed upon the road system. It is clear that this principle is not satisfied by the current US system.

These considerations aside, perhaps the major difficulty in terms of the theoretical framework presented in Chapter 2 is that the pricing system is designed to recover more than marginal cost. It was noted in Chapter 2 that if efficiency losses are to be minimised, the charge over and above marginal cost should be demand related, that is, prices should be set in accordance with the inverse of the price elasticity of demand. This is not the case with the road pricing system in the United States. Here the main charges are not increased in line with demand characteristics but are supplemented by the imposition of additional charges. Hence it is likely that the loss of efficiency from prices being set above marginal cost could be reduced while maintaining revenue collections at the same level.

The key issue is whether a move to an improved, although still

partial, satisfaction of efficiency criteria would prove to be beneficial in terms of resource allocation. In terms of possible first-best solutions the US Federal road pricing system will not maximise economic efficiency. However, if the elasticity of demand for road services is low then departures from first-best pricing criteria may not result in a large loss in efficiency. Further, in these circumstances the improved satisfaction of efficiency criteria may not provide any significant benefits from a resource allocation viewpoint.

**Equity**

Equity criteria are only partially satisfied by the US structure of road charges.

As explained earlier in this chapter, the principal objective underlying the current charging system is one of establishing equity between road users. This may be thought of as comprising two elements: vertical and horizontal equity.

Horizontal equity is achieved when individuals of the same economic capacity are confronted with similar taxation burdens. Vertical equity, on the other hand, is achieved when individuals with different economic capacity pay tax shares that differ according to some notion of 'fairness'.

Horizontal equity implies that vehicles within the same vehicle class which impose the same level of cost upon the road system should be confronted with the same price levels. Vertical equity, however, is focussed on inter-class rather than intra-class equity. Hence, the concern is to ensure that the charges for vehicles within different classes accurately reflect the costs imposed by their actual use upon the road system.

In the case of vertical equity it is unclear that there has been an improvement as a result of the 1982 STAA restructuring of charges. The revision of charges resulted in changes in the relative payments made for different vehicle classes. It was thought that the payment for passenger cars would on average be approximately 90 per cent more than previously, while there would be a 103 per cent increase in the payment for combination trucks and only a 4 per cent increase for single unit trucks (Mingo and Proferes 1983, p. 1). However, it was considered that in spite of these changes heavy vehicles would only pay two-thirds of their total cost responsibility while lighter trucks would overpay by a significant amount. This situation may reflect the

fact that the revisions to the changes made did not accurately mirror the changes recommended in the 1982 Cost Allocation Study. In this respect, it seems certain that improvements in vertical equity can still be made.

However, the greatest concern is that horizontal equity may be adversely affected by the nature of the charging structure. In particular, the major difficulty is that distance related cost factors are inadequately reflected in the charging structure.

A study undertaken by Henion and Merris (1983) of the Oregon Department of Transportation examined this aspect. Their analysis compared the tax payments and cost responsibilities at various annual mileages for selected vehicle classes.

A general conclusion drawn in this study was that a degree of horizontal inequity was present in the payments associated with heavy vehicle classes. Horizontal equity in the passenger vehicle class was not adversely affected by the nature of the charging structure. Under the current scheme passenger vehicles are only subject to excise taxes levied on fuel consumption. It was demonstrated that as annual vehicle miles travelled (VMT) increased the total tax liability of passenger vehicles and the associated cost responsibility increased in approximately the same proportion. Hence, horizontal equity is preserved.

In the case of single-unit trucks, however, the ratio of total tax payments to cost responsibility fell as annual VMT increased. This is the result of the invariance of the heavy vehicle use tax with VMT. The total tax liability of single unit trucks is comprised of collections from the imposition of the heavy vehicles use tax, excise taxes (including tyre taxes) and fuel taxes. The tax liability arising from the imposition of tyre and fuel taxes will increase as VMT increases. However, the level of these taxes is small compared with the heavy vehicle use tax. Therefore, as VMT increases, cost responsibility will also increase, but total tax payments will not increase pro rata. Hence, horizontal equity will be adversely affected. This problem is greatest for the heaviest vehicles, particularly the heavy combination truck class.

In summary, the following conclusions may be drawn. In terms of vertical equity, the current charging system represents an improvement over that which existed prior to the 1982 Cost Allocation Study. However, vertical equity could still be further improved, especially

with regard to heavy vehicles. This would only require a revision of the level of charges, not a modification to the charging structure.

Of far greater concern are the potential horizontal inequities. In this instance, if the level of inequity is to be ameliorated the charging structure would need to be revised, primarily by replacing the heavy vehicle use tax with a weight-distance tax.

**Cost recovery**

It is clear that the charging system is capable of recovering road expenditure within any particular year. The operation of the Highways Trust Fund requires that revenue received balances road expenditure for any financial year. This is the main feature of a pay-as-you-go pricing system. However, in the past the balances of the Trust Fund have fluctuated and there is no guarantee that this will not continue to occur in the future. As a consequence, the planning of road expenditure may be adversely effected. Furthermore, the system of charges implemented are not indexed, which means that revenue collections will only increase as fuel consumption increases or the size of the vehicle fleet increases.

It has been argued that to minimise the efficiency loss emanating from setting price above marginal cost, prices should be set according to the inverse of the price elasticity of demand. However, it is apparent that within the United States pricing system there is little explicit consideration of elasticity factors. Hence, while the pricing scheme is capable of satisfying all revenue requirements, it raises revenue in a manner that will not ensure that losses in efficiency will be minimised.

**CONCLUDING COMMENTS**

The explicit concern of the United States road pricing system is the maintenance of equity between road users. This objective has largely been accomplished. In terms of vertical equity the consensus of opinion is that the current charging system represents an improvement over that which existed before the 1982 Cost Allocation Study. However, the new system falls down in meeting horizontal equity criteria, and simultaneously efficiency, through the failure to implement a weight-distance tax. The heavy vehicle use tax, by not taking distance travelled into account, cannot properly be related to avoidable cost. This is the chief failing of the new system. In addition, because the system follows the cost occasioned methodology,

it also fails to take account of demand in recovering costs above avoidable cost, thus failing to meet the efficient revenue raising objectives of Ramsey pricing.

## CHAPTER 4-ROAD PRICING IN NEW ZEALAND

An extension of the 'user pays' philosophy underlying the road pricing system in New Zealand occurred in the late 1970s with the passage of the Road User Charges Act 1977. This Act introduced a system of road charges which taxed heavy vehicles according to the avoidable costs associated with their road use.

This chapter examines the nature of the current charging structure in New Zealand and compares it to the pricing strategies identified in Chapter 2. The discussion begins, as in the previous chapter, by identifying the level of responsibility for roads undertaken by each level of government. The background to, and the reasons for, the implementation of the Road User Charges Act are then outlined. An analysis of the changes made to the pricing structure is undertaken and conclusions drawn about its ability to satisfy various pricing objectives.

### RESPONSIBILITY FOR ROADS

Unlike the Australian or United States system of government, the New Zealand system is unitary in form. New Zealand does not have a formal Constitution and the Central Government has sole control over all aspects of economic activity including responsibility for all roads. However, in certain cases responsibility is delegated to local government authorities. This division of responsibility is formalised by the provisions of four statutes: the Public Works Act 1928, the Municipal Corporations Act 1954, the Counties Act 1956 and the National Roads Act 1952 (see BTE 1982, p. 76 for further details).

#### Central government responsibility for roads

The Central Government has responsibility for the administration of the State highway system. This is carried out through the functions of the National Roads Board (NRB). The powers of the Board were

established under the provisions of the National Roads Act 1952. These powers include:

- the provision of an adequate road system satisfying roading needs;
- the provision of financial advice to the Central Government concerning roads;
- assisting and advising local governments on road matters; and
- undertaking surveys of various aspects of roads (at intervals of not more than five years) (BTE 1982, p. 76).

The operations of the NRB are financed from revenue placed in the National Roads Fund (NRF). This revenue is derived from road taxation including charges on the operation of heavy vehicles and excises levied on the consumption of petrol.

Other road related charges are levied by the Central Government, including motor vehicle registration fees, import duties (on fuel and motor vehicles) and sales taxes, which, unlike the charges that are paid into the NRF, are not hypothecated to roads (BTE 1982, p. 79).

**Local government responsibility for roads**

The Central Government delegates part of its roads responsibility to local government authorities. In particular, local government authorities are responsible for the administration of most municipal and county roads.

Road expenditure undertaken by local government authorities is financed from a number of sources. Some local government expenditure is financed from revenue sourced from the NRF. However, local government authorities also possess their own revenue sources. These sources include revenue generated from fuel excise and drivers' licence fees. They also allocate part of their general revenue collections from rates, fees and fines to road works.

## ROAD USER TAXATION PRIOR TO 1978

Prior to the implementation of the provisions of the Road User Charges Act, the road pricing structure was different in form from the structure that currently exists.

Chudleigh (1983, p. 242) notes that prior to 1978 the Central Government road user charges structure had the principal objective of

simply raising sufficient revenue to meet road expenditure requirements with little concern directed towards the satisfaction of efficiency or equity objectives. However, the nature of the charges imposed would have lent itself to the satisfaction of these objectives if this was a primary concern. The changes made in 1977 to the road user charges structure extended the concern beyond simple revenue raising requirements.

The structure of charges prior to 1978 included an excise levied on fuel consumption, mileage taxes and heavy traffic fees.

**Petrol tax**

The major form of road taxation levied prior to 1978 was an excise tax on petrol consumption. This tax was introduced in 1927 and was levied on heavy motor vehicles and passenger vehicles alike, although in some circumstances refunds for heavy vehicles were applicable (Ministry of Transport (NZ) 1979, p. 5). In 1977-78 the rate of excise was nine cents per litre. However, only about half of the revenue collected was committed to road expenditure, the residual remaining in the Consolidated Revenue Fund and therefore available for general expenditure purposes (Stacey 1978, p. 2 and BTE 1982, p. 77).

**Mileage tax**

The purpose of the mileage tax was to impose an equivalent tax burden on diesel and other non-petrol powered vehicles for road use as that imposed on petrol powered vehicles. The rates of taxation were adjusted in accordance with movements in the level of revenue collected from the imposition of the petrol tax and, as in the latter case, not all revenues collected were hypothecated to roads (Chudleigh 1982, p. 242).

Different rates of taxation were applicable for different types of vehicles. Tax rates also varied according to vehicle weight, type of fuel consumed, and the nature of the transport operation undertaken (Ministry of Transport (NZ) 1979, p. 6).

**Heavy vehicle fees**

Operators of heavy vehicles weighing more than two tonnes were required to purchase licences prior to 1978. The licence fees were fixed charges but were graduated according to vehicle weight. Licences were transferable between vehicles and in some cases reduced rates were applicable. In particular, vehicles engaged in rural activities and non-commercial vehicles were subject to reduced rates of taxation (Stacey 1978, p. 3).

**Other revenue sources**

A number of additional charges were levied by the Central Government. These included import duties and sales taxes on motor vehicles and motor vehicle registration fees. All of these charges were paid into the Consolidated Revenue Fund and, therefore, were not hypothecated to road expenditure.

In Table 4.1, details of revenue collections from the imposition of these taxes from 1971-72 to 1977-78 are presented. It is clear from the table that petrol taxation had been the major revenue source in past years. In all years petrol taxation accounted for approximately 80 per cent of total hypothecated revenue collections.

## THE MOTIVATION FOR CHANGE OF THE ROAD USER CHARGES STRUCTURE

The motivation for restructuring road user charges came from a number of sources. The principal concerns were economic and financial in nature.

Specifically, the level of revenue collected from road taxation charges had been declining in real terms for a number of years as taxation rates had not been fully adjusted for inflation. Excises on petrol consumption had formed a major part of total revenue collections but had not kept pace with the rate of inflation. Hence, these collections over time had depreciated in real terms. This effect was reinforced by a decline in petrol consumption as a result of the 'oil crisis' which began in 1973.

In addition, the rates of taxation for heavy vehicle fees and mileage taxes had not been adjusted for some time. Revenue collections from these sources had, therefore, also declined in real terms.

While road revenue had been declining in real terms, additional pressure was placed on the NRB to maintain the standard of road services. As a consequence, the Central Government was required in later years to provide supplementary grants from Consolidated Revenue to the NRB for roadworks (Stacey 1978, p. 3). It was suggested that this had an adverse effect on the planning of road expenditure. It was argued that only short term planning could be undertaken given these problems.

As a consequence, the NRB sought a more assured source of income which would allow it to establish a more comprehensive planning procedure for roads expenditure (Stacey 1978, p. 3).

Accompanying the concern over maintaining real levels of road revenue was an additional concern over the efficiency of the charging structure and its effects on intermodal competition, in particular, its effect on road-rail competition. A study undertaken by Wilbur

TABLE 4.1-NATIONAL ROADS BOARD GROSS RECEIPTS FROM ROAD USER TAXATION, 1971-72 TO 1977-78

*($NZ million)*

| *Item* | *1971-72* | *1972-73* | *1973-74* | *1974-75* | *1975-76* | *1976-77* | *1977-78* |
|---|---|---|---|---|---|---|---|
| Motor tax | | | | | | | |
| Petrol tax | 77.9 | 83.9 | 90.2 | 89.7 | 86.2 | 90.3 | 111.9 |
| *Less* collection costs and rebates | 4.9 | 5.4 | 4.9 | 4.4 | 5.4 | 4.4 | 5.4 |
| Net petrol tax | 73.0 | 78.5 | 85.3 | 85.3 | 80.7 | 85.8 | 106.4 |
| Heavy vehicle fees | 10.5 | 11.3 | 12.0 | 12.5 | 13.0 | 13.7 | 10.4 |
| *Less* collection costs | 0.4 | 0.5 | 0.4 | 0.5 | 0.5 | 0.5 | 0.4 |
| Net heavy vehicle fees | 10.1 | 10.8 | 11.5 | 12.1 | 12.6 | 13.2 | 10.0 |
| Mileage tax | 6.0 | 5.8 | 5.8 | 6.9 | 7.4 | 7.8 | 9.1 |
| *Less* collection costs | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 |
| Net mileage tax | 6.0 | 5.7 | 5.7 | 6.8 | 7.3 | 7.6 | 8.9 |
| Total motor tax | 89.1 | 95.0 | 102.5 | 104.1 | 100.6 | 106.6 | 125.3 |
| Contributions from consolidated revenue | 0.0 | 3.0 | 0.7 | 1.3 | 16.4 | 21.0 | 10.0 |

Note: Figures may not add to totals due to rounding.

*Source:* National Roads Board (1972-78).

Smith and Associates (1973) had suggested that the easing of regulations covering road and rail competition would be beneficial in terms of resource allocation between the modes. At this time road-rail competition was subject to a distance restriction whereby goods transported over distances greater than 40 miles were required to use rail transport. In the transport study, it was suggested that this distance limitation could be extended, offering greater scope for intermodal competition.

However, in making this recommendation, it was recognised that there were deficiencies within the current road pricing structure and that if efficient intermodal competition was to be promoted, these problems would need to be remedied. That is, if road-rail competition was to be deregulated it was necessary that the structure of road user charges be revised.

## THE ROAD USER CHARGES ACT 1977 AND ROAD TAXATION POST-1978

### The new system of road user charges

In order to meet the twin objectives of generating higher levels of road revenue and promoting more efficient intermodal competition a new system of road user charges was introduced on 1 April 1978. This was accompanied by a relaxation of the distance restriction on road-rail competition from 40 miles to 150 kilometres.

There are two main elements to the new pricing scheme: distance licence fees (coupled with the mandatory installation of hubodometers on larger vehicles) and a fuel excise tax.

*Distance licences*

The most significant change introduced under the 1977 Act is the requirement for owners of vehicles weighing greater than 3.5 tonnes to purchase distance licences. When purchasing the licences the owners of these vehicles are required to nominate the distance they will travel within the current year. When the nominated distance has been travelled a new licence must be purchased. The distances actually travelled are recorded by hubodometers which must be fitted to vehicles operating under a distance licence.

The maximum gross weight of the vehicle and vehicle type are recorded on the licence. The vehicle must not exceed this weight while operating under the licence. If for unforseen circumstances the vehicle weight exceeds this limit a supplementary licence must be purchased. If the increase in vehicle weight is permanent a new

distance licence will need to be purchased. Licences are available in minimum units of 1000 kilometres although supplementary licences are available in one tonne increments over 50 kilometres. Licence fees vary according to gross vehicle weight and axle configuration (based on the fourth power rule) and distance travelled. Rates are calculated for 14 classes of vehicle. Powered vehicles are treated separately from trailers.

Under the distance licence scheme a number of exemptions are made. First, owners of off-road vehicles are not required to purchase distance licences. However, they are required to purchase time licences. Trailers and petrol powered vehicles weighing less than 3.5 tonnes in gross weight are also exempt. This is because it is considered that the excise duties levied on these vehicles are sufficient to recover the attributable costs associated with these vehicles. Owners of petrol powered vehicles weighing more than 3.5 tonnes are also required to purchase distance licences but they are entitled to a rebate, equivalent to the amount of petrol excise taxation paid.

The New Zealand Post Office, which acts as an agent for the Ministry of Works and Development, is responsible for the issuing of licences and collection of fees, as well as the overall administration of the scheme. Enforcement of the scheme is undertaken by the Ministry of Transport which is responsible for the checking and validation of licences and hubodometers.

*Petrol excises*

The second part of the new pricing scheme is an excise on petrol consumption which is payable by operators of petrol powered vehicles weighing less than 3.5 tonnes. The excise rate is calculated to produce a charge for each vehicle equivalent to that of the distance licences imposed on diesel powered vehicles. However, in terms of recovering avoidable cost the efficacy of this charge will differ from the distance licence fee. Further comments on this issue are made later in this chapter.

Under the new structure of charges provided for in the 1977 Act, mileage taxes and heavy vehicle fees were abolished. However, registration fees, sales taxes and customs duties are still levied.

*Concessions*

With the introduction of the new system of charges a number of concessions were made to alleviate the initial burden of the new pricing scheme. These mainly involved the system of sales taxes

existing at the time of the introduction of the Act. At this time, sales taxes of 40 per cent were levied on the purchase of heavy vehicles. These were reduced to 30 per cent initially, and were subsequently reduced further to 10 per cent. In addition, the new distance taxes were phased in over a two-year period. Shortfalls in revenue were made up from contributions from the Consolidated Revenue Fund. The final concession made involved the altering of taxation scales for an initial period to favour heavy vehicles, as this vehicle class would be subject to an increased taxation burden under the new pricing regime (Chudleigh, p. 251).

These concessions were to be phased out over time.

**Cost allocation and the calculation of road user charges**

Concurrent with the introduction of the Road User Charges Act was a change in philosophy concerning road financing arrangements. Prior to 1978 the NRB had determined its expenditure on the basis of revenue estimates for the current year. However, this process was reversed following the passage of the 1977 Act. The NRB now determines the level of road expenditure that will be required within a particular year and then adjusts road user charges so that sufficient revenue is generated to meet these expenditure requirements.

Applications for funds for road expenditure are made by counties, municipalities and district offices of the Ministry of Works and Development to the NRB. The NRB makes its recommendations for the application of funds to these projects in October each year. However, these are subject to Cabinet approval. A work program is established for the following year and indicative programs for the following two years are developed.

Once the budget for the following financial year has been established, expenditure items are apportioned among different vehicles making use of the road. The budget is divided into a number of different cost items for the three road sectors; municipal, county, and State highways sectors. Each cost item is divided into three components; a driver related component, a space related component, and a strength related component.

Driver related costs include the costs of signposting, road marking, traffic signals and rest areas. This component is invariant with vehicle characteristics such as weight, length and width and is therefore allocated between different vehicle types on the basis of distances travelled.

Space related costs include expenditure on road widening, construction of passing lanes and similar improvements to roads. As this component is related to vehicle dimensions, these costs are allocated between vehicles on the basis of vehicle size (gross vehicle weight) and distance travelled.

Strength related cost components include road construction and maintenance costs. These costs are allocated on the basis of vehicle weight, number of axles and distance travelled. The fourth power of the axle load is used as a summary measure of vehicle characteristics.

The cost allocation methodology just outlined was used in the formulation of the 1977-78 NRB road budget. Charges were calculated for different vehicles for each $100 of expenditure. The results of this allocation of costs are presented in Table 4.2. Total charges were derived using these proportions.

Vehicles weighing over 3.5 tonnes would pay $42 in charges for every $100 of the road budget while other vehicles would pay $58. It is significant to note that in this particular case all strength related costs were recovered from heavy vehicles.

## ASSESSMENT OF THE NEW ZEALAND ROAD USER CHARGES SCHEME

### Economic efficiency

While the Road User Charges Act introduced a number of changes to the existing system of road user taxation, the fundamental philosophy of road pricing in New Zealand has not undergone significant change. The

TABLE 4.2-BREAKDOWN OF EACH $100 OF 1977-78 NRB ROAD EXPENDITURE PROGRAM

*($NZ)*

| *Cost component* | *Vehicles over 3.5 tonnes* | *Other vehicles* | *Total* |
|---|---|---|---|
| Driver costs | 1 | 14 | 15 |
| Space costs | 7 | 44 | 51 |
| Strength costs | 34 | 0 | 34 |
| Total | 42 | 58 | 100 |

*Source:* Ministry of Transport (NZ) (1979, p. 13).

implementation of distance licences is an extension of the philosophy underlying the mileage tax levied under the previous user charges structure.

The purpose of the mileage tax was to impose a charge that adequately reflected the cost responsibility of different heavy vehicles, which varies according to vehicle type, vehicle weight and type of fuel consumed. The rationale of the distance licence (coupled with the use of hubodometers) is similar. However, its main advantage is that the avoidable cost of individual vehicles is more easily identified than was possible under the mileage tax arrangement. The taxation rates are disaggregated to take account of the effects of such elements as axle spacing and wheel configuration, as well as vehicle weight and distance travelled for individual vehicles. Hence, it is possible to vary the charge according to the avoidable cost incurred by different vehicles.

The use of hubodometers is particularly useful in this respect. Their use makes it possible to accurately measure the contribution of distance related factors to road costs. One alternative to hubodometers is to employ a method similar to that which underlies the heavy vehicle use tax employed in the United States. As noted in Chapter 3, the rates of taxation imposed under the heavy vehicle use tax in the United States are representative of average distances travelled by a vehicle class. Hence, this type of heavy vehicle use tax does not take account of the avoidable cost of road use of individual vehicles. It is designed to reflect only the average avoidable costs of specific user classes. Another alternative is to employ road maintenance charges similar to those used previously in Australia.

To some extent a small degree of averaging is also present within the New Zealand pricing system. To fully account for the impact of road use of different vehicles, different charges must be levied accounting for different axle loads and configurations. Under the New Zealand scheme only 14 vehicle classes are identified and hence it is not possible for all combinations of axle loads and axle configurations to be fully accounted for within the charging structure. Therefore, a small element of averaging must occur in the determination of charges. Another source of averaging lies in potential differences in the gross vehicle weight nominated on the licence and actual vehicle weight on specific trips. Furthermore, in nominating vehicle weight no account of the distribution of the load is taken, that is, the weight placed on individual axles (although in practice it would be extremely

difficult and/or costly to take this factor into account). In essence an average load factor is used in the calculation of charges.

Another averaging aspect arises because no account is taken of the different characteristics of roads over which vehicles may travel. It could be expected, for example, that the costs of road use would be different for highly and lightly trafficked roads and roads of different construction characteristics.

Despite these factors it is likely that the degree of averaging present within the New Zealand pricing system is not as great as in the United States system. It is unlikely that the element of insensitivity present in the New Zealand system would greatly distort competition between transport operators.

Were the New Zealand scheme designed to recover only avoidable costs it should achieve a higher level of economic efficency than that attained by the United States system, as the level of averaging of costs is substantially less than in the United States.

However, the New Zealand scheme recovers more than avoidable cost, with the Trust Fund concept ensuring that revenue collections will always balance road expenditure. The charges, which are essentially derived using the cost occasioned approach, are levied to recover all costs, as in the United States. Thus, it is primarily an equity based system and not efficiency based. Efficiency requires that charges levied above avoidable cost be demand related, which does not occur in the New Zealand system of charges.

The rates of taxation applicable under the charging scheme are determined by the expenditure requirements within a financial year. Thus, the user charge rates are determined on a pay-as-you-go basis rather than a public enterprise basis. As noted in Chapter 2 there may be political and financial (budgetary) advantages in this approach but it cannot be justified using theoretical economic arguments.

**Equity**

It was also noted in Chapter 2 that if prices are set at a level reflecting avoidable costs both equity and efficiency criteria will be satisfied. Hence, the charging scheme has the potential to satisfy both horizontal and vertical equity requirements.

The current New Zealand system satisfies these criteria in a number of ways. In particular, the imposition of the requirement to purchase

distance licences for vehicles weighing more than 3.5 tonnes ensures that horizontal equity between the heavier vehicles can be maintained. All relevant cost related factors: distance travelled, axle load, axle spacing and vehicle type are taken into account within this charging structure. Hence, the cost responsibility of different vehicles within this class may be accurately identified and user charges adjusted accordingly, satisfying both efficiency and horizontal equity criteria.

However, for vehicles weighing less than 3.5 tonnes (which are not subject to the imposition of the distance licence), the achievement of horizontal equity may be more tenuous. The principal reason for this is the reliance on fuel excise as the chief means of raising revenue from the operators of these particular vehicles. As noted in Chapter 3, fuel consumption does not provide an accurate reflection of cost responsibility. Pavement damage is an exponential function of axle load, and it is unlikely that the differences in fuel consumption rates for vehicles weighing less than 3.5 tonnes will adequately reflect the differences in the avoidable costs imposed by all the vehicles in this category. Thus, it is likely that the ratio of cost responsibility to tax payments will also vary between these vehicles. The differences are, however, unlikely to be large and therefore the loss in terms of equity may be small.

Similar arguments apply when vertical equity is considered. In terms of road user charges, vertical equity requires that the ratios of cost responsibility to total tax payments for different vehicle classes should be the same. Insufficient information is available to determine whether the current level of charges achieves this result. The scheme does, however, provide for sufficient differentiation of charges on different vehicles types for national equity objectives to be met.

**Cost recovery**

The New Zealand pricing scheme has been designed to achieve full cost recovery on an annual basis. As has been noted above, the level of road user charges is determined by the road expenditure requirements in any one financial year. Hence, as in the United States case, revenues paid into the Trust Fund and expenditures met from it should always balance. However, as discussed in Chapter 3, it is the means by which costs are recovered as well as the actual amount recovered that are the ultimate concerns.

It has already been noted in this chapter that in terms of recovering

avoidable costs the New Zealand scheme possesses considerable potential. The charging system has the ability to identify the unit cost of the provision of road services for different types of vehicles.

However, in terms of raising additional revenue to recover common costs, some conflict may be present when the cost recovery criteria outlined in Chapter 2 are considered because prices above marginal costs are not set according to the inverse of the price elasticity of demand. In the New Zealand scheme those costs above marginal cost are recovered chiefly by the means of fuel excises. However, the resultant misallocation of resources from using fuel taxation as a means of raising additional revenue above the level of marginal cost may be small as the demand for road use, and that of fuel, may be fairly inelastic (see for example BTE 1978, p. 46).

## OTHER OBSERVATIONS CONCERNING THE EFFECTIVENESS OF THE NEW ZEALAND ROAD PRICING SYSTEM

Since the introduction of the current system of charges in 1978 two reviews of the pricing scheme have been made. Some of the issues raised in these reviews in 1979 and 1984 are discussed below.

### Report of the Working Party on Road User Charges: 1979

When the Road User Charges Act was introduced the New Zealand Minister for Transport indicated that the legislation would be reviewed after one year. The *Report of the Working Party on Road User Charges* was released in June 1979 and raised a number of issues concerning the effectiveness of the charging system. The following is an outline of some of the comments and concerns raised in the Report.

*Distance licences and hubodometers*

A number of criticisms were raised by road users in relation to the imposition of distance licences.

One criticism was that the minimum units of the distance licence made available for sale were inappropriate for some transport operations, particularly those which operated over short distances. The minimum unit of the licence sold covered 1000 kilometres of travel and there were suggestions that this should be reduced to 500 kilometres. This suggestion was rejected by the Working Party for it was believed that the demand for smaller units of the licence would be insignificant.

The Road User Charges Act provides that vehicles operating under the

impost of distance licences be fitted with hubodometers. Criticisms of three aspects of this requirement were raised:

- the siting of the hubodometer on the left hand side of the vehicle;
- permanent fixing of hubodometers; and
- the adequacy of hubodometers to accurately measure distance.

With respect to the first issue it was suggested that the siting of the meter on the left hand side of the vehicle was inconvenient to the driver when readings had to be taken. There was also the possibility of damage to the hubodometer when the vehicle was manoeuvred. On these grounds it was suggested that the hubodometer should be changed to the right hand side of the vehicle. No change was recommended by the Working Party which saw overiding benefits to safety, convenience and uniformity.

Opinions on the permanent fixing of hubodometers were divided. One opinion was that permanently fixed hubodometers were inconvenient in the sense that they could not be detached for off-road running thereby necessitating the recording of off-road travel and the need to submit returns for refunds. Conversely, it was also argued that if hubodometers were not fixed then some latitude for evasion was given. In summary, the Working Party recommended that fixed hubodometers continue to be employed and that quick release mechanisms be fitted only in certain circumstances.

The Working Party also noted that hubodometers were the most accurate distance measuring devices currently available and there was no sound basis for operator concern over accuracy and, therefore, the appropriateness of the tax liabilities, incurred by individual vehicles.

*Administration*

A number of issues concerning the difficulties of administration and enforcement of particular aspects of the pricing scheme were raised.

First, there were problems with the format of the licences. For example, incomplete and illegible licences, the requirement to display licences at all times and the effectiveness of the defences allowed in the Act were raised by transport operators. However, on the whole the Working Party regarded the current administration arrangements as satisfactory.

Subsequent to the implementation of the distance licencing scheme the format of the licences had been revised. The Working Party maintained that these changes would satisfy road users' concerns with the licence design. On the issue of fraudulent and incomplete filling out of licences, the Working Party believed that as much as possible had been done to prevent this and no further changes in administration procedures could be made to improve the situation.

A second problem concerned a number of additional responsibilities imposed on both road transport operators and on the government itself. A number of criticisms have been raised concerning these arrangements. Road transport operators are required to check hubodometer readings, purchase licences, maintain records and submit returns for refunds.

In considering this problem the Working Party examined the administrative techniques of a sample of road transport operators. It was found that there was a wide variation in administrative practices among road transport operators and the Working Party suggested that road transport organisations should assist their members in reducing administrative problems.

The increase in administrative responsibilities led to an increase in administrative costs. The Working Party considered that administration costs could be reduced over time as road users became better acquainted with the charging system. It was thought that the administration costs associated with the new system must not only be seen in the light of the administration costs of the previous system but also viewed against the benefits arising from the removal of anomalies existing under the previous system. One positive feature about aspects of the new scheme was the additional information generated about operations which could be used to improve efficiency.

The Road User Charges Act provides for an administration fee of two dollars levied on each licence application. In 1978-79 this comprised 2 per cent of the total tax yield. This compares with collection costs of 3 and 4 per cent for the distance tax and heavy traffic fees respectively in 1976-77. The Working Party argued that the arrangement of levying a fixed fee was a more desirable means of meeting administration costs than absorbing these costs into the licence fees. In the latter case those operators undertaking the largest mileage would bear a disproportionately large share of the administration costs, which were largely unaffected by the size of the licence application.

*Enforcement*

The major criticism raised about enforcement aspects of the scheme was that delays and inconsistencies existed in applying enforcement provisions under the Act. To counter this problem the Working Party examined the possibility of implementing a system of infringement fees. However, it was considered that the implementation of such a scheme was not feasible. The validity of imposing such penalties was also questioned because of the assumptions required about certain aspects of the illegal operation (for example, excessive weight or distance travelled).

However, it was considered that there was a need to strengthen existing penalty provisions. It was envisaged that this could be achieved in a number of ways. First, it was recommended that existing maximum penalties be increased. Second, an interest penalty on outstanding debts was suggested and, finally, it was recommended that in cases where there existed non-compliance with the provisions of the Road User Charges Act that there should be a review of the licence of the transport operator involved (under the provisions of the Transport Act 1962).

**Working Party to review road user charges: 1984**

The need for a second review of the system of road user charges arose for different reasons from those underlying the first review. The need for a second review was due primarily to the growing gap between road user charges and the level of road costs attributed to heavy vehicles. There was also continuing concern expressed from within the road transport industry over certain aspects of the system, especially the scope for evasion of the charges.

Three aspects covered in this review are examined below:

- cost allocation
- administration
- enforcement.

*Cost allocation*

The Working Party recommended a revised cost allocation methodology based on a different approach to the one underlying the current system of charges. As noted earlier in this chapter, the current cost allocation methodology is based on a cost occasioned approach. The alternative approach recommended was referred to as being based on marginal cost pricing concepts.

In the narrowest sense it can be argued that the alternative method is not really a short run marginal cost approach because under the proposed methodology, total road costs are to be divided into variable and fixed costs, variable costs to be allocated in line with marginal cost pricing principles but fixed costs allocated using a cost occasioned approach. Hence, in essence it is still a cost occasioned approach even though it has some efficiency elements.

The Working Party appointed a task force to determine procedures by which such an allocation of costs might be carried out. The task force recommended that the division between fixed and variable costs be determined using the cost categorisation of the European Economic Community (EEC). This is explained more fully in Table 4.3.

The amount to be allocated among road users includes the National Roads Board budget plus the contribution made by local government authorities for local roads. The share of road costs met by local government authorities is not accounted for under the existing cost allocation methodology.

The division of costs into the four EEC categories and into fixed and variable components is based on various opinions produced by a secretariat examining procedures in a number of countries. The Working Party expressed the opinion that road costs in New Zealand were similar to the categories specified in the EEC guidelines but a perfect correlation did not exist. Accordingly, adjustments, based on subjective assessments, were made in the application of the methodology.

The variable component in each of the four categories is allocated on the basis of a distance related parameter. For example, the fourth power rule would be used to allocate costs included in category D3.

However, the Working Party indicated that alternatives existed for the recovery of the fixed cost component; either through a periodic fixed fee or through existing road user charge mechanisms.

The major advantage of a periodic fixed fee was identified as being its simplicity of administration, although it was noted that in terms of flexibility some loss of efficiency would be experienced. In particular, a fixed fee would provide little incentive to encourage minimum axle weights. This could be overcome by including axle weights and axle configurations as factors within the structure of charges. However, as a consequence, administrative arrangements would become more complex.

The Working Party also noted that the imposition of periodic charges could produce an inequity in that operators who make little use of the road will pay the same share of fixed costs as those operators who make more extensive use of the road system. A similar problem exists with the heavy vehicle use tax imposed in the United States.

With these deficiencies in mind, use of the existing road user charges system to recover fixed costs was favoured by the task force.

TABLE 4.3-RECOMMENDED COST ALLOCATION METHODOLOGY; 1984 WORKING PARTY REPORT ON ROAD USER CHARGES

| *Cost category* | *Cost components* | *Allocation methodology* |
|---|---|---|
| D0 | Expenditure on bridge maintenance, grass hedge and tree cutting, road signs and signals, maintenance of paths and curbs and lighting. | Not allocated, treated as fixed costs |
| D1 | Expenditure on winter maintenance, road markings, crash barriers. | 50 per cent of expenditure is included in marginal cost, allocated pro rata according to vehicle kilometres travelled. |
| D2 | Expenditure on surface dressings and the like and paint on signs and signals. | 60 per cent of expenditure is included in marginal cost; allocated pro rata according to vehicle kilometres travelled, weighted by gross vehicle weight. |
| D3 | Expenditure on bituminous surfacing, pavement strengthening and renewal. | 75 per cent of expenditure is included in marginal cost; allocated pro rata according to number of equivalent axles. |

*Source:* Ministry of Transport (NZ) (1984, p. 63).

Problems of equity should not arise as user charge payments would be related to road use and new administration arrangements would not need to be made.

In the Report a comparison was made between the different cost allocation methodologies examined. The results of this comparison are presented in Table 4.4. This Table indicates that in absolute terms there is no overall difference in the application of the existing cost allocation methodology and the recommended methodology.

However, in terms of the charges faced by individual road user groups there will be a considerable difference between the existing and revised cost allocation methodologies. This is demonstrated in Table

TABLE 4.4-COMPARISON OF COST ALLOCATION METHODOLOGIES IN 1984 WORKING PARTY REPORT, 1984-85

*($ million)*

| *Budget component* | *Existing cost allocation methodology* | *Revised cost allocation methodology* | *NZRTA cost allocation methodology* |
|---|---|---|---|
| NRB budget | | | |
| Vehicles subject to taxation under Road User Charges scheme | 179.0 | 175.3 | 105.5 |
| Other vehicles | 181.0 | 184.7 | 209.5 |
| Total | 360.0 | 360.0 | 315.0 |
| Local government authority expenditure | 127.3 | 127.3 | 127.3 |
| Total | 487.3 | 487.3 | 442.3 |

Note: 1. Calculations based on 1984-85 NRB budget of $360 million (excluding $11.7 million carry over from previous year).
2. Revised cost allocation figures for road user charge vehicles based on the allocation of fixed costs excluding a weighting for distance travelled. Administration charges excluded.
3. NZRTA calculations based on a NRB budget of $315 million after a $45 million contribution from Central Government, using a revised general maintenance apportionment and a third power rule.

*Source:* Ministry of Transport (NZ) (1984, p. 74).

4.5. The charges in this table are based on the 1984-85 NRB budget of $360 million. The existing cost allocation methodology was based on attributable costs of $179 million. Under the revised cost allocation methodology, with fixed costs offset, separately attributable costs were $143.1 million. Conversely, where fixed costs are to be recovered by means of the road user charges system, attributable costs were $175.3 million. In each case administration costs are excluded.

The New Zealand Road Transport Association (NZRTA) disagreed with a number of aspects of the revised cost allocation methodology proposed by the Working Party. In particular, NZRTA was opposed to the inclusion of local government expenditure in the calculations. NZRTA maintained that similar economic criteria did not apply to both local roads and State highways because of the purpose, function, and road funding objectives of local government authorities.

In view of these considerations the NZRTA argued that local government authority expenditure be allocated to fixed costs and not included in the cost allocation.

In addition to these comments NZRTA raised two other concerns. First, NZRTA challenged the applicability of using the fourth power rule as a means of allocating New Zealand road costs. It was argued that

TABLE 4.5-TYPICAL CHARGES UNDER ALTERNATIVE COST ALLOCATION METHODOLOGIES

*($ per 1000 kilometres)*

| | | *Revised cost allocation methodology* | |
|---|---|---|---|
| *Vehicle type* | *Existing cost allocation methodology* | *With fixed costs offset* | *With fixed costs recovered via road user charges* |
| Car or van | 8.80 | 4.19 | 8.24 |
| Two axle truck or bus | 121.75 | 88.23 | 110.86 |
| Three axle vehicle | 226.87 | 163.30 | 202.08 |
| Five axle vehicle | 441.02 | 285.82 | 351.21 |
| Truck/trailer combination each having three axles | 367.77 | 277.25 | 342.45 |

Note: Excludes administration charges.

*Source:* Ministry of Transport (NZ) (1984, p. 75).

overseas evidence suggested that the fourth power rule was representative of an average mix of pavements in a number of countries and that rigid pavements, which could attract a power rule of up to nine, were included in the fourth power rule calculations. NZRTA maintained that as few rigid pavements existed in New Zealand and no power rule existed for unsealed pavements, a lower average power rule than four should apply to New Zealand roads.

This is a somewhat paradoxical conclusion in that United States evidence demonstrated that pavement damage was a function of the fourth power of the axle load and the inverse of the seventh power of the thickness of the pavement seal. This would seem to indicate that if, in general, pavements were thin a power rule greater than four should be chosen.

The second issue raised by NZRTA was concerned with possible variations in maintenance expenditure with different traffic volumes. Evidence presented in an Organisation for Economic Co-operation and Development (OECD) Report (OECD 1982) used by the Working Party task force in establishing the recommended cost allocation methodology indicated a low variability in road costs with variations in the volume of traffic. It was NZRTA's view that it was erroneous to base a cost allocation for New Zealand roads on the basis of the European Economic Community's guidelines, which to some extent had been contradicted in the OECD Report. In particular, it was argued that technical evidence presented in OECD (1982) indicated that a low level of cost variability of maintenance expenditure existed.

Using the OECD evidence as a guide, NZRTA recalculated the cost allocation with an alternative distribution of maintenance expenditure. In doing so the cost responsibility for heavy vehicles was reduced to below that calculated by the Working Party task force.

Taking these considerations into account the Working Party recommended that either the cost allocation methodology recommended by the task force be implemented or that the methodology with amendments proposed by NZRTA be implemented, with fixed costs being allocated between road users (by excluding a weighting for distance travelled) and not in the same manner as variable costs.

NZRTA also proposed an alternative system of charges to that currently implemented. The major difference between the system proposed by NZRTA and the current system is the omission of a distance licence and its replacement by a periodic fixed fee. The alternative charging system proposed by NZRTA comprised an excise on diesel, a sales tax on

tyres and the periodic fixed fee graduated according to vehicle weight and axle configuration. It was intended that half the total revenue requirements would be satisfied through fuel taxation.

NZRTA believed that this system of charges offered advantages over and above the current system. It was argued that the system would encourage axle configurations that would spread vehicle load, therefore minimising pavement damage. In addition, it was believed that fuel consumption and tyre wear would reflect a number of use related factors and therefore be representative of the cost responsibility of different types of vehicles.

In response to these claims the Working Party considered that the system of charges proposed by NZRTA would not result in an effective matching of cost responsibility and user charge payments for different vehicles. It was argued that a direct proportional relationship between fuel consumption and vehicle weight did not exist. Similarly, a definitive relationship between vehicle weight and tyre wear could not be identified. It was argued that if fuel and tyre taxation were to be the major charging instruments then an anomaly must necessarily be introduced into the charging system as a consequence. In addition, it was believed that fuel consumption and tyre wear were related to factors which in turn were not related to road costs.

The Working Party criticised the suggested imposition of a fixed fee to recover 'fourth power' related costs. It was argued that under the system proposed by NZRTA the fixed component would only account for 22 per cent of revenue collections whereas under the recommended cost allocation methodology these costs would represent 42 per cent of variable costs. Remaining costs would therefore have to be recovered through fuel and tyre taxation, hence increasing the possibility of introducing distortions within the pricing system.

The Working Party also identified weaknesses associated with using a fixed charge to recover variable costs. It was argued that a degree of averaging would be introduced by the implementation of a fixed charge and this would introduce a distortion between vehicles travelling short distances and those travelling longer distances.

In sum, the Working Party considered that the disadvantages of the alternative scheme, in the form of cross-subsidisation, outweighed any of the inherent advantages. It was also considered that the benefits of improved administration were minimal and that the use of fuel and tyre taxation would create distortions in resource allocation in other areas of the economy.

*Administration*

In addition to the cost allocation issues a number of administration aspects of the pricing scheme were examined. These include:

- limitations placed on increases in the charges;
- methods of payment;
- methods for credits or refunds;
- administration charges;
- methods of payment;
- administration costs to operators;
- aggregation of loads; and
- hubodometers.

Since the implementation of the Road User Charges Act in 1977 increases in the level of road user charges were limited by an amount of 20 per cent. However, no restriction was placed on the number of adjustments that could be made within one financial year. In this context, the Working Party recommended no maximum or minimum levels to changes in the rates of taxation be applicable.

The main concern expressed in submissions to the Working Party about methods of payments was over the need for prepayment of licence fees. As an alternative to this scheme a combination of pre- and post-payments was suggested. In response to this argument the Working Party reiterated its findings expounded in the 1979 Report. The 1979 Working Party had recommended that no change be made to the current pre-payment system. There were a number of reasons underlying this recommendation. First, it was thought that if a post-payment scheme was put into operation the liquidity problems which operators were experiencing under the current system would not be resolved. Second, the 1979 Working Party noted that there was scope for improvement within the current charging system, both in terms of operator efficiency and on the part of government. Improvements at the government level had been noted by the Working Party.

A related concern raised in the 1984 Report was over the methods of payment of credits and refunds. In particular, concern was expressed by transport operators over the Government's slowness in paying refunds. It was suggested that payments for credits or refunds be made when purchasing new licences could overcome this problem. A system involving reducing the cost of new licences by the amount of credit of the unexpired licence was not recommended by the Working

Party. Rather the Working Party recommended that steps by taken to quicken the pace of refunds.

Under the current scheme an administration charge of two dollars is levied to recover associated administration costs. Two aspects of this arrangement were identified by the Working Party as requiring attention:

- what administration costs should be met by road users; and
- how administration costs should be recovered?

In the past the fees had been set to recover the collection costs of the New Zealand Post Office who issue the licences. However, administration costs are also incurred by the Ministry of Works and Development. It was argued that these costs should also be recovered by the administration fee. The NZRTA did not agree with this approach. The Working Party could not agree on which administration costs should be recovered but argued that administration costs should be treated in the same manner as other fixed costs under the revised cost allocation methodology.

Under the current system of road user charges, petrol-powered vehicles weighing greater than 3.5 tonnes are subject to double taxation initially and refunded the amount of petrol taxation paid. Submissions to the Working Party suggested that these vehicles be subject to a lower rate of taxation under the road user charges system instead, reflecting the amount of petrol taxation paid by these vehicles. In response, the Working Party recommended that this matter be investigated further. It was noted that the system of charges would be made more complex by adopting the differential tax suggestion. It was also noted that such a change may not be necessary in that petrol taxation alone may fully recover the costs of road use of these vehicles, in which case distance licences would not be necessary.

Similar concerns over hubodometers expressed in the 1979 Report were also expressed in the 1984 Report, namely reliability and avoidance. The Working Party recommended that action be taken to reduce manufacturing defects and improve hubodometer design to improve security.

*Enforcement*

The Working Party noted that it was not possible to evaluate the extent of evasion present in the current charging system.

One proposal considered to reduce evasion was to fit shrouds to hubodometers, effectively sealing them. This was seen as having two principal advantages. First, it would prevent hubodometers from being accidentally damaged and second it would reduce the scope for deliberately tampering with hubodometers with a view to evasion.

With regard to other forms of evasion it was noted that little could be done to prevent this other than improve current arrangements.

In total the Working Party made 16 recommendations in its Final Report. The New Zealand Government has subsequently acted on some of these recommendations although some problems identified by the Working Party still need to be resolved. Other recommendations are currently under consideration including improvements to the security of hubdometers. The revised cost allocation methodology recommended by the Working Party has been implemented and this has led to a revision of road user charges which became effective from 1 February 1985.

## CONCLUDING COMMENTS

The implementation of the provisions of the Road User Charges Act would represent an extension, albeit considerably more sophisticated, of the philosophy existing under the previous system of road taxation. The major changes provided for under this Act were the introduction of distance licences for heavy vehicles and the associated use of hubodometers.

The chief advantage of the charging system introduced in the 1977 Act over the previous system is that it provides a more disaggregated scale of charges enabling closer correlation with the costs occasioned by individual vehicles. Hence, there are likely to be improvements both in terms of economic efficiency and equity over the previous charging system.

This may be contrasted with the United States pricing scheme where the focus of attention is on vehicle classes rather than individual vehicles. In this respect, it is likely that the New Zealand scheme is capable of achieving greater levels of economic efficiency than the United States charging system. Of course this is not surprising given the emphasis in the United States on equity. However, the New Zealand improvements must be viewed in the context of the potential additional administration costs that may be inherent in the operation of the scheme.

There have been some concerns that the administration costs of the New Zealand scheme outweigh the potential benefits. However, these must be viewed in terms of the administration costs that were incurred in the operation of the previous scheme. It is possible that the administration costs of the new scheme may not be significantly more than that of the previous scheme while the benefits generated may be significantly greater.

On balance the scheme appears to be primarily equity rather than efficiency based. It is also a user pays system entailing hypothecation of revenue to expenditure on a pay-as-you-go approach. Nevertheless, to the extent that charges are closely related to avoidable cost, efficiency is enhanced. However, efficiency is lessened by the failure to adopt demand based pricing for charges exceeding marginal cost, although the potential loss of efficiency may not be large.

## CHAPTER 5-ROAD PRICING IN SINGAPORE AND HONG KONG

One important aspect of road pricing is properly accounting for congestion costs. Congestion costs form part of the avoidable costs associated with road use. Therefore, some measurement of congestion costs must be made in order that prices can be established which fully reflect avoidable cost.

The foremost examples of road congestion pricing schemes are those operating in Singapore and Hong Kong. In these cities different strategies have been adopted in pursuit of the same pricing objective.

This chapter briefly examines the nature of these two charging systems and assesses their effectiveness in efficiently recovering congestion costs. It is pertinent to note, however, that the circumstances in which congestion pricing was introduced in Singapore and Hong Kong are different from those which exist in most Australian cities. The expansion of road capacity within the central business areas of Singapore and Hong Kong is limited because of geographic considerations and high traffic densities exist in both countries. These are not major problems in Australia. However, to the extent that congestion is present in some Australian cities, the Singapore and Hong Kong experience is of some relevance and hence deserves examination.

### ROAD CONGESTION PRICING IN SINGAPORE

The introduction of congestion pricing in Singapore in 1975 was in direct response to demand pressures placed on the road system, particularly in the central business area, by the existing vehicle fleet. It was also expected that demand pressures would increase over time.

In 1974, approximately 250 000 motor vehicles were registered in Singapore, of which approximately 60 per cent were privately owned. It was estimated around that time that the number of vehicles would increase to approximately three times this level by 1992 (Watson and

Holland 1975, p. 1). Hence, it was expected that the congestion problem would worsen significantly in the future.

The congestion problem in Singapore was compounded by its geographic characteristics. Singapore is a small island country which is densely populated. In 1975, approximately 70 per cent of the total population lived within an eight kilometre radius of the central business district (CBD). Hence, the scope for road capacity expansion was limited and therefore some form of ordered rationing of road space was considered desirable.

In view of these factors the Singapore Government examined alternative means of restraining road use. The various alternatives considered are discussed below.

**Policy alternatives**

The following alternatives were considered by the Singapore Government in formulating policies to restrain road user demand:

- fuel taxation;
- metering;
- tolls;
- parking fees; and
- area licences (Watson and Holland 1975, p. 3).

Fuel excises were dismissed as a means of restraining road user demand as it was considered that fuel consumption was an inaccurate measure of congestion costs. Fuel consumption will partly reflect road use, but the associated excise tax paid would have an insignificant effect on restraining demand at specific times or in certain areas, in particular, during peak hours when congestion costs are highest. Although the rate of fuel consumption increases during periods of high congestion, insufficient distinction can be drawn between vehicles of different types and the congestion costs associated with their road use.

The major problem identified with metering was the lack of suitable equipment. At the time, the state of technology was such that metering equipment was not readily available and was relatively expensive. There were also problems associated with road tolls. Collection facilities would be needed, imposing an additional cost upon the Singapore Government and, more importantly, contributing to congestion in itself. Tolls are also expensive to collect because of

labour costs. The imposition of parking fees in the CBD was thought to suffer from similar problems to those of fuel excise in that they have little impact on restricting traffic travelling through the CBD.

Area licences were considered to have difficulties relating to administration and enforcement aspects. However, they did offer solutions to the problems arising from the deficiencies existing in other charges. The primary advantage of area licences is that charges can be set which accurately reflect congestion costs, varying according to time of day and location as required.

After taking all these aspects into consideration, the Singapore Government decided that a combined system of area licences and parking charges would form the core of the congestion pricing scheme adopted.

**Elements of the pricing scheme**

*Area licences*

The central element of the pricing scheme introduced in 1975 was the requirement for vehicle owners to purchase licences to travel through certain areas of Singapore at specific times.

The restriction applied to an area which covered the CBD of Singapore. This region, known as the Restricted Zone, is 62 hectares in area. In defining this zone, a number of considerations were taken into account. First, it was necessary to make provision for road users who did not have destinations within the Restricted Zone by making alternative routes outside the zone available. This was accomplished, in part, by designating entry points to the Restricted Zone. The chief objective in defining the entry points was to minimise their number, thereby minimising the need for monitoring and hence administration costs. In total, 22 entry points to the Zone were specified.

The Zone was also designed so that it took the greatest advantage of existing facilities, especially parking facilities. Other design considerations included the maintenance of mobility within the restricted area in order to sustain its economic viability, the need for the provision of alternative means of transportation for road users who would be discouraged from road use by the charging system and recognition of the benefits of the use of private vehicles.

The setting of licence fees was a matter of judgement. Initially, licences were sold for S$60 per month or S$3 per day. However, it was considered sufficient to make charges only applicable during the

morning peak period. It was thought that this morning charge would reduce demand for later time periods (particularly the evening demand peak) without the need to impose additional restraints.

*Exemptions to the licencing scheme*

The restraining effects of the area licencing system on private motor vehicles are reinforced by a number of exemptions applying to other vehicles. These exemptions take several forms. First, exemptions apply to buses and commercial vehicles. The exemption for buses is designed to encourage the use of public transport while the exemption for commercial vehicles is designed to ensure that the licencing system would not affect commercial activity within the CBD.

Second, private cars carrying four or more passengers are also exempt from the provisions of the scheme. The motivation underlying this was to encourage higher vehicle occupancy rates, thereby reducing congestion levels. Motor cycles are also exempt from the provisions of the scheme.

Third, taxis were initially exempt, but after a short period this exemption was removed. A surcharge of S$1 was subsequently allowed on taxi fares to provide an incentive for greater numbers of taxis to service the CBD. The surcharge is payable for every trip originating within the Restricted Zone between the hours of 7.30 and 9.30 a.m. on weekdays and from noon to 3.00 p.m. on Saturdays. The surcharge is reported to have encouraged more taxis to operate during peak hours within the CBD.

*Parking charges*

Road use within the CBD was further discouraged by increasing existing parking charges. When the traffic restraint scheme was first introduced, parking charges for public car parks were increased by approximately 100 per cent (Watson and Holland 1975, p. 5). Parking charges in the CBD at that time were 50 Singapore cents for the first hour, one dollar for the second hour and one dollar for each subsequent half hour. In less congested areas of the Restricted Zone, charges were below these levels. Parking fees in these areas have subsequently been revised upwards over a number of years.

Privately owned parking stations were, in general, levying charges different from those levied by public parking stations when the area licencing scheme was introduced. To ensure that the restraining effects of the pricing scheme were not lessened the Singapore Government imposed a surcharge on the fees levied by these stations so

that their charges were brought in line with those levied by public parking stations.

*Park-and-ride scheme*

As noted previously, it was considered, prior to the introduction of the licencing scheme, that if road demand was to be constrained it would be necessary to provide adequate alternative means of transport to cater for road users discouraged from using private cars. Accordingly, a park-and-ride scheme was instituted to complement the licencing system. The system was based on a system of bus operations between parking stations and the central business district. However, no additional incentive was provided to encourage the use of these services. They were provided at additional expense to the individual and were relatively more expensive than regular bus services.

*Road tax*

In a feasibility study undertaken by Wilbur Smith and Associates (1974) on the possibility of implementing a mass transit system in Singapore, one of the alternatives proposed to restrain private car use was to increase the level of road tax. This suggestion was incorporated within the total traffic restraint package of the area licence scheme.

The road tax takes the form of an annual surcharge levied on the value of private motor vehicles. In December 1975, six months after the implementation of the area licence scheme, the rates of tax were raised to 30 per cent of the value of passenger cars seven to 10 years old and 50 per cent for vehicles over 10 years old. However, in January 1976 the surcharge was removed in response to public disfavour.

**Assessment of the Singapore congestion pricing scheme**

The chief element of the Singapore pricing scheme is the area licence fee. While it is clear that the scheme has had the desired effect of reducing the absolute levels of congestion, the charges are fixed in nature and there is a constraint placed upon the degree to which either efficiency or equity is achieved.

Strict efficiency criteria require charges to vary with factors such as time of day, location and congestion levels. The area licences imposed under the Singapore scheme do not satisfy these requirements. The level of the charge remains the same irrespective of variations in these factors. For example, the level of the charge does not vary with the point of entry to the Restricted Zone. Hence, charges do not

vary despite potential differences in congestion levels at these entry points. In addition, the charges imposed only partially vary with time and do not specifically account for all peaks in demand. Only congestion in the morning peak is taken into account; there is no charge operating after this period.

This charging structure means that decisions concerning road use are made on the basis of charges which do not accurately reflect the true costs which individual road users impose on each other and on the road system. As a consequence, some loss in economic efficiency can be expected.

In addition, insofar as the charges imposed under the licencing scheme are not variable and, therefore, not closely related to avoidable cost, the possibility also exists that equity (user pays) requirements may not be fully satisfied either. While the other requirements of the pricing scheme reinforce the demand restraint aspect, it is uncertain that efficiency or equity elements within the pricing scheme will be improved as a result.

The Singapore scheme may at best only be considered as rudimentary. However, it is still a positive attempt to use the market mechanism to achieve specific road user objectives. The ultimate effect of the pricing scheme is a reduction in congestion levels, although, in bringing this about, efficiency or equity elements do not seem to have been given explicit consideration. The main advantage of this scheme is its simplicity.

*World Bank study*

A study undertaken by the International Bank for Reconstruction and Development (World Bank) six months after the area licensing scheme was introduced in Singapore indicated that the impact of the scheme was significant. However, it highlighted other difficulties with the congestion pricing scheme (International Bank for Reconstruction and Development 1975). These findings are summarised below.

Some business owners felt that the Restricted Zone had an adverse effect on their operations, principally because of the inconvenience it imposed upon private travel. It was considered that the ultimate effect of the Restricted Zone would be to raise transport costs, and in the case of employees, this would be borne by businesses within the Zone. Furthermore, it was envisaged that the concept of the Restricted Zone would ultimately have an effect on location decisions. In particular, business offices formerly located within

the Restricted Zone could be relocated to areas outside the Zone, especially in suburban areas.

The general perception among businesses surveyed was that the area licence scheme was the most effective means of restricting congestion within the central business areas. The original intention of the scheme was to reduce traffic levels by approximately 20 to 30 per cent. However, the scheme is believed to have reduced congestion levels by approximately 40 per cent. In this respect, there was some concern that charges may have been set too high and that they could have been lowered to a point where congestion would have been reduced to acceptable levels and not beyond.

It was noted above that the intention of the scheme was to charge only morning peak period road users in the anticipation that there would be a flow-on effect for later time periods. However, this flow-on effect did not occur. The Study found that there has been little change in the evening peak in demand. A number of possible reasons for this were cited.

Some road users who avoid the Restricted Zone during the morning peak period could return through the Zone during unrestricted time periods. Furthermore, individuals who use public transport in the morning peak period may make use of private transport in later time periods. Consequently, it was suggested that some constraints on road users in the evening peak period would have to be put in place.

Since the implementation of the scheme a number of changes have been made to its structure. For example, the time limits of the restriction have been expanded from 7.30 a.m. to 9.30 a.m. to 7.30 a.m. to 10.15 a.m. but no evening restrictions have been introduced.

An increase was also made in the level of area licence charges. This change was subject to some criticism on the grounds that it was considered to be a revenue raising measure and not designed specifically to restrain traffic levels. It was argued that since congestion levels had been reduced by amounts greater than expected there was no necessity to increase charges above current levels to reduce congestion further.

The World Bank survey also drew attention to potential problems with the park-and-ride scheme. The patronage of the scheme has been low and areas provided for parking have been underutilised. The main reason for this is that the system is inconvenient for individuals and it represents an additional cost that would not otherwise have to be

incurred if public transport was used for the whole journey. In addition, it was recognised that some potential road users preferred a lower cost bus service to that provided by the park-and-ride scheme.

The study also suggested that in some cases the costs of parking had been absorbed into business overheads. This would reduce the likely discouragement of private car use.

The exemption available under the area licence scheme for cars carrying four or more persons was designed to encourage car pooling. The study conclusions indicated that the attitude towards car pooling was not favourable. Nevertheless, there was evidence to suggest that the exemption was having the desired effect, an increase in car pooling of up to 80 per cent having been reported. However, there was some concern that this increase may have had little effect on congestion levels insofar as it is possible that the increase represents a shift in demand from public transport rather than from private motor vehicles.

Since the imposition of the charging scheme, a change in the distribution of working hours in Singapore has been experienced. For example, the staggering of working hours has become more widespread. In general, those offices which operated under a system of staggered working hours have permitted their staff to begin work from 7.30 a.m., the beginning of the restriction period. This means that employees can still proceed to work by private vehicle and avoid the congestion charges.

A final concern of the study was the efficiency of the public transport system. A survey of transport users indicated that the public transport system was below the standard required to satisfy the increased demand resulting from restricting the private demand for road use. It was suggested that improvements to public transport services would provide a disincentive for individuals to use private vehicles. Most respondents to the survey were in favour of the institution of a mass rapid transit system.

## ROAD CONGESTION PRICING IN HONG KONG

Hong Kong faced similar congestion problems to those in Singapore during the 1970s and the question of congestion pricing was raised as a consequence. The congestion pricing strategy adopted in Hong Kong, however, is significantly different from the Singapore approach. The scheme, which was introduced in limited form in 1983, makes use of electronic measuring devices.

**Background**

As in the case of Singapore in 1975, Hong Kong in the late 1970s and early 1980s experienced a large growth in private vehicle ownership. It is reported that between 1967 and 1981 car ownership increased by 70 per cent (Dawson 1983, p. 372). In addition, Hong Kong was believed to have one of the highest traffic densities in the world being of the order of approximately 270 vehicles per kilometre of road (Australia's traffic density is approximately nine vehicles per kilometre of road). Hong Kong also has similar geographic characteristics to those of Singapore. Hong Kong consists geographically of a small island plus a small part of the Chinese mainland and hence there are limitations placed on capacity expansion.

Rising traffic volumes were placing additional pressure upon the road system despite increases in real terms in road construction expenditure. To counteract this problem a number of alternatives, much the same as those considered in Singapore, were examined. Included in these alternatives were parking controls, supplementary licencing, physical restraint (odd/even day usage) and increases in taxation on new vehicles. In May 1982 the first registration fee for private vehicles was doubled while annual licence fees were trebled. Excises on fuel consumption were also increased. As a result of these changes, motor vehicle registrations fell by 6 per cent between 1982 and 1983. However, it was considered that in terms of modifying road usage all these measures were unsatisfactory. Even though some reduction in congestion was experienced the primary concern was that this had not occurred in areas where congestion was a significant problem.

In response to these problems a form of electronic road pricing was adopted, an option which had not been considered in Singapore. By 1983, there had been technological developments that had made this form of pricing both practical and economically feasible.

**Implementation of the pricing scheme**

The operation of the scheme involves two principal components. First there is a requirement that toll monitoring devices be fixed to all vehicles. These devices take the form of electronic number plates which are fixed underneath vehicles.

The second component of the charging scheme is comprised of a system of outstations. The purpose of these stations is to record vehicle movements throughout the toll areas. At each toll location recording

devices are buried beneath the road surface. These are activated when a vehicle passes through the toll location point. A signal is then transmitted to a computer located in the outstation which identifies the vehicle and carries out a number of validity checks. The identification code, the time of day and outstation number are transmitted to a central control and accounting centre where the vehicle's account is charged a specified amount for entering the area.

Motor vehicle owners are charged on a monthly basis according to their accumulated charges during that month. Drivers are also notified of the charges they incur by displays situated close to the outstation.

So far the system has only been implemented on a restricted basis. The pilot system consists of 20 outstations and 3000 electronic number plates installed mainly on government vehicles and some volunteer private vehicles. A fully implemented system would cover approximately 10 times the number of vehicles and require 300 outstations. It is envisaged that a complete system would be operational by 1987. However, whether a complete system is introduced will depend on whether the benefits of the system are assessed as outweighing its costs. A study of the potential impact of the electronic road pricing scheme on different economic entities has yet to be completed.

**Assessment of the Hong Kong congestion pricing system**

In terms of efficiency and equity criteria the Hong Kong system represents an advance over the Singapore pricing system. The Hong Kong system adopts a scale of charges which vary with demand related factors. Charges can be changed according to location, time of day and congestion levels. Hence, it is possible to match user charges with the cost responsibility of individual road users.

However, the potential benefits of the scheme must be weighed against the associated costs. The Hong Kong scheme is more sophisticated than the one implemented in Singapore and provides a method by which charges can be adjusted to more accurately reflect congestion costs. In contrast, it is likely that the administration and operating costs of the Hong Kong system are greater than those associated with the Singapore system. Therefore, the additional benefits of adopting a scheme which has the potential to fulfill efficiency criteria needs to be weighed against the consequent costs. Ultimately, both schemes should achieve the same objective, but at this stage it is uncertain that the additional benefits of adopting the Hong Kong system are

significant. It may not be necessary to achieve the degree of fine-tuning which is evident in the Hong Kong system if the objective is simply to reduce overall congestion. However, if the main concern is over the process of reducing congestion and over the relative payments of individual road users, then the Hong Kong system represents an improvement over the Singapore system.

## CHAPTER 6-ROAD PRICING IN AUSTRALIA

The previous chapters have examined the road pricing strategies implemented in the United States, New Zealand, Singapore and Hong Kong. The structure of road user charges in Australia, which is examined in this chapter, can now be assessed against this background.

The Australian road pricing structure is significantly different in character from those implemented in the other countries considered in this Paper. Each of the overseas countries examined have explicitly sought to follow equity or efficiency criteria. However, in Australia the objective pursued in the past appears to have been one of simply raising revenue to meet expenditure requirements (either for road works or general budgetary purposes) without explicit regard to efficiency or equity. As a consequence, concern has been expressed by a number of commentators that the charging structure may be inadequate in satisfying such objectives.

The chapter begins, as in earlier chapters, with an outline of each level of government's responsibility for roads. The form of various road user charges are then discussed and an examination of the results of a number of Australian cost allocation studies is presented. Attention is focussed on the relative cost responsibilities and user charge payments of different road users. Finally, some comments on possible constraints to improvement to the Australian road pricing system are made.

### RESPONSIBILITY FOR ROADS

In Australia, as in the United States, the responsibility for road construction, maintenance, and funding is divided among the different levels of government.

The Australian Constitution provides that primary responsibility for roads rests with the States. The Commonwealth Government has only specific powers over roads in the Commonwealth Territories. This is covered under Section 122 of the Constitution. However, in practice

the Commonwealth Government plays a large role in financing roads expenditure. This is mainly an historical development which owes much to the greater revenue raising power of the Commonwealth Government, gained through the transfer of income taxation raising powers from the States to the Commonwealth in 1942. The States have also transferred responsibilities for roadworks on unclassified roads to local government.

Details of the current roles of the three levels of government in road financing are examined in greater detail below.

**The role of the Commonwealth Government**

The Commonwealth Government's role in road financing is covered under two heads of Constitutional power. Under Section 122 of the Constitution, the Commonwealth Government has direct responsibility for roads in the Territories. Prior to 1978 this included road revenue raising and the construction and maintenance of roads in both the Northern Territory and the Australian Capital Territory. However, in 1978 the responsibility for roads in the Northern Territory, along with other government functions in the Territory, were transferred to the newly established Northern Territory Government. The question of self government for the Australian Capital Territory is currently under review. At this stage the Commonwealth is still responsible for the financing and the construction and maintenance of roads in the Australian Capital Territory.

The more important Commonwealth role, however, is that of the provision of grants to the States for roadworks under Section 96 of the Constitution. Section 96 provides that the Commonwealth Parliament may provide money to the States on such terms and conditions as it sees fit. Grants to the States for expenditure on roads are provided for on this basis. Currently, these grants amount to approximately 40 per cent of total public road expenditure in Australia. Total road expenditure by all levels of government in 1982-83 was approximately $3 200 million.

The Commonwealth Government imposes several different charges which are paid directly or indirectly by road users, although most of these are not hypothecated to road expenditure[1]. These charges include the

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1. At the time this Paper was nearing completion the Commonwealth Government announced that it was introducing an Australian Land Transport Program which would provide continued grants to the States for roadwork and involve hypothecation of some of the excise receipts from petroleum products.

following:

- excise and customs duties on petroleum products;
- sales taxes on new vehicles and parts; and
- customs duties levied on new vehicles and parts imported into Australia.

Customs duties are levied on the quantity of petroleum products (including motor spirit and automotive distillate) imported into Australia. Currently, the rate of this duty is around nine cents per litre. In addition, excise taxes are also levied on the production of crude and refined petroleum products. The excise duty is levied on both motor spirit and automotive distillate. In the latter case rebates are allowed for non-transport usage, for example, home heating. Currently, the rate of excise duty is the same as the customs duty. Of this amount two cents per litre is hypothecated to road works. The revenue from this two cent levy is paid into the Australian Bicentennial Road Development (ABRD) Trust Fund for use on roadworks financed under the ABRD Program. The balance, as well as the remaining taxes and charges outlined here, are treated as general revenue taxes.

Another tax on petroleum levied by the Commonwealth Government is on crude oil produced in Australia from oil fields which were discovered before 15 September 1975. At the time the levy was introduced in 1977 the Government relaxed controls over the price at which crude oil could be sold to refineries by introducing a policy of import parity pricing. The concept of import parity pricing is designed to ensure that prices for domestically produced crude oil reflect international prices and hence its opportunity cost. As a result, oil subject to the production levy could be sold to refineries at only the same price (approximately) as oil not subject to the levy. Thus the price to consumers is the same whether the tax is imposed or not. The rate of the levy, however, will vary according to the oil field involved. The production levy is in essence a tax on producers and not on consumers and cannot be considered as a road user tax. This argument was recognised in the recent report of the National Road Freight Industry Inquiry (NRFII 1984, p. 217-9).

The other major charges levied by the Commonwealth Government which are paid by road users are customs duties and sales taxes on the sale of new vehicles and motor vehicle parts and accessories. The rates of charge for customs duties vary on two bases. First, they vary according to vehicle type. For example, passenger vehicles and

commercial vehicles are differentiated within the taxation structure. Second, the rates of charge also depend on whether the imported vehicles are assembled or unassembled.

The level of customs duty payable is calculated by applying the rate of duty to the customs value of the vehicle imported. The customs value of the vehicle is established on the basis of the purchase price paid by the owner of the vehicle less an allowance for depreciation. The maximum allowance for depreciation is 76 per cent of the value of the vehicle. Further details concerning the structure of customs duties are provided in Table 6.1.

Sales tax on the sale of new, imported and second-hand passenger vehicles is currently 24 per cent of the wholesale price. However, prime movers and trailers are subject to a rate of 20 per cent. Taxes on tyres and motor vehicle parts are levied at the same rate as the sales tax on motor vehicles.

In a number of cases exemptions from the imposition of customs duties and sales taxes are granted. These cases include:

TABLE 6.1-RATES OF CUSTOMS DUTY ON IMPORTED ASSEMBLED MOTOR VEHICLES, AS AT JANUARY 1985

*(per cent)*

| *Vehicle type* | *Rate of duty* |
|---|---|
| Cars and station wagons | |
| 0- 5 years old | 95.3 |
| 5-30 years old | 79.8 |
| > 30 years old | 24.0 |
| Panel vans (some) | 95.3 |
| Other vehicles having a gross vehicle weight of 2.72 tonnes or more | 51.9 |
| Four wheel drive vehicles less than 2.72 tonnes gross vehicle weight | |
| Vehicles with an independent chassis | 55.0 |
| Other | 95.3 |
| Other vehicles | 67.4 |

*Source*: Department of Industry and Commerce (1984, p. 5).

- vehicles owned by individuals arriving in Australia to take up residence for the first time;
- vehicles bought on or before 1 December 1978 by people returning to reside in Australia; and
- vehicles manufactured in Australia which were owned and used overseas then returned to Australia.

It is important to note that not all of these charges can be regarded unambiguously as road user charges. They may be levied for purposes other than confronting road users with the costs associated with their road use. For example, sales taxes and customs and stamp duties are not usually regarded as road user charges because they form part of general taxation on a wide range of goods and transactions and are not specific to road vehicles or their usage. However, although these charges cannot be regarded unambiguously as road user charges, they still have effects on vehicle ownership and road use.

**The State Government role**

As noted in BTE (1982a) the various State governments are responsible for the construction, maintenance and operational aspects of the States' 'declared'[1] road network. This network is comprised of the State highways, developmental roads, main and trunk roads and some local roads.

The State governments also perform a co-ordinating function whereby they are responsible for the receipt of Commonwealth road grants and their distribution among different areas of the roads sector. They are also responsible for distribution of the proportion of Commonwealth funds that are made available to local government authorities for local roads.

In addition to the Commonwealth road grants, State governments raise their own revenue. The revenue sources include the following:

- registration fees
- drivers' licence fees
- regulation charges
- fuel franchise fees.

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1. 'Declared' roads are those specified in State legislation as being roads over which the State government has total responsibility or joint responsibility with local government authorities for the construction and upkeep.

Motor vehicle registration fees are levied in all States. The level of the charge is related to the type of vehicle, in some cases on the basis of the vehicle's power-to-weight ratio. In all States, registration fees are fixed annual charges. To date only a nominal registration fee has been levied on vehicles engaged in interstate transport because of constitutional considerations. A number of different types of vehicles are also subject to concessions.

Drivers' licence fees are also fixed annual charges. The level of the fee imposed varies among the States and according to vehicle type. Most States also charge a variety of related fees such as those for transfer of registration, number plates and special licences. Stamp duty is charged on all transfers of motor vehicles and is levied as a percentage of the sales price. The rates are independently set in each State.

In addition to these charges, certain transport charges are imposed in some States as a means of regulating road transport competition with State railways. These charges include licences which need to be obtained before undertaking specific trips or for carrying particular types of freight. These fees are usually levied on the basis of vehicle weight, commodity type and area of operation. Most of these charges have, however, been abolished in recent years.

From 1979, fuel franchise fees have been introduced in all States except Queensland, to replace road maintenance charges which were abolished that year. The licence fees are levied on wholesalers and retailers of petroleum products and involve both fixed fees and fees based on either quantity or value of petroleum products sold. In most States higher fees apply to automotive distillate than to motor spirit. Current rates of charge levied under the various State fuel franchise schemes are outlined in Table 6.2.

Not all of the revenue raised from these charges is hypothecated to road expenditure, although the bulk of the revenue is actually allocated to road works after the deduction of collection costs. Registration charges are hypothecated but in most States drivers' licence fees are not. Drivers' licence fees in some States are hypothecated to other purposes, for example, accident compensation.

The fuel franchise fees are generally not formally hypothecated but in practice are largely allocated to road works. The single major exception is in New South Wales where revenue from the fees on motor spirit are paid into the Consolidated Fund while revenue from automotive distillate is allocated to road works. On the other hand,

TABLE 6.2-COMPARISON OF STATE BUSINESS FUEL FRANCHISE FEES, JUNE 1985
*(cents per litre)*[a]

| State | *Motor spirit* | | *Automotive distillate* |
|---|---|---|---|
| | *Super* | *Standard* | |
| New South Wales | 3.53 | 3.45 | 3.57 |
| Victoria | 3.88 | 3.76 | 5.59 |
| South Australia | 2.51 | 2.51 | 3.49 |
| Western Australia | 2.17 | 2.17 | 3.95 |
| Tasmania | 3.15 | 3.15 | 3.13 |

a. Calculations for *ad valorem* rates based on capital city wholesale prices (all States except Western Australia, which has fixed fees per litre).

*Source:* Prices Surveillance Authority (1985).

a large amount of loan funds are used to finance road works in New South Wales, unlike in other States.

Table 6.3 compares the level of revenue derived from the imposition of the various Commonwealth and State government charges associated with road use.

### The local government role

The only local government road user charges are parking fines and associated charges. Road expenditure by local governments from their own sources is largely financed from general budget receipts which include rates, loans and grants from the Commonwealth and State governments.

The remainder of this chapter examines the efficacy of only Commonwealth and State government charges on road use because of the relative insignificance of local government road user charges.

## AUSTRALIAN COST ALLOCATION STUDIES

A number of studies have been undertaken in Australia which have sought to identify the cost responsibility of different types of vehicles and compare this level of responsibility with associated user charge payments. The techniques employed in these studies are not similar although they all point to some form of deficiency with the current structure of road user charges.

**Bland Inquiry**

One of the earliest studies undertaken in Australia which investigated the relationship between cost responsibility and road taxation levels was the Bland Inquiry Report released in 1972. The Inquiry reported to the Victorian Government on the performance and cost of road and rail transport in the State. The relative cost responsibilities of various classes of vehicles for road construction and maintenance were assessed as a part of the Report.

The analysis used was an equity approach, specifically, the 'user pays' or 'cost occasioned' method, with road costs being allocated between different types of vehicles on the basis of incremental methodology. This in turn was based on the incremental method used by the US Department of Transportation, which made use of the fourth power rule in attributing costs between different vehicle classes.

TABLE 6.3-COMPARISON OF REVENUES DERIVED FROM THE PURCHASE AND USE OF ROAD VEHICLES, 1982-83

*($ million)*

| *Road user charges* | *Amount* |
|---|---|
| Commonwealth charges[a] | |
| Motor spirit and diesel excise | 1 065 |
| ABRD levy | 171 |
| Motor vehicle sales tax | 756 |
| Sales tax on motor vehicle tyres and parts | 308 |
| Customs duties on vehicles and parts | 229 |
| Total | 2 529 |
| State charges | |
| Business fuel franchise fees | 334 |
| Motor vehicle registration fees and taxes | 778 |
| Drivers' licence fees | 117 |
| Road transport taxes | 9 |
| Stamp duties | 233 |
| Total | 1 471 |
| Total | 4 000 |

a. Excludes taxes on petroleum production.

*Source:* ABS (1984a, 1984b). BTE (1985). DoTA (1983). NCA (1984). NRFII (1984).

Using this methodology costs were divided into increments required by vehicles possessing different characteristics. The allocation methodology adopted in the Bland Report is summarised in Table 6.4.

The approach adopted was to calculate the costs attributable to different vehicle classes, with capital costs being treated as construction costs. The 1969-70 Victorian State highways allocations of the Country Roads Board (for 110 road projects) were used to classify expenditures into cost items. This represented approximately 15 per cent of total road construction costs in Victoria for that year. However, because of data constraints, it was assumed that the cost structure of the State highways was representative of all construction expenditure.

Three alternative criteria were adopted for assigning pavement, shoulder, seal and surface construction costs between vehicle classes. These criteria were:

- ton-miles incrementally for these four costs;
- axle-miles incrementally for these four costs; and

TABLE 6.4-ALLOCATION METHODOLOGY ADOPTED IN THE BLAND REPORT

| *Cost category* | *Allocation methodology* |
|---|---|
| Construction | |
| Land acquisition, right of way, earthworks and drainage | VMT weighted by PCU |
| Bridges | VMT applied incrementally |
| Pavement and shoulders: cars | Ton-miles applied incrementally |
| Pavement and shoulders: trucks | VMT weighted by PCU applied incrementally |
| Other expenditure | VMT |
| Maintenance | |
| Pavement and shoulder | Ton-miles applied incrementally |
| Roadside, landscape, trees, bridge and culvert maintenance | VMT |

Note: 1. VMT - Vehicle Miles Travelled
2. PCU - Passenger Car Units

*Source:* Bland (1972) Appendix XVI, Table 6, p. 195.

. ton-miles incrementally for increasing depths of pavements and shoulders with constant pavement width as required for cars; passenger car unit miles incrementally for increasing widths of pavement, shoulders, seal and surface.

Table 6.5 provides details on the allocation of costs between different vehicle classes that results from the adoption of the last criterion. The results of using the other two criteria are produced in the Report but are not presented in as much detail.

The results from adopting the third allocation criterion indicated that the total cost responsibility of passenger and freight vehicles was approximately the same, in terms of both construction and maintenance expenditure. It was found that passenger vehicles were responsible for approximately 51 per cent of total road costs, while trucks of varying weight were responsible for approximately 44 per cent of total costs.

However, the distribution of costs within these vehicle classes was not uniform. Trucks of more than four tons carrying capacity, although representing only a small percentage of all trucks, accounted for by far the largest proportion of total road costs of trucks of all weights. Forty one per cent of total road construction costs and 35 per cent of total road maintenance costs were found to be attributable to this class of vehicle.

Revenue contributions for heavy vehicles of greater than four tons carrying capacity were calculated at $37.9 million, of which $14.1 million was hypothecated to road expenditure. The proportion of construction and maintenance costs attributable to these vehicles was calculated at $56 million. This represents a revenue shortfall of 32 per cent or, in the case of hypothecated revenue, 75 per cent.

Given the assumptions made in the Bland report concerning the number of trucks in the vehicle fleet and vehicle miles travelled, Robinson and Rattray (1982) calculated that heavy vehicles with a carrying capacity greater than four tons were responsible for costs amounting to 0.52 cents per tonne-kilometre. In comparison, revenue contributions were estimated at 0.19 cents per tonne-kilometre. This represents a rate of recovery of costs of 36 per cent. General taxation revenue was not included in total revenue estimates.

The methodology adopted in the Bland Inquiry Report to allocate costs among vehicle classes has been subject to some criticism (see for

TABLE 6.5-ALLOCATION OF CONSTRUCTION AND MAINTENANCE COSTS BETWEEN VEHICLE CLASSES, 1969-70

| | *Construction cost* | | *Maintenance cost* | | *Total* | |
|---|---|---|---|---|---|---|
| *Vehicle class* | *$ million* | *per cent* | *$ million* | *per cent* | *$ million* | *per cent* |
| Cars, station wagons, utilities and panel vans | 7.333 | 49.1 | 2.594 | 56.1 | 9.927 | 50.8 |
| Trucks up to two tons carrying capacity | 0.289 | 1.9 | 0.109 | 2.3 | 0.398 | 2.0 |
| Trucks from two tons to four tons carrying capacity | 0.426 | 2.9 | 0.130 | 2.8 | 0.556 | 2.8 |
| Trucks greater than four tons carrying capacity | 6.121 | 41.1 | 1.626 | 35.2 | 7.747 | 39.6 |
| Buses | 0.743 | 5.0 | 0.168 | 3.6 | 0.911 | 4.7 |
| Total | 14.912 | 100.0 | 4.627 | 100.0 | 19.539 | 100.0 |

Note: Figures may not add to totals due to rounding.

*Source:* Bland (1972, pp. 201 and 203).

example Kolsen, Ferguson and Docwra 1975). One of the criticisms was that an equity or cost occasioned approach was used and not a marginal cost-efficiency approach. The accuracy of the data used by Bland has also been questioned on the grounds that they may only have been representative of one particular year and, as such, the results may not be universally applicable. Furthermore, the data were based solely on State highways which only amounted to a small proportion of total construction and maintenance expenditure within the State for the year examined. The estimates of the relative cost responsibilities of different types of vehicles may therefore be conservative.

**Separable pavement costs estimates prepared by Pittard, Webber and Both**

In 1977 a further study of separable pavement costs was undertaken by Pittard, Webber and Both at the request of a subcommittee of the Australian Transport Advisory Council (ATAC). Results of the Study were reported in a paper presented at the 1978 proceedings of the Annual Conference of the Australian Road Research Board (ARRB) (Webber, Both and Ker 1978).

The ARRB paper presented estimates of the level of separable pavement costs attributable to heavy vehicles using the results obtained in the Economics of Road Vehicle Limits (ERVL) Study undertaken by the National Association of Australian State Road Authorities (NAASRA), published the previous year. Table 6.6 provides details of this work.

Avoidable pavement costs for the Australian arterial road system were evaluated at $224 million (1976-77 prices). Three axle rigid trucks were responsible for the lowest avoidable pavement cost levels in terms of cost per tonne-kilometre. Six axle articulated trucks incurred the highest level of avoidable pavement cost. In general, the cost responsiblities of rigid trucks and articulated trucks were assessed at 0.22 and 0.3 cents per tonne-kilometre respectively (1976-77 prices).

In comparison, road maintenance charges for that year were assessed by Webber, Both and Ker to be about 0.17 cents per tonne-kilometre. Robinson and Rattray (1982, p. 216) have also estimated that revenue collections from the imposition of fuel excises, plus road maintenance charges, amounted to $176 million. This is equivalent to a relative contribution from rigid and articulated trucks of 0.23 and 0.28 cents per tonne-kilometre respectively.

These cost and revenue figures indicate that revenue contributions of heavy articulated vehicles were below the level that would recover avoidable pavement costs incurred through the use of the arterial road system. Revenue collected would not, therefore, provide any contribution towards the recovery of common costs.

In addition, the costs measured in the work by Webber, Both and Ker (1978) were only for pavement costs and thus a number of other separable and avoidable costs were excluded from the cost recovery comparisons. For example, no allowance was made for the fact that the provision of additional road lanes is dependent upon the proportion of heavy vehicles within the total vehicle fleet. As well, the additional cost of bridge structures due to commercial vehicle design loads, including the replacement of structures which are adequate for light vehicles, had been ignored. Finally, externalities in the form of pollution, congestion, noise, and accident factors had not been taken into account.

**McDonell Report**

In 1978 a Commission of Enquiry was established in New South Wales to examine aspects of the road freight industry in the State. As part of

TABLE 6.6-AVOIDABLE PAVEMENT COSTS FOR ARTERIAL ROADS; 1975-76, CALCULATED BY WEBBER, BOTH AND KER (1976-77 PRICES)

| *Vehicle type* | *Annual truck travel (million kilometres)* | *Annual change in pavement costs ($m)* | *Avoidable pavement costs (cents per vehicle km)* | *(cents per tonne-km)* |
|---|---|---|---|---|
| 2 axle rigid | 4 331 | 81 | 1.9 | 0.23 |
| 3 axle rigid | 882 | 23 | 2.6 | 0.22 |
| 4 axle rigid | 236 | 8 | 3.6 | 0.25 |
| 3 axle articulated | 410 | 16 | 4.0 | 0.30 |
| 4 axle articulated | 777 | 40 | 5.2 | 0.30 |
| 5 axle articulated | 690 | 42 | 6.0 | 0.30 |
| 6 axle articulated | 183 | 14 | 7.5 | 0.35 |
| Total | 7 509 | 224 | | |

Note: Excludes the Northern Territory.

*Source:* Webber, Both and Ker (1978, p. 304).

its work, the Commission examined the cost responsibility and revenue contributions of road freight vehicles in New South Wales.

Costs were allocated among vehicle classes, as in the Bland Report, by using an incremental cost methodology. It was assumed that the costs incurred in a particular year were those associated with maintaining the road system to existing standards (McDonell 1980, p. 3/10). Data from the ERVL study were used.

Revenue estimates included sales taxes, customs duties, motor vehicle taxes, motor vehicle registration charges, fuel taxes and road maintenance charges. Estimates did not include taxes such as income, corporate and payroll taxes. Cost components were divided into separable pavement costs, other separable costs and common costs.

Two estimates of separable costs were calculated. These estimates were based on different vehicle distance information obtained from the Australian Bureau of Statistics' (ABS) 1976 Motor Vehicle Usage Survey and from ERVLS. There was some concern that the ABS data had under-estimated distances travelled for heavy vehicles. The results of the cost analysis undertaken in the McDonnell Report are summarised in Table 6.7.

These data indicate a significant level of under-recovery of costs from heavy vehicles. For all trucks, total revenues collected amounted to approximately 70 to 80 per cent of total costs incurred. However, a greater disparity between cost responsibility and road user charge payments existed when different types of vehicles within this class were considered.

The McDonell Report found that revenue contributions exceeded cost for rigid trucks with a carrying capacity less than 4.1 tonnes. However, revenue collections fell substantially short of total costs for rigid trucks of greater than 4.1 tonnes carrying capacity and articulated trucks. It was suggested in McDonell's Report that the cost estimates presented may have been conservative. Therefore the level of under-recovery of costs indicated by the data in Table 6.7 may, in fact, have been greater.

**Transport Economics Centre study**

In 1981 the Transport Economics Centre (TEC) of the University of Tasmania reported the findings of a study on road pricing in Tasmania. The study was concerned, first, with determining the level of marginal cost each vehicle imposed on the Tasmanian road system,

and second, with allocating the balance of all Tasmanian road system costs on the inverse price elasticity principle. This study was the first major Australian work to be concerned with determining the

TABLE 6.7-ROAD COSTS AND REVENUES CALCULATED BY THE McDONELL INQUIRY, 1977-78

| Costs/revenues | Rigid trucks: less than 4.1 tonnes carrying capacity | Rigid trucks: greater than 4.1 tonnes carrying capacity | Articulated trucks | Total trucks |
|---|---|---|---|---|
| ABS | | | | |
| Costs | | | | |
| Separable costs | | | | |
| Pavement | 1.9 | 18.5 | 36.8 | 57.2 |
| Other | 13.6 | 32.4 | 15.2 | 61.2 |
| Common costs | 29.2 | 26.9 | 31.5 | 87.6 |
| Total costs | 44.7 | 77.8 | 83.5 | 206.0 |
| Revenues | | | | |
| Variable | 15.1 | 25.3 | 34.2 | 74.6 |
| Fixed | 38.8 | 36.1 | 21.3 | 96.2 |
| Total revenues | 53.9 | 61.4 | 55.6 | 170.8 |
| EVRLS | | | | |
| Costs | | | | |
| Separable costs | | | | |
| Pavement | 1.9 | 34.9 | 52.6 | 89.4 |
| Other | 13.6 | 32.4 | 15.2 | 61.2 |
| Common costs | 25.9 | 45.4 | 40.0 | 111.3 |
| Total costs | 41.3 | 112.7 | 107.8 | 261.9 |
| Revenues | | | | |
| Variable | 15.1 | 37.8 | 46.0 | 98.9 |
| Fixed | 38.8 | 36.1 | 21.3 | 96.2 |
| Total revenues | 53.9 | 73.9 | 67.3 | 195.1 |

Note: Figures may not add to totals due to rounding.

*Source:* McDonell (1980, p. 3/16).

actual level of road prices to achieve full cost recovery in the most economically efficient manner.

The study used an econometric approach to determine the total level of avoidable costs attributable to road users. Regression equations were developed to determine the effect of different causal variables on three categories of road expenditure. These expenditure items were:

- routine seal maintenance
- pavement thickness
- pavement width.

The last two categories were used as proxy measures for long-run construction and/or reconstruction activities. The regression analysis was used primarily to determine the effect of the volume of heavy vehicle traffic on each of these cost categories, although 11 other causal variables were also considered.

Table 6.8 presents the conclusions reached in the study concerning the level of short-run and long-run pavement costs due to heavy vehicle usage.

The total amount of each of these three marginal costs was attributed to specific vehicle classes in different ways.

The marginal seal maintenance and marginal pavement thickness costs were attributed to heavy vehicle classes on the basis of relative destructiveness as established by the AASHO road tests conducted in the United States during the 1960s. The relationship between relative destructiveness of various wheel and axle configurations and road

TABLE 6.8-SHORT-RUN AND LONG-RUN PAVEMENT COSTS PER HEAVY VEHICLE KILOMETRE, 1979-80

*(cents)*

| *Cost item* | *Cost responsibility* |
|---|---|
| Marginal seal maintenance cost | 0.370 |
| Marginal pavement thickness cost | 0.447 |
| Marginal pavement width cost | 0.595 |
| Total marginal pavement cost | 1.412 |

*Source:* TEC (1981, p. 35).

distributions were those summarised in the ERVLS Report. The marginal pavement width costs, however, were allocated among heavy vehicle classes on the basis of vehicle weight, using weight as a proxy for size. The results of this allocation process are presented in Table 6.9.

Total charges calculated using the marginal pavement costs for all vehicles would have amounted to approximately $3.3 million in 1980, or less than 10 per cent of Tasmania's annual road budget.

The majority of Tasmanian road system costs were not attributable to any specific vehicle class. It was argued that if all costs were to be recovered, the loss of economic efficiency would be least if the balance of the charge required to cover total road costs was based on demand for road use (see discussion in Chapter 2).

This Ramsey pricing approach requires estimates of the elasticity of demand for the various road users. The study used -0.33 as the long-run price elasticity of demand for car use and -0.13 as the long-run price elasticity of demand for truck use. These values were based on previous estimates of the demand and supply elasticities for commodities carried by freight vehicles, demand for car use and demand

TABLE 6.9-ALLOCATION OF MARGINAL PAVEMENT COSTS AMONG HEAVY VEHICLES, 1979-80

*(cents per heavy vehicle kilometre)*

| *Vehicle type* | *Cost responsibility* |
|---|---|
| Rigid 2-axle, average laden mass 4.5 tonnes (4 to 7 tonnes GVM) | 0.145 |
| Rigid 2-axle, average laden mass 9.7 tonnes (over 7 tonnes GVM) | 0.583 |
| Rigid 3-axle with tandem axles | 1.282 |
| Articulated 3-axle | 1.983 |
| Articulated 4-axle with tandem axles | 2.149 |
| Articulated 5-axle timber jinkers with tandem axles | 2.811 |
| Articulated 5-axle with tandem axles - other than timber jinkers | 2.461 |
| Traffic weighted mean | 1.412 |

Note: GVM = Gross Vehicle Mass

*Source:* TEC (1981, p. 40).

for petrol from various studies in Australia and overseas. Where elasticity estimates were uncertain, the values chosen were such that the costs to be allocated to heavy vehicles were minimised. This produced a result which favoured heavy vehicles.

It was shown that even with these conservative estimates most of the costs allocated to heavy vehicles were not recovered. Table 6.10 shows that rigid 2-axle trucks of four to seven tonnes GVM recovered approximately three times fully allocated costs while the heaviest vehicles, articulated 5-axle trucks, recovered only about one-fifth to one-quarter of fully allocated costs.

TABLE 6.10-COMPARISON OF TASMANIAN ROAD COSTS, REVENUES AND RATES OF COST RECOVERY, 1979-80

| *Vehicle type* | *Fuel and motor taxes (cents/km)* | *Fully allocated costs (cents/km)* | *Cost recovery ratio* |
|---|---|---|---|
| Rigid 2-axle, average laden mass 4.5 tonnes (4 to 7 tonnes GVM) | 2.99 | 1.00 | 2.99 |
| Rigid 2-axle, average laden mass 9.7 tonnes (over 7 tonnes GVM) | 3.87 | 4.03 | 0.96 |
| Rigid 3-axle with tandem axles | 3.94 | 8.86 | 0.44 |
| Articulated 3-axle | 3.98 | 13.70 | 0.29 |
| Articulated 4-axle with tandem axles | 4.12 | 14.85 | 0.28 |
| Articulated 5-axle timber jinkers with tandem axles | 4.17 | 19.42 | 0.21 |
| Articulated 5-axle with tandem axles (other than timber jinkers) | 4.17 | 17.01 | 0.25 |

*Source:* TEC (1981, p. 62).

The determination of marginal costs using regression analysis contrasts with the physical measurement techniques used in the AASHO tests but produced similar overall results. The AASHO study results were used, as noted above, for allocating these costs among road users. The uniqueness of the TEC study is its use of the economic efficiency approach to allocate road costs above marginal costs. The results produced are similar to those obtained from the arbitrary allocations in earlier Australian and overseas studies and tend to confirm that heavy vehicles are substantially under-recovering fully allocated costs compared with light vehicles and cars.

There are a number of concerns about the approach used by the TEC, particularly with the estimates of elasticity of demand. Sensitivity analysis conducted by the BTE shows that the degree of over- or under-recovery from a particular market sector is very sensitive to the choice of elasticity value, the more so the closer the elasticity is to zero. There are wide variations in the elasticity values produced in various studies, including those referenced in the TEC report. However, the actual application of Ramsey pricing principles will always involve some uncertainty in this area because of the difficulties in deriving robust elasticity values.

**National Road Freight Industry Inquiry**

In September 1983, the Federal Minister for Transport announced terms of reference for a National Road Freight Industry Inquiry (NRFII). The Inquiry presented its report in late 1984. As part of this Inquiry the cost responsibility and user charge payments of different classes of road users were investigated. The results presented drew on work undertaken for the Inquiry by Nicholas Clark and Associates (NCA). This work only considered arterial roads (including National Highways) and six different classes of vehicles were identified. These classes are outlined in Table 6.11. For cost allocation purposes, these classes were, however, further disaggregated (NCA 1984, pp. 146-148).

In many respects, the approach adopted in the NRFII Report is similar to that taken in the TEC Study. The main similarity is that an efficency approach to allocating costs was adopted, with costs being allocated among vehicles in the following manner. Avoidable costs for each class of vehicle and common and joint costs were identified. Avoidable costs for trucks were allocated on the basis of vehicle-kilometres weighted by the number of equivalent standard axles (calculated approximately on the basis of the fourth power rule). Passenger car avoidable costs, however, were allocated among cars and

TABLE 6.11-DEFINITION OF VEHICLE CLASSES USED BY NATIONAL ROAD FREIGHT INDUSTRY INQUIRY

| *Vehicle class* | *Class definition* | *Vehicle weight (gross)* |
|---|---|---|
| Cars and station wagons | Vehicles registered | Less than 2 tonnes |
| Utilities and panel vans | Vehicles registered | Less than 2 tonnes |
| Trucks | | |
| Light rigid | Less than 2 tonnes tare | Less than 7 tonnes |
| Medium rigid | Between 3 and 4 tonnes tare | 7 to 10 tonnes |
| Heavy rigid | 4 tonnes tare and greater | Over 10 tonnes |
| Articulated | All articulated trucks | - |

*Source:* NRFII (1984, p. 418).

station wagons and utilities and panel vans on the basis of vehicle-kilometres. To satisfy efficiency criteria, joint costs were allocated among vehicles on the basis of the inverse of the price elasticity of demand applied in tonne-kilometres and passenger-kilometres (NRFII 1984, p. 423). Demand elasticities of -0.1 for trucks and -0.3 for cars were assumed. The major departure from the TEC methodology was that all common costs were allocated on the basis of vehicle kilometres, weighted by passenger car unit (PCU) equivalents (which account for vehicle size). This is also a departure from traditional micro-economic theory which, as noted in Chapter 2, requires that all costs above marginal cost be allocated according to Ramsey pricing rules if the loss of efficiency is to be minimised.

Revenue estimates included excise taxes on fuel (both Commonwealth and State government excises), motor vehicle registration fees, drivers' licence fees and sales taxes and customs duties levied on new motor vehicles and parts and accessories. As noted above, sales taxes and customs duties are not usually considered to be road user charges but are regarded as general taxation measures.

Summarised in Table 6.12 are the average allocated costs on all arterial roads and average user charge payments for each class of vehicle presented in the NRFII report.

The NRFII report reached similar conclusions to previous studies regarding the overpayment of costs by operators of cars, station wagons, utilities, panel vans and light and medium rigid trucks and underpayment by operators of articulated trucks (by about 35 per cent).

TABLE 6.12-AVERAGE ALLOCATED COSTS AND AVERAGE USER CHARGE PAYMENTS; AUSTRALIA, 1981-82

*($A)*

| *Vehicle class* | *Average allocated costs per vehicle* | *Average user charge payments per vehicle*[a] |
|---|---|---|
| Cars and station wagons | 92 | 340 |
| Utilities and panel vans | 94 | 404 |
| Trucks | | |
| Light rigid | 153 | 645 |
| Medium rigid | 250 | 971 |
| Heavy rigid | 1 226 | 1 323 |
| Articulated | 8 276 | 5 383 |

a. The NRFII revenue estimates include sales tax and customs duties levied on new motor vehicles, parts and accessories. These revenue sources are often regarded as general taxation measures rather than road user charges.

*Source:* NRFII (1984, p. 231).

## CONCLUDING COMMENTS

The cost allocation studies that have been undertaken in Australia have all indicated that heavy vehicles under-pay in relation to the costs that they impose upon the road system. The distribution of the taxation burden among vehicles of different types does not accurately reflect cost responsibility, with some vehicle classes contributing less than the avoidable cost associated with their use of the road system.

In these circumstances, the current road pricing system does not promote either economic efficiency or the usual equity objectives. The main reason for this is the heavy reliance on fuel excise to collect revenue from road users.

It might be argued that the current system raises sufficient revenue to recover the total costs attributable to all road users. However,

the results of various studies suggest that economic efficiency and equity could be improved if charges better reflected actual costs associated with road use. This would encourage the use of vehicles of an appropriate size and axle configuration.

An assessment of the current Australian road pricing mechanisms and options for change are presented in the next chapter.

## CHAPTER 7-OPTIONS FOR CHANGE TO THE AUSTRALIAN ROAD PRICING SYSTEM

It is evident from the discussion in Chapter 6 that deficiencies exist within the current Australian road user charges structure. Consideration is given in this chapter to the feasibility of making changes to this structure which might encourage improvements in terms of the satisfaction of the pricing criteria (efficiency, equity and cost recovery) outlined in Chapter 2.

Evaluation criteria need to be specified to assess possible changes to the pricing system. These criteria could include:

- efficiency
- equity
- cost recovery
- practical implementation
- evasion and enforcement
- Commonwealth-State relations.

However, in making any assessment there should be an awareness of constraints which may prevent the full satisfaction of one or more of the criterion. Possible constraints to improvement are discussed in the next section.

### CONSTRAINTS TO IMPROVEMENT

The difficulties associated with a systematic rearrangement of road user charges can be classified into four groups:

- constitutional
- intergovernmental relations
- road user reactions
- administrative considerations.

The first three of these are discussed briefly below. The fourth is

discussed in considering the merits of existing charges in the following section.

**Section 92 of the Australian Constitution**

One constraining influence on road pricing is Section 92 of the Australian Constitution which states:

> On the imposition of uniform duties and customs, trade, commerce and intercourse among the States, whether by means of internal carriage or ocean navigation, shall be absolutely free.

The High Court's interpretation of Section 92 has, in the past, placed a constraint on the nature of charges which can be imposed on interstate road freight operations. The basis for this interpretation is the decision upheld in *Hughes and Vale Pty Ltd v. NSW (No.2)* (1955) 93 CLR 127.

At the time of this case the New South Wales Government had intended to introduce a system of licences applicable to interstate road transport. The issue of concern in the *Hughes and Vale* case was the validity of these charges. The general principle which arose from the court's decision was that charges could only be validly imposed if they were reasonably related to road user costs (McDonell 1980, vol. VI p. AN 6/9). However, this was interpreted as including only charges that would recover road maintenance costs and does not extend to charges to recover capital costs.

It is not certain that the High Court would still hold this view if it were presented with the same case today. Advice provided by the Attorney General's Department to the National Road Freight Industry Inquiry indicated that the state of law on this matter was not clear and that a possibility exists that previous decisions could be overturned (NRFII 1984, p. 74). The only way that this matter will be resolved is if a similar case is brought before the High Court and there is a new ruling on which road user costs can be regarded as constitutionally valid.

**Intergovermental co-operation**

It has been argued that significant changes to the current charging system would require a large degree of intergovernmental co-operation (for example, see Starkie, Grenning and Starrs 1982, pp. 84-86). It would be necessary for the Commonwealth Government to be convinced of

the need for change as it alone is responsible for the control of interstate road transport. Furthermore, to ensure consistent application of charges there would need to be agreement between the various State governments and the Commonwealth Government on the revised method of charging.

The National Road Freight Industry Inquiry considered that impediments to road cost recovery might be removed if co-operation between the Commonwealth Government and the various State governments could be achieved (NRFII 1984, p. 74).

### Road users' reactions

A third possible constraint is the reaction of road users to the imposition of particular road user charges. Increased prices for some segments of the road transport market could be expected to be strongly resisted. There may also be political implications associated with a government imposing additional charges to those currently in force.

It should be noted that the charging structure could be changed without increasing the net revenue collected. The available evidence suggests that improvements in efficiency and equity can be achieved by a restructuring of charges, so that different classes of road users are confronted more closely with the costs that they as individuals impose upon the road system. The level of total cost recovery can be dealt with separately.

## ASSESSMENT OF EXISTING ROAD USER CHARGES

Each of the existing road user charges can be assessed against the evaluation criteria specified earlier. This task is simplified here by identifying those charges which are most likely to satisfy the efficiency, equity and cost recovery criteria and then assessing how the best charges might perform from the stand points of practicality, scope for evasion and Commonwealth-State relations.

The discussion in Chapter 2 indicates that fixed charges are not very suitable for the recovery of avoidable costs. Economic efficiency considerations require that users be confronted as closely as possible with the cost of each decision to use the road. Therefore, variable charges, those related to actual road use, are preferable to fixed costs where it is desired to recover avoidable costs in an efficient manner. Of the various charges discussed so far, weight-distance taxes, fuel taxes and congestion taxes have the best potential for recovering avoidable costs while meeting strict efficiency criteria.

As far as cost recovery above avoidable cost levels is concerned, it was noted in Chapter 2 that economic efficiency requires that this additional revenue is collected in a way that creates the least distortions in demand patterns. The distortions created by a particular charge can generally be reduced by relating the amount charged to the inverse elasticity of demand (Ramsey pricing). In practice, there are few charges that can be adjusted to properly reflect demand elasticities. The most likely candidate is a fixed annual charge such as for vehicle registration. Fuel taxes offer only limited scope through a differentiated tax between motor spirit and automotive distillate. However, *a priori*, it is not clear whether a registration charge, properly adjusted to reflect demand elasticities, would create more or less distortions to demand patterns than a fuel excise tax.

To evaluate charges that would satisfy equity requirements, it is first necessary to specify which particular equity criteria are sought. For example, fixed and variable charges can both be used to achieve different equity effects in a user pays or cost occasioned approach. On the other hand, equity could be so broadly defined that charges such as income taxation could be considered.

The major charges assessed in this Paper are:

- weight-distance taxes
- fuel taxation
- registration taxes.

A number of other types of charges are examined briefly and congestion taxes are discussed in a separate section at the conclusion of the chapter.

**Weight-distance taxes**

It was noted briefly in Chapter 2 that one of the main components of the avoidable cost of road use is pavement damage. Studies in the United States and elsewhere have concluded that the main factor influencing pavement damage is vehicle axle load. Thus any charge seeking to recover avoidable costs should take vehicle axle weights into account. A specific charge related to the axle weights of individual vehicles and distance travelled is likely to be the best method for recovering avoidable costs.

The prime example of weight-distance taxation is that employed in the New Zealand road pricing scheme (which was discussed in Chapter 4).

The central element of this scheme is the compulsory use of hubodometers, which enables distance travelled to be measured and hence provides a basis for charging for actual road costs incurred.

While the United States heavy vehicle tax, discussed in Chapter 3, is based on vehicle weight and distance travelled, it is nevertheless a fixed annual tax. Accordingly, its use may not result in avoidable costs being recovered in the most efficient manner.

The chief advantage of the US type of heavy vehicle tax is in meeting prescribed equity objectives based on the cost occasioned approach. It also has the administrative advantages of a fixed annual charge over variable charges.

A variant of the United States heavy vehicle tax has been proposed recently for Australia. This involves the imposition of a registration fee on vehicles engaged in interstate trade and commerce[1]. These vehicles currently pay only a nominal State registration charge, full registration charges being considered as contravening Section 92 of the Constitution. As noted in Chapter 6, recent legal opinion suggests that a Commonwealth charge might survive a possible challenge in the High Court. In terms of efficiency and equity considerations, the impact of the registration fee would be similar to the US heavy vehicle tax.

A possible variant of such a tax which may improve the efficiency aspects would be to provide for rebates where users fitted hubodometers to their vehicles and demonstrated that they travelled less than a given annual distance. The higher the set distance (and fee), the greater the incentive for heavy vehicle operators to fit the hubodometers and the lower the potential loss in efficiency. However, any gains may be offset to some extent by an increase in administrative costs for both operators and the government.

Australia did have weight-distance taxes prior to July 1979, in the form of State road maintenance charges. The main reasons for their abolition were avoidance and evasion of the charges and the administrative costs of collection. Avoidance was largely practised

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1. This proposal was contained in the recommendations of the National Road Freight Industry Inquiry Report (for example p. 251). The introduction of a registation fee on vehicles engaged in interstate trade and commerce has been foreshadowed by the Commonwealth Minister for Transport but no specific details had been announced at the time this Paper was printed.

through the use of 'straw' companies located in South Australia. These were companies with a low paid up capital (for example, only two dollars). When operators from these companies were prosecuted for failing to pay the road maintenance charges only the paid up capital could be legally recovered. Evasion was primarily a consequence of the reliance on drivers to fill in log books honestly with relatively little policing. As well, the avoidance practices of some operators encouraged others to simply not pay the charges. The administrative costs were relatively high; up to 30 per cent of total revenue collections. However, this was in part the result of failure to raise the charges for many years. By 1979 most estimates indicated that road maintenance charges were well below the level of avoidable cost (for example, Webber, Both and Ker 1978).

The New Zealand weight-distance tax does not appear to suffer avoidance and evasion problems to any large extent. Reliance on the use of hubodometers undoubtedly reduces evasion and there appears to be less scope in New Zealand for avoidance through the use of straw companies and related devices.

While it is not clear that the New Zealand charges are actually set with a view to maximising efficiency, their heavy vehicle tax certainly has the scope to achieve economic efficiency objectives. The reintroduction of a similar scheme in Australia appears, at least in theory, to offer the best chance of achieving efficiency objectives. The recovery of avoidable costs using a fixed annual charge, even with a rebate scheme, must be considered, ceteris paribus, as inferior to a weight-distance tax on efficiency grounds.

**Fuel taxation**

The current system of road user charges in Australia relies heavily on fuel taxation and this reliance has increased over the last six years.

Fuel taxation has attributes which mean that it can be used to either recover avoidable costs or as a Ramsey pricing charge to achieve a particular revenue-raising objective. In the former role a number of problems have been identified in earlier chapters. Most notably, fuel consumption does not vary sufficiently with vehicle weight for taxation receipts to accurately reflect avoidable road costs. This results in heavy vehicle road usage being undertaxed relative to that of lighter vehicles when fuel taxation is the major road user charge. This encourages heavy vehicle operators to over-use roads or other operators to under-utilise them. The imposition of fuel taxation may also result in a non-optimal change in fleet structure.

The use of fuel taxation as a means of raising revenue over and above avoidable costs has the advantage that such a tax may not greatly upset road user demand patterns because the demand for fuel is generally regarded as being fairly inelastic. However, adjustments to further minimise the efficiency loss from a fuel tax are difficult because of the problems of differentiating between user groups.

The chief attributes of fuel taxation as a road user charge are its ease of administration and the difficulty of evasion. All vehicle operators, including those of interstate vehicles, must pay a fuel tax unless special exemptions are provided. There is only limited scope to vary the rate of taxation on motor spirit and automotive distillate to achieve different revenue payments from the two user groups, although some States do impose different levels of tax. In addition, a rebate could be provided on diesel excise to operators of lighter trucks, although this would increase administrative costs. The scope for such differentiation is likely to be constrained by possible shifts from diesel to petrol engined vehicles. More importantly, heavy vehicles can cause many times the road damage of light vehicles, so the differentiation of taxes on petrol and distillate, aimed at recovering avoidable costs of heavy vehicles, is likely to be only partially successful.

**Registration fees**

Fixed charges such as registration fees, drivers' licence fees, stamp duties on vehicle registration and transfers and third party premiums are inferior mechanisms to weight-distance and fuel taxes for recovering avoidable costs in an economically efficient manner. Their chief role is in obtaining additional revenue to achieve specific cost recovery targets. Insofar as they are far removed from individual road use decisions, their impact on road usage should be small and thus these types of charges have the potential to raise revenue to recover total road costs without creating significant distortions in road usage patterns. Information about likely reactions is required to assess the relative merits of these charges, including their impact on vehicle ownership (and consequently road use).

It can be demonstrated that the loss of efficiency from the imposition of any charge designed to recover revenue over and above avoidable costs can generally be reduced by structuring the charge to reflect the different demand elasticities of different user groups. Registration fees, unlike charges such as sales tax, customs duty and stamp duties, can be more easily structured to reflect demand

elasticities. Such a system has been devised by Kolsen, Ferguson and Docwra (1975). They suggested a 'points' system of registration which determines charges on the basis of the value of the vehicle, performance, area of use and type of use. These variables were considered as proxies of demand elasticities.

Fixed charges such as registration fees can be excellent ways to achieve particular equity objectives. The United States heavy vehicle tax is an example. They are also usually simple to administer and in practice there is little evasion of these types of charges.

**Other charges**

Other charges which may be used as a means of recovering road costs include sales taxes and customs duties on new vehicles and parts and stamp duties. Taxation collections from these sources will, to some extent, reflect road usage insofar as vehicle components 'wear out' with vehicle use. However, sales taxes and stamp duties are not ideal charges for recovering avoidable costs since they are tied to other values, such as the price of vehicles and parts, which do not vary directly with road use. They also do not offer as much scope as other charges for manipulation to reflect the demand for road usage.

Clearly, sales taxes and stamp duty on vehicles will have some effect on vehicle choice, encouraging the retention of older vehicles and perhaps improving the utilisation of existing vehicles. These effects need to be considered when determining the advantages (if any) of these types of charges over other alternatives.

One possible road user charge which has received specific attention is a tyre tax, primarily because it would vary with road use. However, the link with road use may be somewhat tenuous. To some degree it would be perceived as a fixed tax since tyres are purchased irregularly. Administratively, such a scheme would be simple and inexpensive and would apply to both interstate and intrastate operators. However, as in the United States scheme, differential taxation rates would need to be applied to tyres of different sizes for effective cost recovery over the full range of vehicles.

The principal disadvantage of a tyre tax relates to safety, in that transport operators may be encouraged to retain tyres past their safe life. An equity problem may also be perceived because the road users who use roads which are in poorer condition may incur the highest levels of tyre tax because of low tyre life. However, avoidable cost may be higher for roads of poorer condition and so this result could

be both efficient and equitable. A further problem of tyre tax is that it may produce incentives for operators to limit the number of axles and tyres on their vehicles. This reaction would increase axle weight and therefore road damage. Furthermore, while there is some correlation between axle weight, tyre wear and road damage, the relationship may not be directly proportional and so it may be difficult to relate tyre taxation levels to avoidable cost.

## CONGESTION CHARGES

One aspect of road pricing is the concern with congestion costs. Congestion pricing schemes in Singapore and Hong Kong were examined in Chapter 5.

The merits of such schemes for Australia are not clear, particularly the Hong Kong scheme which is still in a pilot stage. There are obvious areas in Australian capital cities where congestion is a problem and in the absence of pricing schemes or some form of traffic limitation road congestion will continue. On the other hand, there is little evidence that congestion has become worse in recent years. Any decision to introduce congestion pricing schemes needs to be the result of a careful weighing of all the benefits and costs. The costs of implementing sophisticated schemes is likely to be high. It needs to be established that the benefits are also likely to be high.

The analysis in Chapter 5 indicates that the electronic road pricing scheme currently employed in Hong Kong offers some advantages, in terms of promoting economic efficiency, over the Singapore area licencing scheme. However, there exists some doubt as to the size of these additional benefits. If the additional benefits do not outweigh the additional costs, the Singapore scheme may prove to be a preferable alternative.

## OPTIONS

The options for improving road pricing in Australia are constrained by legal considerations as well as the perception of governments, Commonwealth and State, of the acceptability of alternative types of taxes.

It seems that the only way to make any major improvement to the existing Australian charging structure from an efficiency viewpoint is by introducing a weight-distance tax. This type of tax is, in theory, superior for efficiently recovering avoidable pavement costs, but the history of similar charges in Australia suggests that there can be

operational difficulties as well as political concerns with this type of tax. Nevertheless, the recent New Zealand experience indicates that many of these problems can be overcome and the tax used as the basis for an efficient road charging system.

The evidence about road damage and fuel consumption indicates that no matter how a fuel tax is structured (for example, petrol/diesel differentials, rebates and so on) all users cannot be charged close to avoidable road cost. The data suggest that for every possible structure there must be either over-recovery or under-recovery of avoidable costs from some road users, most likely to a very large degree.

Given a weight-distance tax for recovery of avoidable cost, there are a number of other charges which could be used, either singly or in combination, to achieve the desired cost recovery or revenue target. The choice of the best charge or combination of charges will depend on expected user reactions to different charges and on equity considerations. However, annual registration fees and fuel taxes would seem to be two of the best charges for collecting any additional revenue required from an efficiency viewpoint, although these two types of charges would have very different equity implications.

Private motorists would tend to be better off if the road pricing structure were changed to incorporate a weight-distance tax and there was less reliance on fuel taxation. This is because the contributions to revenue from heavy vehicles would be substantially increased.

In the absence of a weight-distance tax it is probably impossible to structure a pricing system to ensure all vehicle operators pay close to their avoidable costs. What is not clear is the likely loss of economic efficiency from alternative charges (for example a fixed annual charge). In theory a variable charge is preferable for recovering avoidable costs as a fixed charge could induce excessive use of the road system once it has been paid by operators. Whether this happens in practice and the extent of the resulting efficiency loss are difficult to predict in the absence of much more detailed knowledge of road user behaviour patterns.

Charges aimed at recovering costs above avoidable costs should ideally cause minimum impact on demand. However, it is unclear whether from an efficiency point of view a variable charge or a fixed charge is preferred. Equally, it is unclear as to whether the charge should be levied on price inelastic inputs close to the decision to use the road (for example fuel tax) or as far away as possible on a complement of

road use (for example vehicle sales tax). These issues require a great deal more examination than has occurred to date and are areas of further study for the BTE.

Should equity be the paramount objective there are also alternatives to the current structure which should be investigated. For example, it is possible to correct for the current inequities associated with the use of fuel taxation as the main source of revenue from road users. This could be achieved through the use of a graduated fixed tax such as the United States heavy vehicle tax and a corresponding reduction in the level of fuel taxes. Full consideration should be given to changes of this type if the charging structure derived using economic efficiency criteria is unacceptable from other viewpoints.

## CHAPTER 8-CONCLUDING COMMENTS

The main purpose of the work reported in this Paper has been to assess the structure of road user charges in Australia and to identify possible options for change which may lead to improvements in terms of the satisfaction of specific pricing objectives.

The approach taken has been to outline the theory of road pricing, describe the various principles which underly different pricing strategies, and examine how different pricing strategies have been implemented in practice in the United States, New Zealand, Singapore and Hong Kong.

Three basic pricing objectives can be identified from an examination of the theory of road pricing:

- economic efficiency
- equity
- cost recovery.

It is clear that in most cases a different strategy would need to be pursued to fully satisfy each of these objectives and that conflicts exist when an attempt is made to satisfy all objectives simultaneously using one strategy.

These conflicts are exemplified by the strategies followed in the United States, New Zealand and Singapore. In each of these countries elements of efficiency, equity and cost recovery are all built into the pricing system. However, not all are entirely satisfied. The one exception may be the congestion pricing scheme implemented in Hong Kong, which is focussed primarily on efficiency considerations.

The current road pricing scheme in Australia differs from the other schemes considered in this Paper in that no explicit pricing objective has been pursued. It has been argued (for example, NRFII 1984, p. 220) that the current pricing system raises sufficient revenue to cover the total costs attributable to all road users. However, under

the current system, operators of heavy vehicles may not be paying sufficient road user charges to cover their share of road costs. It appears that equity aspects could be improved if charges were restructured. There may also be efficiency gains through changes in the pricing system.

The major deficiencies which exist within the Austraian road pricing structure result from the reliance on fuel taxation as the principal charging mechanism. Improvements in terms of economic efficiency and equity require reduced emphasis on this component.

The analysis in the Paper indicates that a weight-distance charge has a number of advantages as a charging mechanism over fuel taxation and that a charge of this nature is required where efficiency and equity aspects are considered important.

The central problem with a weight-distance charge is the measurement of distance. Two approaches to solving this problem have been discussed:

- the use of metering devices with variable charges; and
- the adoption of fixed fees.

Variable charges such as road maintenance charges, which were employed in Australia up until June 1979, rely on the honesty of the transport operator in reporting distances travelled. These charges were abolished in Australia because of a number of problems, particularly with evasion and enforcement, and the high cost of collection.

Problems of evasion can largely be overcome by using meters to measure distances travelled by different vehicles. This is evidenced in New Zealand where meters are employed in conjunction with a strict regulatory framework.

In terms of administration requirements the use of metering devices can be complicated and costly. Fixed annual fees are much easier to administer. However, they involve a trade-off between achieving efficiency and equity goals and administrative simplicity.

A weight-distance tax need not take either of the forms discussed above. It is possible to devise pricing schemes which utilise elements of each method, for example, a heavy vehicle use tax with rebates for lower mileage road users who fit hubodometers.

There are a number of potential constraints that may affect the choice

of a particular type of charge. One particular problem is the acceptance on the part of road users. The history of road maintenance charges in Australia suggests that there may be some resistance to the re-introduction of weight-distance taxes. Alternatives such as the heavy vehicle use tax, which is used in the United States, may be more acceptable despite their theoretical deficiencies.

Another major problem relates to the provisions of Section 92 of the Constitution. As noted in Chapter 7, unless the High Court's current interpretation of this section is clarified and liberalised it is doubtful whether full cost recovery from interstate heavy vehicle operators can be achieved in an efficient manner.

There appears to be little in the way of improvements in efficiency and equity that could be achieved by restructuring current charges unless these constraints are overcome. For example, a restructuring of fuel taxes would not solve existing efficiency and equity problems.

The current system of charges may only be considered as being satisfactory from the point of view of total revenue raising. However, in accepting the current system, there should be an awareness of the possible losses involved and the likely consequences of distorting the competitive forces within the transport industry.

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## ABBREVIATIONS

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|---|---|
| AASHO | American Association of State Highway Officials |
| ABRD | Australian Bicentennial Roads Development |
| ABS | Australian Bureau of Statistics |
| ARRB | Australian Road Research Board |
| ATAC | Australian Transport Advisory Council |
| BTE | Bureau of Transport Economics |
| EEC | European Economic Community |
| ERVLS | Economics of Road Vehicle Limits Study |
| ESAL | Equivalent Standard Axle Load |
| FHWA | Federal Highway Administration |
| GVM | Gross Vehicle Mass |
| NAASRA | National Association of Australian State Road Authorities |
| NRB | National Roads Board |
| NRF | National Roads Fund |
| NRFII | National Road Freight Industry Inquiry |
| NZRTA | New Zealand Road Transport Association |
| OECD | Organisation for Economic Co-operation and Development |
| PCU | Passenger Car Units |

| | |
|---|---|
| STAA | Surface Transportation Assistance Act |
| SWATS | South Western Australian Transport Study |
| TEC | Transport Economics Centre |

Bureau of Transport Economics

Our Reference:

# REVIEW OF ROAD PRICING IN AUSTRALIA AND OVERSEAS

## Extended Summary - BTE Occasional Paper 73

The federal Bureau of Transport Economics (BTE) today released Occasional Paper 73. The Paper contains the result of a study of road pricing policies in Australia and a number of overseas countries (the United States of America, New Zealand, Hong Kong and Singapore). The Paper also examines the economic theory of road pricing.

Recent Australian studies have shown that private motorists have been paying a disproportionately large share of the revenue raised by governments from road users. This is primarily the result of the heavy reliance on fuel taxes as the basic charge for road usage. Fuel taxes do not reflect adequately the fact that heavy trucks cause far more damage to the roads than private cars.

In order to ensure that operators of heavy trucks do meet their share of road costs, the United States of America has recently introduced an annual heavy vehicle tax which is related to the weight of trucks. New Zealand has introduced a tax based on vehicle weight and distance travelled that relies on the use of distance measuring devices fitted to vehicle axles. In both countries the taxes are much larger for the heaviest trucks. In contrast, the equivalent Australian heavy vehicle taxes (called road maintenance charges) were abolished in 1979 because of problems with evasion, enforcement and high collection costs.

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The BTE Paper notes that a tax that would vary with load and distance may improve the economic efficiency of Australian road pricing arrangements. The experiences in the United States and New Zealand provide some ideas on the types of taxes which could be considered.

The Paper outlines various other refinements which could be introduced once the problem of pricing heavy vehicles is solved. Road congestion in large cities is one of the issues examined and the Paper reviews the experience with an electronic congestion taxing system in Hong Kong and an area permit system in Singapore. Although the Australian situation is not comparable with those of Hong Kong and Singapore, there may be benefits from introducing some form of congestion taxes in the large Australian capital cities.

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