Road User Charges: Theories and Possibilities

Occasional Paper

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BUREAU OF TRANSPORT ECONOMICS

ROAD USER CHARGES: THEORIES AND POSSIBILITIES

A Report Prepared for the

Bureau of Transport Economics by

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AUSTRALIAN GOVERNMENT PUBLISHING SERVICE

CANBERRA 1975

ISBN 0 642 01729 8

Printed by Watson Ferguson and Co., Brisbane

FOREWORD

Considerable disagreement exists on an appropriate system of road user charges and road investment policies. While some work in this important area of resource allocation has been done in other countries, until recently, little investigatory research has been carried out in Australia. The BTE has commenced a programme of research into road pricing and road investment policies in Australia.

As part of this research programme Professor H.M. Kolsen was invited to examine the theoretical possibilities. Messrs D.C. Ferguson and G.E. Docwra, members of Professor Kolsen's staff in the Department of Economics of the University of Queensland became part of the study team commissioned by the BTE to report on road pricing in the Australian context.

The study considers all roads other than access roads. The essential objective is to show up the deficiencies in the cost responsibility approach to road pricing by emphasising the joint cost characteristics of roads. The approach of the study team has been to derive a reasonable set of relative road pricing strategies, given the cost of supplying the road network, based on the demand characteristics of road users.

The implications for road investment policies of the use of a pricing policy based on the demand for roads, are brought out in the study by means of examples drawn from the situation in Queensland during 1972. The report is a valuable contribution to an understanding of the theoretical basis for setting road user charges in Australia. Use of data related to Queensland must be taken as no more than convenient examples, readily accessible to the authors and used to illustrate the practicability of their theoretical and pricing models.

J.H.E. Taplin
Director

Bureau of Transport Economics
Canberra
July 1975.

CONTENTS

CHAPTER 1 - INTRODUCTION

This study is concerned with the pricing of roads which provide intercommunity transport services. Where the dominant characteristic is access to property, other pricing policies can be adopted. To avoid the usual charge that all roads ultimately provide access, the possibility exists of dividing any particular piece of road between users; those for whom access is the dominant characteristic, and those who use it to get from one place to another. Costs can then be divided between these user classes in proportion to use. However, the classifications used by road suppliers, such as main roads, arterial roads, declared roads, suggest that a simple and ready distinction between local access and intercommunity roads is already in use.

The major aim is to show the deficiencies in present approaches to road pricing generally, and in the cost based models used to 'determine' the cost responsibility of particular user classes. Emphasis is given to the joint cost characteristics of roads, since these have been neglected by other writers in the field. It is the presence of joint costs which, inter alia, makes it possible to obtain a wide range of apparently reasonable sets of relative prices from engineering data, none of which can be unambiguously declared to be superior to the others. They represent the 'prices' which might be set (by engineers or anyone) for steak, liver, bones, etc., of a beef carcass when the only information relied upon is the cost of supply. Such prices would rapidly be proved wrong by the excess demand for steak and excess supply of liver which would develop. For roads, the lesson is not so easily learned, though the basic similarity remains. Our approach therefore takes demand characteristics explicitly, though imperfectly, into account.

OUTLINE OF STUDY

In Chapter 2, we draw attention to the reasons for much of the confusion in the literature on road price, output and investment policy. The classical economists, using a number of fairly restrictive explicit or implicit assumptions, determined the 'optimal' policies, and hence the 'optimal' share of total resources, to be devoted to any economic activity by reference to (marginal) benefits and costs. The pragmatists borrowed parts of the classical system and sometimes misinterpreted it. They attempted to fit together the parts drawn from the unconstrained (with respect to price, output and investment) classical system with parts drawn from systems which were implicitly subject to price, output and investment constraints. Other 'schools' of thought were also mentioned briefly.

Chapter 3 is a more detailed discussion of a possible marriage of the classical with pragmatic systems. The presence of costs jointly incurred for heterogeneous users has implications for pricing. This has been discussed extensively in the literature on public utility price theory. Some of the possibilities for road track pricing are mentioned.

Chapter 4 demonstrates that the method used to 'determine' costs associated with particular user classes by the Victorian Inquiry[(1)] is essentially arbitrary. Using similar assumptions, we show an entirely different result. An equal number of arguments can be found to favour either 'method'. The Bland selection of assumptions was heavily biased against heavy vehicles.

Chapter 5 deals with the treatment of joint costs. As emphasised throughout, the important characteristic of joint costs is that they cannot be attributed to or apportioned between the various outputs for which they are jointly incurred except by arbitrary rules of thumb or on the basis of demand. This is a problem

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(1) Report of the Board of Inquiry into the Victorian Land Transport System, H.A. Bland, 1971-72 (Government Printer, Melbourne).

encountered in many multi-product enterprises, and such enterprises are the norm rather than the exception.

Chapter 6 examines briefly how some other multi-product firms, particularly railways and other public utilities, have tackled such problems. Using a similar public utility approach, the possibilities are examined for charging road users 'what the traffic will bear'. The model is applied to Queensland, but it should be emphasised that the application is mainly for expository purposes.

The conclusion in Chapter 7 re-emphasises the points made throughout. In particular, it is futile to continue to attempt to determine cost responsibility ex post without the recognition that significant elements of jointness make this possible only within wide limits, or on an arbitrary basis. Finally, we draw attention again to the possibility of a different approach. However, in the absence of some method which enables differential charges to be levied on a per mile basis, such as a tamper-proof meter attached to the vehicle, the differential charging system can be applied only through a system of annual or quarterly fees.

CHAPTER 2 - THE THEORETICAL BACKGROUND: SOME REASONS FOR CONFUSION

The main point to be made is that road pricing and investment policies have been, and continue to be, discussed from a variety of different bases or assumptions. A great deal of confusion has been created by not recognising the differences in prescriptive advice which are due to these different bases. The theory of the 'best' allocation of resources follows the classical line. This is based on the employment of resources in their 'best' alternative uses; i.e., yielding the greatest 'benefits' to society. It recognises few, if any, constraints on the ability to pursue price and investment policies which are 'right' in this sense. Public utility price and investment policies have been discussed in this tradition. This paper attempts to put road tracks into the public utility classification.

The other approaches may be briefly labelled as the public finance, the pragmatic, and the technical. The public finance approach argues that significant characteristics of the <u>public</u> and/or <u>merit good</u> type are present as, say, in defence and education. The appropriate policies are then discussed in a framework of benefits which are valued by the community as a whole rather than the market. The pragmatic approach works within some constraints, such as existing policies about pricing and investment, occasionally tempering the wind of efficient resource allocation to the real world by accepting some institutional constraints. This is sometimes done implicitly, the general assumption still being efficient resource allocation within, if not between, industries. The technical school is mainly represented by discussion of how to 'allocate' costs between users or other beneficiaries, deriving prices from formulas based on vehicle weights, axle weights, or any other technical (as distinct from economic) characteristics of beneficiaries.

This short and very inadequate classification of theories about road track pricing and investment is given to avoid confusion in subsequent discussion. Most disagreements will ultimately be due to some differences in what the disputants accept as the objectives of track price and investment policy, and/or about the constraints they are willing to accept for the achievement of the objectives. Mixing objectives and assumptions of different schools of thought leads to unnecessary confusion, especially since no school of thought is willing to admit that its prescriptions do not necessarily result in the 'best' allocation of society's resources.

To demonstrate the confusion usually created by different assumptions about constraints and other fundamentals, a comparison between two of the major schools of thought is useful. These are:

(a) the Classical School, including Marshall, Pigou and Little, who concentrated on optimum allocation of resources in the absence of constraints. Resources were to be used where, when converted into outputs, they were of most value to consumers.

(b) the Pragmatic School, perhaps better described as the practical school, including Taussig and most modern transport economists.

Confusion arises when the principles appropriate for (a) are used by (b). The analogy between first and second best arguments is useful in making judgements about the result. Acceptance of various constraints, about the total investment, its allocation and pricing of roads, changes the appropriateness of some of the principles derived from first best arguments.

THE CLASSICAL SCHOOL.

The arguments of this school are those usually applied to public utilities. In the absence of significant externalities, and with universal perfect competition, resources are efficiently allocated when the value of the benefit at the margin is equal to the value of the marginal resource used up to provide the benefit. The theory of the multi-product firm then provides the 'optimal' price, output and investment policy. 'Policy' is used in the singular, because price, output and investment are determined by the same principles. The 'right' price automatically makes output and investment 'right' also, as in textbook models of the firm.

The problems seen as most important by this school are those concerned with making price, output and investment policies in the public sector similar to those in the private sector. Track supply (quantity/quality) was adapted to existing and expected demand in the same way as the supply of any other output. Because cost complexities (jointness, non-renewable or long-lived and specific assets, indivisibilities) existed, these were discussed, under various headings, to bring out the essence of 'right' price, output and investment policies under such circumstances. The basic principle was the simple and obvious one of ensuring that no resource was used for an output unless the value of its output contribution was at least as great as it would have been anywhere else. Since no new investment is undertaken in the private sector if existing investment cannot earn its replacement costs, the same applies to the public sector. Hence, the reference by the Classical School to long run marginal costs (lrmc).

Briefly, pricing was to maximise revenue, usually, but not always, under conditions of "simple competition". Price could never be less than the cost which could be avoided by ceasing production of any particular output or any of the interdependent outputs. Beyond that, revenue from existing capacity will indicate whether there is too much, too little, or just enough capacity. The existence of long-lived and specific assets meant that if such assets were in over-supply i.e. unable to earn their replacement cost from prices which maximise revenue, bygones are treated as bygones automatically. No identical new assets would be created. Track investment would take place where and when expected revenues indicated that existing plus new capacity could earn its opportunity cost.

While much of this is (or should be) obvious, it creates problems when parts of it are drawn into the discussion of the pragmatic school.

THE PRAGMATIC SCHOOL

The explicit, or more usually, implied assumptions of the "practical" transport economists are mainly with respect to the investment or budget constraint, and the pricing constraint. However, this does not lead to the appropriate adjustment of some of the classical principles, and the attempt to apply them in the presence of the constraints leads to contradiction. The best example is the marginal cost pricing principle. As outlined above, it works to determine price, output and investment in the classical model. If there is a budget constraint and a pricing constraint, the marginal cost pricing principle in its classical form, no matter how adjusted to cope with cost complexities, cannot be used without a great deal of second-best adaptation.

To labour the obvious: if the road budget is constrained, say, to one half of what it would be in the classical model, and prices are determined by political considerations without reference to their economic implications, the systematic relationship between value of benefit or price and opportunity cost which exists in the rest of the economy does not exist in the road supply industry. There is then little point in deriving investment criteria from the classical model, unless they are of the form: given the (largely arbitrary) economic effects of existing pricing policy, investment funds available should be directed to projects which yield the highest benefits. A crude cost-effectiveness analysis will do. The result is bound to be inferior in economic efficiency terms to either a move towards a price policy which rations use of the road supply in the presence of a given budget constraint, or to a removal or modification of the budget constraint. Preferably, both constraints should be removed.

The fact that prices have a rationing effect in the classical model is frequently ignored by the pragmatic school. The 'optimal' quantity/quality track can never be produced if some of the misguided interpretations of short run marginal cost pricing are accepted. Put crudely, the argument is that bygones are bygones (true but irrelevant unless there has been an overestimate of demand), and that only the current opportunity costs need to be recovered from users. With price equal to current maintenance costs only, congestion appears, superficially indicating that more capacity is needed. A benefit-cost study establishes this desirability, without reference to what quantity demand would have been with a valid definition of cost and a price which reflected such costs. Almost anything can be made to appear scarce by charging a sufficiently low price for it.

It will be noted that we have not mentioned the usual second-best refinements found in the models of the pragmatists. The reason is that most of them become unnecessary and/or unimportant in a model in which prices and investment are arbitrary. 'Arbitrary' here means with respect to the classical model. Thus, if prices bear no systematic relationship to costs in the road supply sector, little is gained from the knowledge that prices elsewhere are systematically related to costs, at least within limits, unless the objective of the exercise is to relate prices systematically to costs. To worry about what actual price/cost ratios are in an imperfectly competitive world outside the road supply sector is then of insignificant importance compared with the acceptance within the road supply sector of any systematic price/cost relationship within the limits, or even outside them. Where total investment to a sector of the economy or its allocation within that sector is not determined by principles similar to those used elsewhere, then in terms of economic efficiency, resources would be mis-allocated. However, the differences between the allocation of resources under the classical model with assumed universal perfect competition and the second-best model allowing for non-perfect competition will be very small, compared with the differences between either of these and the arbitrarily determined allocation.

Hence, second-besting usually assumes that prices and investment are somewhere near the unconstrained neo-classical optimum. In road track pricing and investment, this is simply not the case.

CHAPTER 3 - SOME ALTERNATIVE MODELS

It seems likely that some constraints will have to be accepted. It is then necessary to indicate the efficiency effects of continuing with the constraints and to examine possibilities within the constraints for feasible (politically acceptable?) improvements. Specifically, given a budget constraint, and interpreting the pricing constraint to mean that a given level of revenue is to be obtained, we will ask what other pricing methods will raise the same revenue but are less arbitrary with respect to the effects on efficiency in resource use.

There are many variants in the manipulation of constraints. Thus it is possible to assume that governments will regard a certain proportion of total revenue purely as a tax, and to regard the remainder as a payment for road use. Road users are then in part taxed like consumers of beer and tobacco, and in part as payers for a good or service. The proportion tax/user charge can always be varied, of course, but provides some guidance for road suppliers and users which is absent if road prices plus taxes are regarded as being determined arbitrarily. There is a connection between Federal tax collections and disbursements, de facto but not de jure. One might persuade the Federal authorities that specification of the tax and user charge proportions is a good idea. In any case, it can always be worked out ex post.

Much of what will be said about other pricing methods under a budget constraint will draw heavily on public utility price theory. As will be shown in our examination of the classical model, joint supply and joint costs are relevant to road pricing. The pricing problems and solutions by other suppliers facing similar conditions, especially electricity, will be examined briefly. The importance of 'price discrimination', badly defined in the literature for multi-product firms with joint costs, will receive particular attention. Thus costs jointly incurred for a number of user classes having different demand characteristics are 'allocated' in the market place by taking demand elasticities ('what the traffic will bear') into consideration.

Various consumer classes are supplied with electricity under different tariffs. Though they may not consciously be attempting to recover joint costs (until recently, electricity suppliers were blissfully unaware of the term, though very much aware of its implications), they are aware of the cost and demand characteristics of the various user classes they supply. Since it is obviously useless to try to charge what the traffic will not bear, the only thing left is to charge what it will bear, or less. Over years of experimentation a (very imperfect, but far better than nothing) number of guidelines have emerged. Some of these are useful for road pricing.

The most important requirement for 'price discrimination' is that supply to one user or user class cannot be re-sold to another. The petrol tax is thus not useful for any pricing method which is either based on a road occupancy factor, or which seeks to discriminate between user classes on some other basis (e.g. commercial, agricultural, private, city, country). As with electricity, the requirement is a meter (odometer) secured against tampering and read at regular intervals.

Even if the meter is introduced only notionally, it permits examination of what is possible. In the absence of metering, the fixed charge (licence-registration fee) emerges as the only practicable means of 'discrimination', in the absence of tolls everywhere. The effect of these under the given constraints will be examined.

The next chapter evaluates the incremental cost approach used in the Bland Inquiry and attempts to show the arbitrary nature of the approach in determining cost responsibility by user class. In general, user class responsibility for joint costs requires taking demand characteristics into the problem.

CHAPTER 4 - EVALUATION OF THE INCREMENTAL COST APPROACH AS USED IN THE BLAND REPORT

Several criticisms have been made of the data used in the Bland Report to analyse the cost responsibility for construction and maintenance by user class. Specifically these relate to:

- failure to allocate costs to non user beneficiaries;
- representativeness of cost data based on expenditure in one year; and
- cost data based on State Highway expenditure which in the chosen year amounted to only 15 per cent of total road construction and maintenance expenditure in Victoria.

This discussion does not evaluate the appropriateness of the data used. Rather, attention is focused on the way in which it is used, to show that even if the data are accepted the incremental cost approach does not result in an unambiguous division of cost responsibility.

The Bland Report classified construction expenditure into six items:

land acquisition and right of way clearance
earthworks and drainage
bridge construction
pavement and shoulder construction
bitumen surfacing
other expenditure including investigation and survey.

Maintenance items were divided into two categories:

pavement and shoulder patching and resurfacing;
general roadside maintenance including trees and traffic control devices.

Four cost assignment criteria were adopted in the study:

passenger car units
vehicle miles of travel
ton miles of travel
axle miles of travel.

These criteria were allocated to the cost categories in the following way:

- land acquisition, right-of-way (ROW), earth works and drainage - allocated to passenger car units with no increments;
- bridges - vehicle miles of travel incrementally;
- pavement and shoulders for constant width as required for cars - average loaded weight ton miles incrementally;
- pavement and shoulder sealing and surfacing for widening as required for trucks - passenger car unit miles applied incrementally;
- other expenditure - vehicle miles of travel with no increments;
- general road side maintenance - vehicle miles of travel with no increments;
- pavement and shoulder maintenance - average loaded weight ton miles incrementally.

This cost allocation, which is the crux of the incremental cost approach, is reached with the disarming statement:

> "Based on the manner in which work items are affected by vehicle type, size, weight or operating characteristics, construction and maintenance work items were divided into groups for cost determination to vehicle classes."(1)

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(1) Bland Report, Ibid., Appendix XVI, page 190.

No further argument is advanced and, in the light of this, the following method of cost classification is also reasonable:

- land acquisition ROW, earthworks etc. - vehicle miles with no increment;
- bridges - axle miles incrementally;
- pavement and shoulders constant width as required for cars - axle miles incrementally;
- pavement and shoulder sealing and surfacing as required for trucks - axle miles incrementally;
- other construction expenditure - vehicle miles with no increments;
- road side maintenance etc. - vehicle miles with no increments;
- pavement and shoulder maintenance - axle miles.

The various calculations of each category are included in tables I to VIII.

Using these different cost allocation criteria, and applying them to the same engineering data used in the Bland Inquiry, results in cost responsibilities by vehicle class significantly different from those accepted in that report. The 'responsibility' for road construction costs for vehicles in the greater than 4 ton class (excluding buses for compatibility with the Report) is 31.7 per cent which compares with 41.1 per cent suggested by the Report. Similarly, these classes of vehicles are held 'responsible' for 19.7 per cent of maintenance costs while the Bland Report accepts a responsibility of 35.2 per cent.

The point being made here is that the apparently unambiguous engineering data can be used to obtain a wide range of 'cost responsibility'. Engineers can debate the relative merits of vehicle weight, axle weight, pressure per square inch, impact values and other characteristics without being able to use any one or any combination of these to yield

TABLE 4.1 - COST RESPONSIBILITY FOR LAND ACQUISITION, RIGHT OF WAY, EARTHWORKS, DRAINAGE AND OTHER EXPENDITURE[a]

Vehicle class[b]	Vehicle miles by class (%)	Cost allocation ($'000)
1	80.7	5,331
2	10.0	661
3	2.3	152
4	0.5	33
5	1.0	66
6	0.3	20
7	2.2	145
8	2.2	145
9	0.8	53
TOTAL	100.0	6,606

(a) Total expenditure (see Bland Report p.196) consists of:

	($'000)
Right of way, earthworks drainage	5,085
Other expenditure	1,521
	6,606

(b) Vehicles are classified according to tons carrying capacity (T) as follows:

Vehicle class	Type of vehicle
1	Cars and station wagons
2	Utilities and panel vans
3	Trucks up to 2T
4	Trucks over 2T to 3T
5	Trucks over 3T to 4T
6	Trucks over 4T to 5T
7	Trucks over 5T (rigid)
8	Trucks over 5T (articulated)
9	Buses

TABLE 4.2 - INCREMENTAL COST RESPONSIBILITY FOR PAVEMENT AND SHOULDER CONSTRUCTION (CONSTANT WIDTH)

Vehicle class	Increment of index cost	Cost allocation ($'000)						
			23,527	2,881	2,355	2,017	200	Cumulative axle-miles (million)
			20,646	526	338	1,817	200	Million axle-miles per class
			Incremental $ cost per million axle - miles by vehicle class					
			1 & 2	3	4&5	6,7&8	9	Vehicle class
1 & 2	26.7	988	41.99	41.99	41.99	41.99	41.99	988,000 / 23,527
3	13.3	492		170.77	170.77	170.77	170.77	492,000 / 2,881
4 & 5	13.3	492			208.92	208.92	208.92	492,000 / 2,355
6,7,8 & 9	46.7	1,728				856.72	856.72	1,728,000 / 2,017
TOTAL	100.0	3,700	41.99	212.76	421.68	1,278.40	1,278.40	
Cost - responsibility[a]		($'000)	866.9	111.9	142.5	2322.9	255.7	3,700
		(%)	23.4	3.0	3.9	62.8	6.9	100.0

(a) Cost responsibility is calculated as follows: Incremental cost by vehicle class times axle-miles per vehicle class, e.g. for Vehicle Classes 1 and 2 - $41.99 x 20,646 = $866,900.

TABLE 4.3 - INCREMENTAL COST RESPONSIBILITY FOR PAVEMENT AND SHOULDER CONSTRUCTION (PAVEMENT WIDENING)

Vehicle class	Increment of index cost (%)	Cost allocation ($'000)						
							200	Cumulative axle-miles (million)
						2,017		
					2,355			
				2,331				
			23,527					
			20,646	526	338	1,817	200	Million axle-miles by class
			Incremental $ cost per million axle-miles by vehicle class					
			1 & 2	3	4&5	6,7&8	9	Vehicle class
1 & 2								
3								
4 & 5	35.5	390			165.61	165.61	165.61	390,000 / 2,355
6,7,8 & 9	64.5	712				353.00	353.00	712,000 / 2,017
TOTAL	100.0	1,102			165.61	518.61	518.61	
Cost - responsibility[a]		($'000)			56.00	942.3	103.7	1,102
		(%)			5.1	85.5	9.4	100.0

(a) Cost responsibility is calculated as follows: Incremental cost by vehicle class times axle-miles per vehicle class, e.g., for Vehicle Classes 4 and 5 - $165.61 x 338 = $56,000.

TABLE 4.4 - TOTAL COST RESPONSIBILITY FOR PAVEMENT AND SHOULDER CONSTRUCTION

Vehicle class	Cost responsibility ($'000) 1 & 2	3	4 & 5	6,7&8	9	Total
Constant width (a)	866.9	111.9	142.5	2,322.8	255.7	3,700
Widening (b)			56.0	942.3	103.7	1,102
Cost - responsibility ($'000)	866.9	111.9	198.5	3,265.1	359.4	4,802
Cost - responsibility (%)	18.1	2.3	4.1	68.0	7.5	100.0
Cost - responsibility (%) in Bland Report	11.8	1.3	3.4	75.4	8.1	100.0

(a) See Table 2.
(b) See Table 3.

TABLE 4.5 - INCREMENTAL COST RESPONSIBILITY FOR BITUMEN SURFACING

Vehicle class	Increment of index cost (%)	Cost allocation ($'000)						
							200	Cumulative axle-miles (million)
						2,017		
					2,355			
				2,881				
			23,527					
			20,646	526	338	1,817	200	Million axle-miles by class
			Incremental $ cost per million axle-miles by vehicle class					
			1 & 2	3	4 & 5	6,7& 8	9	Vehicle class
1,2 & 3	75.0	1,107	47.05	47.05	47.05	47.05	47.05	1,107,000 / 23,527
4 & 5	16.6	245			104.03	104.03	104.03	245,000 / 2,355
6,7,8, & 9	8.4	124				61.48	61.48	124,000 / 2,017
TOTAL	100.0	1,476	47.05	47.05	151.08	212.56	212.56	
Cost - responsibility[(a)]		($'000)	971.5	24.7	51.1	386.2	42.5	1,476
		(%)	65.7	1.7	3.5	26.2	2.9	100.0
Cost - responsibility in Bland Report		(%)	53.9	1.4	2.7	37.4	4.6	100.0

(a) Cost responsibility is calculated as follows: Incremental cost by vehicle class times axle-miles per vehicle class, e.g., for Vehicle Classes 1 and 2 - $47.05 x 20,646 = $971,500.

TABLE 4.6 - INCREMENTAL COST RESPONSIBILITY FOR BRIDGE CONSTRUCTION

Vehicle class	Increment of index cost (%)	Cost allocation ($'000)	1 & 2	3	4	5	6,7&8	9	
								200	Cumulative axle-miles (million)
							2,017		
						2,237			
					2,355				
				2,881					
			23,527						
			20,646	526	118	220	1,817	200	Million axle-miles by class
			Incremental $ cost per million axle-miles by vehicle class						
			1 & 2	3	4	5	6,7&8	9	Vehicle class
1 & 2	51	1,034	43.94	43.94	43.94	43.94	43.94	43.94	1,034,000 / 23,527
3	11	233		77.40	77.40	77.40	77.40	77.40	233,000 / 2,881
4	7	142			60.30	60.30	60.30	60.30	142,000 / 2,355
5	7	142				63.48	63.48	63.48	142,000 / 2,237
6,7,8 & 9	24	487					241.45	241.45	487,000 / 2,017
TOTAL	100	2,028	43.94	121.34	181.64	245.12	486.57	486.57	
Cost - responsibility [(a)]		($'000)	908	64	21	54	884	97	2028
		(%)	44.8	3.2	1.0	2.7	43.6	4.8	100.0
Cost - responsibility in Bland Report		(%)	46.1	3.9	1.4	3.7	38.1	6.8	100.0

(a) Cost responsibility is calculated as follows: Incremental cost by vehicle class times axle-miles per vehicle class, e.g. for Vehicle Classes 1 and 2 - $43.94 x 20,646 = $908,000.

TABLE 4.7 - INCREMENTAL COST RESPONSIBILITY FOR PAVEMENT AND SHOULDER MAINTENANCE (a)

Vehicle class	Increment of index cost (%)	Cost allocation ($'000)							
								200	Cumulative axle-miles (million)
							2,017		
						2,237			
					2,355				
				2,881					
			23,527						
			20,646	526	118	220	1,817	200	Million axle-miles by class
			Incremental $ cost per million axle-miles by vehicle class						
			1 & 2	3	4	5	6,7&8	9	Vehicle class
1 - 5	80	2,857	121.43	121.43	121.43	121.43	121.43	121.43	2,857,000 / 23,527
6 - 9	20	714					354.00	354.00	714,000 / 2,017
TOTAL		3,571	121.43	121.43	121.43	121.43	415.93	475.43	
Cost - responsibility (b)		($'000)	2,507	64	41		864	95	3,571
		(%)	70.2	1.8	1.2		24.2	2.6	100.0

(a) Maintenance in the Bland Report (see p.202) consists of:

	$'000
Resheet	411
Reseal	916
Patrol maintenance	2,244
	3,571

(b) Cost responsibility is calculated as follows: Incremental cost by vehicle class times axle-miles per vehicle class, e.g., for Vehicle Classes 1 and 2 - $121.43 x 20,646 = $2,507,000.

TABLE 4.8 - DETERMINATION OF CONSTRUCTION AND MAINTENANCE COST RESPONSIBILITY BY ALTERNATIVE ALLOCATION CRITERIA

Vehicle class	Land acquisition R.O.W. Earthworks and Other (a)	Pavement and shoulder construction (constant width)(b)	Pavement and shoulder widening(b)	Bitumen surfacing (b)	Bridges (b)	Total construction cost	%	Resheet, Reseal, Patrol, Maintenance (b)	Other maintenance cost(a)	Total maintenance cost	%
	($'000)							($'000)			
1 & 2	5,992	867		972	936	8,767	58.8	2,507	958	3,465	75.0
3	152	112		25	79	368	2.5	64	24	88	1.9
4 & 5	99	143	56	51	103	452	3.0	41	16	57	1.2
6,7 & 8	310	2,322	942	386	772	4,732	31.7	864	50	914	19.7
9	53	256	104	42	138	593	4.0	95	8	103	2.2
TOTAL	6,606	3,700	1,102	1,476	2,028	14,912	100.0	3,571	1,056 (c)	4,627	100.0

(a) Allocated by vehicle miles, no increment.

(b) Allocated by axle-miles, incrementally.

(c) See Bland Report, p.202.

a superior conclusion. Our argument is that many multi-product firms have the same problems and solve these by a reference to cost and demand characteristics. This aspect is pursued in the following chapters.

CHAPTER 5 - THE TREATMENT OF JOINT COSTS

THEORY

The question of whether joint or common cost problems are faced by track users has attracted little attention since the days of Marshall, Taussig and Pigou. It is of obvious importance in discussion of appropriate price policies. Though the existence and importance of joint costs in road track supply is not seriously disputed anywhere, most studies mention it as a disagreeable fact and then return to the non-joint cost solution.

However, the first question to be asked is: what is the reason for arguing that road investment exhibits joint cost characteristics? The answer in part depends on the definition of output. If output is defined in Marshallian terms, it is clear that roads produce outputs which cannot be regarded as perfect substitutes for each other. There are thus a number of product classes with the characteristic that substitutability within each class is much greater than substitutability between classes. If each of the user classes had its own permanent way, no problem of jointness would arise because all costs are then uniquely assignable to and within each class. It is because roads are not built exclusively for such narrowly defined user classes that the problem arises. The reason for not doing so is simply one of cost. Put crudely, it is very much cheaper to provide permanent ways for use by a number of user classes than to provide each user class with its own exclusive permanent way.

Secondly, if all costs were a simple function of some technical or other unique characteristic, e.g. if roads were used up by amounts determined only by vehicle weight and distance travelled, joint cost problems would be small and insignificant. Every ton-mile would create as much road cost as any other. From the supplier's point of view, tons carried and distance would be all the information needed to determine charges for road use. The road supplier is then like a sausage manufacturer from whom any quantity can be bought of a homogeneous commodity at a fixed price per unit. Again roads are not like that. For a network, the road supplier is not indifferent between trips from A to B and B to A; nor between trips at 2 p.m. and 2 a.m., to mention only two. Unlike the sausage man, he cannot store the product at 2 a.m. and then release it for use at 2 p.m., nor does he provide capacity from A to B without also providing it from B to A. Nor does the road wear out as a direct function of use. Because it is exposed to the elements, it wears out also as a function of time. This also differs from the sausage man's machinery, but is certainly not unique to road and rail transport (e.g. electricity generating stations do not wear out, they become obsolete).

Costs are thus incurred to provide heterogeneous outputs. Some of these costs can be directly assigned to a particular class, in the sense that they are incurred only to enable that particular class of users onto the road, or to enable them to continue to use a road. These long run and short run separable costs are not joint costs, as the name 'separable' indicates. There are many costs which cannot be separated. The obvious ones are right-of-way costs, the costs incurred for maintenance not the direct result of use, and the capital costs of the minimum quality road necessary before any traffic at all can pass over it.

This is taking a very technical view of jointness. If users cannot be induced to use roads at 2 a.m. with the same intensity as 2 p.m. and as the service cannot be stored, then the 2 p.m. users will indicate capacity requirements. There is then no economic or other reason (except an institutional one) why, in the case of roads, 2 a.m. users should pay the same price as 2 p.m. users even if costs were the only consideration. The long-run separable costs of 2 p.m. users could include all capital costs, and those of the 2 a.m. users may not include any capital charges. This 'benefit' to the latter users results from time-jointness, i.e. that capacity created to meet a peak is also available at the off-peak.

The proportion of the separable cost component of total costs is unknown. In part it depends on what road supply policy is followed. Thus if all roads are built to only one technical standard, so that all user classes can use all roads (i.e. none is excluded because, e.g. his vehicle is too heavy), then only opportunity (congestion) and maintenance costs caused by use become separable.(1) The other costs are jointly incurred for all user classes. If roads are built to exclude certain user classes, then obviously costs can only be apportioned among those user classes not excluded. At the limit, we are back with different roads for different user classes, and jointness becomes less and less important.

Since the main concern is charging for an existing road network, it is only necessary to make brief reference to road investment under conditions of jointness. What is relevant is the sum of the value of the benefits (i.e. market simulation) and the sum of the costs associated with any change. As already mentioned, such calculations are only now being made, very imperfectly and apparently quite independent of price. The question is frequently raised about whether a road supply authority should act as a monopolist, or as a competitive industry. The relevance of this question to overall investment in roads is small, since the road suppliers are unable or unwilling to act either as monopolists or as competitors, or anything in between. It does become relevant when the question arises about the implications of jointness in costs if prices and costs are to be related in a manner not too dissimilar from what happens elsewhere in the economy.

Pure joint products (the strongest kind of jointness in production) may be produced under conditions approaching pure competition or under monopoly conditions. Relative prices in both polar cases are determined by demand. The difference, as in the single product case, is in the quantity sold. Thus, under monopoly, it is possible to sell a portion of the total output of one of the joint products. It will again be true that the difference between the relative prices of joint

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(1) See I.M.D. Little and K.M. McLeod, The New Pricing Policy of the British Airports Authority, Journal of Transport Economy and Policy, May 1972, p.110.

products under pure competition and monopoly will be small compared with the difference between either of these and any presently existing set of road prices. The movement towards monopolistic relative pricing would be an improvement, since prices would be systematically related to costs at the upper limit to price/cost ratios, rather than, as now, hardly related to costs at all.

It is not possible to sidestep the problem altogether. Pragmatism can help. Thus roads are supplied monopolistically in the technical sense of absence, in Australia, of alternative road suppliers. This institutional fact does not imply, however, that the road supplier acts like a monopolist. As with other public utilities, their 'public' status has obligations as well as monopolistic privileges. On the whole, the other public utilities are expected to behave as a competitive firm would, so far as their price, output and investment policies are concerned. Otherwise there would be no point in having 'public' utilities. Though the impact on price policy will not be great, there are problems in translating the behaviour of a single firm industry into what it would have been had it been a competitive one. The most obvious absurdity is met with by supposing the monopolist to have been a large number of small firms. In road supply, this would lead to a very complicated equilibrium picture with little or no usefulness. For unless the entire country is covered with bitumen, the location of one road is necessarily different from that of others and therefore confers some monopoly power on each supplier. All one can say is that the relationship between prices and costs should be those which, under different cost and supply conditions, pertain in competitive industries. This amounts to no more than saying that the system should not, in total or in any one part of it, make more than normal profits.

This is of some importance when phrases like 'maximising revenue' are used. For a public utility, they mean maximising revenue subject to the constraint imposed by statute not to exploit the monopoly privilege conferred upon them. What is implied is simply that where a maximising revenue price policy is adopted, output will be increased whenever and wherever profits are greater than normal. Implicitly assumed is a demand elasticity everywhere greater than unity.

At its simplest, we are left with three major classes of costs, to be recovered in some way from users of the existing road system, approaching relative prices which are competitively or monopolistically related to costs:

(i) costs of maintenance directly made necessary by use;

(ii) non-separable capacity and maintenance costs;

(iii) separable capacity costs.

This may be reduced to two by joining (ii) and (iii) in the form: capacity costs, so long as no user class pays less than the separable capacity costs associated with it. The three way split is preferred, because it makes it clear that (ii) is not 'allocatable' from simple cost data, but is a joint cost which, elsewhere in the economy, would be 'allocated' to the different user classes by market forces. The incremental cost approach as used by the Bland Inquiry is invalid partly because it attempts the arbitrary allocation of (ii) without knowledge about the various implications of other, equally arbitrary, allocational 'methods', and some which are much less arbitrary.

SOME PRACTICAL ALTERNATIVES

A road network will show evidence of over and under-supply of capacity in different parts of the network during peak and off-peak periods. This is not unique, since many multi-product firms face the same set of circumstances and manage to get by. They do so by being fairly imprecise about their pricing principles, and very precise about their pricing practices. We will do it the other way around. At this stage, we will not introduce the peak/off-peak problem. All we seek is a charging method which reflects cost and demand factors more effectively than any other we can think of, and which can actually be applied.

First of all, there is the issue of charges varying directly with use, and those which do not. Except for access roads, there seems little point in an annual fixed levy. However, the main reason for such levies is the ability to 'discriminate' between different user classes, given existing means of charging for road use. If it were possible to 'discriminate' in the charge which is a direct function of road use, little purpose is served by the fixed charge.

The charges which vary with mileage include fuel, tyre and ton-mile taxes. The deficiencies of the fuel and tyre taxes are well known: neither cost of road space nor demand elasticities are reflected in such taxes (i.e. consuming four times as much fuel per mile does not mean that four times as much has been incurred in costs, or that the difference is explainable by demand elasticity arguments); 'discrimination' between classes is not practicable (i.e. having different rates of fuel taxes for different road consumer classes); and the tax distorts engine or wheel design and results in a capital/labour ratio here different from that in the rest of the economy. The ton-mile tax fares somewhat better, suffering from some of the difficulties in 'discriminating' between user classes; evasion; unexplained reliance on vehicle weight; and non-universal application (e.g. not to private cars or primary producers).

The charge should, if at all possible, meet at least two conditions: it should be related to relevant costs; <u>and</u> it should be related to some rule-of-thumb regarding demand elasticities (the former to meet separable, the latter to meet non-separable or joint costs). It must be possible to define a user class in terms of costs and in terms of demand elasticities.

This is not as novel as it sounds. The old RAC horsepower rating principle used in the UK some time ago used the crude rule-of-thumb that richer people with lower demand elasticities had higher horsepower cars. This was, however, only possible with the fixed charge. Since fixed charges have no other really desirable characteristics, is it possible to combine demand and cost factors in a variable charge?

The answer is yes. A slight disgression into electricity pricing is called for before the possibilities can be examined for roads. Electricity users are sometimes put into classes which reflect their demand and cost characteristics. Commercial users are regarded as having more inelastic demand than industrial users; private users are sometimes sub-divided into those having access to substitutes (i.e. having higher demand elasticities) and given lower rates for 'all-electric' houses, and so on. This is made possible by separately metering each user (and sometimes each use), and preventing transfer from one user or use to another. Other large suppliers do the same (gas, telephones).

For roads, the requirement is a meter for each vehicle which, like electricity meters, cannot be tampered with. Much depends on how sophisticated the metering device is to be. In electricity, time-of-day meters, ripple control meters, maximum demand meters, and so on, are available. For roads, the least sophisticated device is an odometer (already on your speedo) which costs next to nothing to install. This could be read whenever the vehicle changed hands, and with the annual vehicle inspection. The charge per mile would depend on the demand and cost characteristics of the vehicle. The road occupancy characteristics of the vehicle, the area where it is used, and the time at which it is used, would be the important cost components. The uses to which it is put, the value of the vehicle, and its performance characteristics would be the important elasticity components. The cost-determined charge per mile for a given vehicle is then multiplied by a demand determined coefficient (e.g. 1.0 for private use, 1.01 for commercial use, 0.98 for farmers, 1.02 for specially constructed, special purpose vehicles, etc.).

Much more sophisticated metering devices are known, some of which might be acceptable for larger vehicles. The simplest records time and mileage, and enables some allowance to be made for charging for high demand road space (i.e. because the vehicle would be moving slowly and this would show on the punched tape which results). The tachograph is already in use in the USA and UK on larger vehicles. For most users anything but a simple device is probably ruled out by costs. Furthermore, a limited approach to the distinction between high and low cost road space can be made by discriminating, as is done now, between different geographical regions within which vehicles operate.

If such metering is not acceptable to policy makers (it would almost certainly be acceptable to most users once it is explained that the intention is not to collect more revenue but merely to collect it differently), what other possibilities remain? Fuel and tyre taxes have already been discussed, and suffer the additional disadvantage that they are sometimes treated as a price, sometimes as a tax. There seems to be no alternative to collecting differential charges from an annual or quarterly fixed charge.

CHAPTER 6 - CHARGING ROAD USERS 'WHAT THE TRAFFIC WILL BEAR'

It has been argued above that a large proportion of the costs of road supply and maintenance are joint costs and cannot therefore be allocated directly to the user classes for which they are jointly incurred. Wherever joint costs are present, their allocation is undertaken by a rule of thumb, usually with a fairly arbitrary base, or left to the market place. Under conditions of pure competition, prices are entirely determined by demand, subject to the lower limit which requires that the seller must be made better off by selling the product than he would have been, had he treated it as waste.

Our study now requires that some variables relevant to road pricing in this sense be specified and their possible use indicated. The authorities responsible for supplying and selling road space are not alone in what appears to be the dilemma of setting prices for joint products. The following briefly reviews the methods used by public utilities in the past and at present. The application of the arguments about demand elasticities to the Queensland vehicle population and the various models applied, are then discussed.

PRICE DISCRIMINATION AND PUBLIC UTILITY PRICE THEORY

The use of the term price discrimination in multi-product situations characterised by some degree of jointness is extremely misleading. The arguments are given in detail elsewhere[(1)]. The point is made that different products are frequently sold at

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(1) See H.M. Kolsen, 'Price Discrimination and the 'Definition of Joint Products', Appendix 2 to Chapter 4, The Economics and Control of Road-Rail Competition (Sydney University Press, 1968) and D.C. Ferguson, 'Joint Products and Road Transport Rates in Transport Models', Journal of Transport Economics and Policy Vol. VI No. 1, January, 1972.

different prices, without great surprise to anyone. A careful definition of 'product' is necessary in applied terms - a Marshallian one in terms of product classes consisting of perfect substitutes. Few people would argue that a trip from A to B is a substitute for a trip from B to A, anymore than cowhides are a substitute for steak. But there are less clear cut cases, such as peak and off-peak electricity or transport.

The term price differentiation is perhaps better, since it carried no necessary connotation of monopoly(1). It is worth adding that the term indivisibilities has been used in many confusing senses. In what follows we will use the more appropriate terms separable and non-separable costs. However, many writers refer to the inseparable costs as indivisibilities(2).

The problem is one of recovering those costs which cannot be attributed to a particular consumer or consumer class, i.e. the non-separable costs. Avoiding for the moment the question of the long and the short run, the only way by which such costs would be recovered in perfect competition is by charging what the traffic will bear, i.e. demand elasticities. Many devices have been used, though perhaps not on the same theoretical basis as suggested here.

The older railway literature frequently contains the rule of thumb that the higher the value of the goods per pound, the more the traffic will bear, i.e the smaller the elasticity the higher the price that could be levied(3).

Hazlewood(4) makes a number of suggestions which include differences in prices to business and private subscribers. House size was used for this

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(1) H.M. Kolsen, op. cit., p.78.

(2) A. Hazlewood 'Optimal Pricing as Applies to Telephone Service', reprinted in Turvey, R. (ed) Public Enterprise (Penguin Modern Economics, 1968)

(3) For example, see J.B. Lansing, Transportation and Economic Policy, p.53.

(4) Hazlewood, op.cit. especially p.243.

purpose in the older electricity tariffs in the U.K.[(1)]. These examples are attempts to collect the non-separable costs by differential charges - in the case of telephone services, for the main routes and exchanges. In the electricity example, costs can be separated and it is a question of how far to go. Hence any 'subscriber' buying peak electricity can be made to pay the same price as any other subscriber buying peak electricity[(2)]. Numerous references to 'price discrimination' (old style) are also made in the literature[(3)].

There are common elements, to both Dupuit's example of a bridge which was pure price discrimination, and to the case where the charge for crossing the bridge is based on the opportunity cost which is price differentiation. In the charge for roads, both elements can appear if a meter is used to record the relative scarcity of the road space used. In the absence of such a meter (or rather, in the absence of its use) we are forced to apply rules of thumb about demand elasticities to licence and registration fees. The argument used by the railways - that a higher price per pound for a highly valued commodity represents a smaller proportion of the total ultimate cost of that commodity - is applied in our model to registration and/or other charges for using the road. Though the charge in our model appears to rise rapidly with the value of the vehicle, it falls as a proportion of total vehicle outlay. Thus the owner of a new Jaguar might

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(1) H.S. Houthakker, 'Electricity Tariffs in Theory and Practice', Economic Journal, March 1951.

(2) H.M. Kolsen, 'The Economics of Electricity Pricing in NSW', in J. Dixon (ed.), The Public Sector, Pelican 1972.

(3) A.E. Kahn, The Economics of Regulation (Wiley and Sons, 1971, 2 Vols.)

pay two per cent of purchase price in registration fees, while the owner of a ten year old Morris Minor would pay 10 per cent under the suggested charges. This is less than at present for the Morris Minor, and more than at present for the Jaguar.

The opportunity cost argument is represented by differentiation between country, provincial city and metropolitan city locations of vehicles. Partly because of errors in supplying inappropriate quantities/ qualities of road space in some places, there is no shortage of country road space. No-one is seriously affected by one more vehicle in the country, some are in provincial cities, many are in metropolitan cities. Hence the opportunity cost, given existing road space, is high in the metropolis, lower in the provincial cities, and lowest in the country.

The high performance element is added because it reduces somewhat the elasticity of demand for high performance cars compared to those with low performance; and because the opportunity cost argument suggests that high performance cars may take up more road space, regardless of age, than the average vehicle.

It should be noted that a practical system of road pricing, without meter or congestion charges, would continue to recover costs from a wide variety of charges, including especially a tax on fuels. The practical impact of some of our suggestions is therefore directed at this stage to only a small part of the problem. The meter system is superior in all respects to both the existing and the alternative meter-less systems suggested here.

We examine the problem and possibilities by moving from a very impractical and oversimplified model in the following section, intended only for facilitating subsequent versions, to models becoming progressively more flexible and also somewhat more complex in subsequent sections.

THE BASIC MODEL

The aim of the model is to recover the present collections from the motoring sector in a manner similar to that suggested by public utility price theory. This requires that elasticities of demand and opportunity costs form the basis of this approach. The problem therefore is to translate this theoretically more acceptable approach into a formula which may be applied in practice. For our purposes it is suggested that four major classifications be included in the model: use, area of use, performance and value. Such data could be included in a simple collections model in the following way:

Use -	if private, value 1 if public authority, etc., value 0
Area of use -	if city, value 1 if country, value 0
Performance -	if high, value 1 if normal, value 0
Value -	if the value of the vehicle on the first day of a given accounting period is greater than the mean of the car population, value 1; if the value is less than the mean, the value for the purposes of the model is 0.

Thus a new Jaguar in the city for private use would attract a value of 4, while an old Volkswagen for private use in the country would attract a value of 1.

If the total vehicle population is evaluated on this basis, an aggregate point score will result. If the required total revenue is specified, it is then possible to put a dollar valuation on the value 1 in the model. Thus if the required revenue is $50 million and the aggregate point score for a particular State is 2.5 million points, the value of each point is $20. The Jaguar referred to above would be required to pay $80 while the Volkswagen would pay $20.

Clearly such a model is too unsophisticated, and further subdivisions of the classification characteristics would be desirable. This simple model is merely intended to provide a basis for refinement.

DEVELOPMENT OF A MORE REFINED MODEL

Vehicle Type and Area of Use

The total number of vehicles on register in Queensland was taken from Main Roads Department published data and relate to June 30, 1972. These data are collected by region and so it was relatively easy to determine the location of these vehicles. This assumes that the location of predominant use is the same as the address of the registered owner. While this would not be the case in all instances it is likely that this is an acceptable assumption for the purpose of this model.

Table 6.1 includes data on vehicle type and location of use from Main Roads Department statistics.

TABLE 6.1 - QUEENSLAND MOTOR VEHICLE TYPE AND LOCATION OF USE

Motor vehicle classification	Total vehicles	Area of use		
		Brisbane	Provincial City	Country
Cars/station wagons	571211	305597	96535	169078
utilities/panel vans	108691	37607	14347	56737
Trucks/Cabs/Chassis				
20-30 cwt.	12312	3694	1231	7387
30-40 cwt.	5175	1553	518	3105
40-50 cwt.	4222	1267	422	2533
50-60 cwt.	1071	321	107	642
60-80 cwt.	5948	1785	595	3570
80-100 cwt.	6543	1962	654	3924
100-190 cwt.	10528	3159	1053	6318
> 190 cwt.	8565	2571	857	5142
Prime movers	4682	1404	468	2808 (a)
Caravan trucks	364	109	37	218 (a)
Cycles	31963	17100	5401	9461 (b)
Buses	3207	1716	542	949 (b)
School buses	98	52	16	29 (b)
Ambulances	489	266	82	144 (b)
Hearses	120	64	20	36 (b)
Semi trailers	4672	1401	467	2892 (a)
Low loaders	394	117	39	234 (a)
Timber jinkers	665	198	66	396 (a)
Caravans	26650	14257	4503	7888 (b)
Trailers < 10 cwt.	96438	51594	16298	28545 (b)
Trailers > 10 cwt.	16195	4857	1619	9714 (a)

(a) regional classification as for trucks

(b) regional classification as for cars

Source: Main Roads Department Planning Manual.

Provincial cities include: Gold Coast, Toowoomba, Rockhampton, Townsville and Cairns. Brisbane includes: Brisbane city, Ipswich city, Pine Rivers, Redcliffe city and Redland shire.

Vehicle Usage

While the determination of the area of use was quite straightforward. the breakdown of vehicles by use was more difficult. The number of vehicles on register to various governmental bodies is included in the Main Roads Department data, but estimates of use for most vehicle classes had to be made. In fact, vehicle use is the focus of a separate study by the Main Roads Department.

The estimates used in the Main Roads Department project have been adopted in this study and are included in Table 6.2.

Vehicle Value

No information is readily available for the distribution of value of the Queensland motor vehicle population. As these data were needed for this study the approach adopted was as follows: statistics are available on the number of motor vehicles by make and type sold in each State each year(1). The latest available were for 1971. To make the car and station wagon data compatible with the figures from the Main Roads Department the former figures were increased by the approximate growth rate for motor car and wagon registrations (9 per cent). The market values of new vehicles were obtained from the list prices quoted in trade journals. These prices understate the value of the new cars being registered, because they fail to include the cost of the various options which significantly increase the price of a vehicle. The values of new cars established in this way were then aggregated into various classes ranging to greater than $8000. It is assumed that the distribution of value of motor

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(1) Commonwealth Bureau of Census and Statistics; also published in the Australian Automotive Industry Vol. 1, Federal Chamber of Automotive Industry, Canberra, ACT.

TABLE 6.2 - ESTIMATES OF MOTOR VEHICLE USAGE BY VEHICLE CLASS

(per cent)[(a)]

Vehicle Type	Private	Ancillary	Commercial
Cars and wagons	90	9	1
Utilities & panel vans	47	28	25
Buses			100
Trucks (capacity: <40cwt)	6	35	60
Trucks (capacity: 40-60 cwt)		33	67
Trucks (capacity: >60 cwt)		27	73[(b)]
Semi trailers, Low loaders, Timber jinkers			100
Motor cycles	95		5
Caravans	95		5
Small trailers	90	9	1
Trailers >10 cwt	6	35	60

(a) Small percentage errors due to rounding. (b) Ancillary vehicles in this class are quite high because of the proportion of primary producer vehicles.

Source: Main Roads Department

cars and wagons sold in Queensland in 1971 was the same as in previous years. It is then possible to determine the distribution of value of all cars and wagons on register in Queensland. In doing this a reasonable simplification was achieved by excluding cars older than 10 years from the model, thereby implicitly assuming that these vehicles had zero value. Obviously this assumption is arbitrary and any age may be chosen(1). It is likely that the assumption of a zero value in the 11th and subsequent years significantly reduces the overall value of the motor car stock in Queensland. Given this assumption, we have used a 10 per cent straight line depreciation rate to determine the number of motor vehicles less than 10 years old in each class in Queensland. This value distribution is shown in Table 6.3. The distribution of value for utilities and panel vans was derived in the same way, but with a 3 per cent growth rate to make the 1971 figures compatible with Main Roads Department data. Table 6.4 shows the distribution of utilities and panel vans by value.

The distribution of value of trucks and motor cycles is derived in the same way, with growth factors for trucks 1 per cent and motor cycles 41 per cent. Table 6.5 includes these data for trucks and motor cycles.

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(1) Ideally if this information was collected rather than generated from existing data no cut off age need be included as existing market value would be available.

TABLE 6.3 - DISTRIBUTION OF CARS AND STATIONS WAGONS BY VALUE IN QUEENSLAND

As at June 30, 1972

Value class	Number of cars and wagons
$	
> 8000	1434
8000-6001	1604
6000-5001	1463
5000-4501	1458
4500-4001	2445
4000-3501	13099
3500-3001	34786
3000-2501	58141
2500-2001	62635
2000-1501	88072
1500-1001	49145
1000- 501	50468
500- 0	24625

TABLE 6.4 - DISTRIBUTION OF UTILITIES AND PANEL VANS BY VALUE IN QUEENSLAND

As at June 30, 1972

Value class	Number
$	
4500-4001	674
4000-3501	848
3500-3001	1256
3000-2501	7953
2500-2001	14557
2000-1501	14212
1500-1001	13644
1000- 501	12854
500- 0	7030

TABLE 6.5 - DISTRIBUTION OF TRUCKS, SEMI-TRAILERS AND MOTOR CYCLES BY VALUE IN QUEENSLAND

As at June 30, 1972

Value class	Trucks	Motor cycles
$		
>14000	1044	
14000-10001	2688	
10000- 6001	8334	
6000- 5001	3092	
5000- 4501	2931	
4500- 4001	1298	
4000- 3501	4448	
3500- 3001	4399	
3000- 2501	5070	
2500- 2001	5226	
2000- 1501	5893	
1500 1001	4706	3805
1000- 50	5019	13779
500- 0	2761	11915

Performance

The final variable included is performance. This was considered a useful variable to include in this model as another indicator of 'what the traffic will bear'. The classification of vehicles in this model into high performance and normal performance characteristics is arbitrary. If such a model were used it would be quite easy to establish an unambiguous decision rule, say, brake horse-power to weight ratio.

In this analysis the following vehicle makes were considered to be in the high performance category:

Alfa Romeo	Holden V8
Audi	Jaguar
BMW	Lamborghini
Bolwell	Lancia
Buick	Lotus
Cadillac	Maserati
Chevrolet	Mercedes Benz 280
Valiant V8	Mercedes Benz 3.5
Dodge	Mercedes Benz 6.3
Citroen DS21	M.G.
Daimler	Cooper S
Datsun 240C	NSU Ro 80
Datsun 240Z	Peugeot 504
Capri V6	Rambler
Fairlane V8	Rolls Royce
Mustang	Rover 3500
Thunderbird	Statesman
	Triumph

The high performance category amounted to 12.6 per cent of the 1971 registrations. The distribution of high performance cars was assumed constant from year to year. In the absence of other information, 66 per cent all motor cycles were assumed to fall in the high performance category.

Operation of the Model

The total number of motor vehicles in Queensland has been classified into various classes relating to:

(a) the area in which it is registered
(b) the purpose for which it is used
(c) performance characteristics and
(d) value.

The variables b, c and d have been chosen as proxies for the elasticity of demand for road space by various user classes. Variable a, area of use, was included because previous investment decisions in roads have resulted in significant shortages of road space in cities and urban areas and significant excess supply in country areas. The relative weight given to this factor can obviously be varied greatly. The weights used in the model were chosen mainly for purposes of exposition.

Clearly each variable is not of the same importance as a proxy for elasticity of demand. Ownership of a high priced motor vehicle is a clear indication that the owner/user has a less elastic demand for road space than the owner/user of a vehicle having a much lower value. But the relative importance of the value component in a formula, which includes other variables mentioned, requires assignment of weights to each of the components in the formula. Since value is argued to be the most important, it is given the heaviest absolute weight.

The determination of the value of the relative weights is based on a reasoned judgement about the relevant elasticities. When more is known about the actual elasticity coefficients the weights can be adjusted. Table 6.6 shows the relative weights attached in our model to the various value classes of vehicles.

TABLE 6.6 - ESTIMATES OF RELATIVE WEIGHTS FOR DEMAND ELASTICITIES BY VALUE CLASS OF VEHICLE

Value class [(a)] $	Relative weight
> 8000	55
8000-6001	36
6000-5001	24
5000-4501	19
4500-4001	16
4000-3501	13
3500-3001	11
3000-2501	9
2500-2001	7
2000-1501	5
1500-1001	3
1000- 501	2
500- 0	1

(a) Motor cars, station wagons, panel vans, utilities and motor cycles.

The weights attached to the value classes for trucks are similar to Table 6.6 and are illustrated in Table 6.7.

Consider one characteristic alone, say value. There are 1458 cars and wagons in the \$5,000 to \$4,501 class, and this value category attracts a weight of 19. Thus for the state as a whole this category yields 27,702 points. Similarly, for the value class less than \$500 there are 24,625 vehicles in this value group yielding 24,625 points.

So far as the weights to be attached to the other variables are concerned, high performance vehicles attract a weight of one while normal performance vehicles have a value of zero in the model. The weights attached to the use and the area of use of motor vehicles in the model are shown below. As mentioned, the weights have been chosen mainly for expository purposes (as shown in Table 6.8).

Using these data and the relative weights, it is possible, by considering each characteristic in isolation, to determine a total point score for the State. The necessary charge per point can be determined by relating this aggregate point score to the required revenue. This model formulation has several advantages over other models which may be used to achieve the same objective. Data sources are readily and separately available for each of the characteristics used in the model, and the operation of the model is simple, convenient and direct.

APPLICATION OF MODEL TO QUEENSLAND

Registration charges

The model may be used to demonstrate how an amount equal to existing total registration revenue may be collected from users by annual lump sum payment, based on 'what the traffic will bear' but leaving the method of collection of excise tax on petrol unchanged.

TABLE 6.7 - ESTIMATES OF RELATIVE WEIGHTS FOR DEMAND ELASTICITIES BY VALUE CLASS OF VEHICLE

Value class[a] $	Relative weight
> 14000	130
14000-10001	70
10000- 6001	46
6000- 5001	24
5000- 4501	19
4500- 4001	16
4000- 3501	13
3500- 3001	11
3000- 2501	9
2500- 2001	7
2000- 1501	5
1500- 1001	3
1000- 501	2
500- 0	1

(a) Trucks and semi trailers.

TABLE 6.8 - ESTIMATES OF RELATIVE WEIGHTS BY USE/ AREA OF USE

Use/Area of use	Relative weight
Government/Local Government	1
Private	1
Ancillary	2
Commercial	3
Brisbane	3
Provincial City	2
Country	1

In 1972 registration revenue collected from motorists in Queensland amounted to approximately $28 million. The aggregate point score for Queensland in 1972 was 7.362 million. Therefore each point has a value of $3.80. The annual lump sum payment by owners of particular motor vehicles will then be calculated in the following way:

Example 1 - Lump sum payment for a new Jaguar for private use in the Brisbane Metropolitan Area (BMA), with weights determined from the previous tables:

Value	55
Performance	1
Private use	1
Brisbane	3
Aggregate score	60
Annual cost per unit	$3.80
Total cost	60 x $3.80 = $228

Example 2 - Lump sum payment for the same Jaguar for private use in the country:

Value	55
Performance	1
Private use	1
Country	1
Aggregate score	58
Total cost	$220.40

Example 3 - Lump sum payment for a new Valiant (cost $4050) for private use in the BMA:

Value	16
Performance	0
Private use	1
Brisbane	3
Aggregate score	20
Total cost	$76.00

Example 4 - Lump sum payment for the same Valiant, after an elapse of 4 years, for private use in the BMA:

Value	7
Performance	0
Private use	1
Brisbane	3
Aggregate score	11
Total cost	$41.80

Example 5 - Lump sum payment for a new Mini for private use in the BMA:

Value	7
Performance	0
Private use	1
Brisbane	3
Aggregate score	11
Total cost	$41.80

Example 6 - Lump sum payment for a car of normal performance for private use in the BMA with an age of greater than 10 years:

Value	0
Performance	0
Private use	1
Brisbane	3
Aggregate score	4
Total cost	$15.20

If the vehicle in Example 6 was a high performance type the annual lump sum charge would rise to $19.80. By using the above weights, it is possible to establish the annual lump sum payment by motor vehicle class which would provide any required revenue.

Comparisons of above model application with the existing situation

Example 1 - The current registration charge for a Mini Minor (based on horse power and tare weight) is $17.25. This charge is independent of the age of the vehicle. From the model the charge for a new Mini Minor would be $24.55, a 42 per cent increase.

Example 2 - Using the model, a very expensive motor car, such as a Mercedes Benz would cost $228 to register in the first year, compared with $60.50 under the present system. Thus the lump sum payment for this vehicle class would increase by 277 per cent.

Example 3 - An 11 year old Mini Minor for private use in the city would attract a point score of 4 and a charge of $15.20. This represents a decline of 14 per cent. when compared with the present system.

Example 4 - For vehicles older than 10 years in the Holden, Falcon and Valiant class (the dominant makes in the market) the effect is more pronounced. The present registration charge for each member of this group is approximately $45 per year. Using the model, the lump sum payment for these vehicles will decline to $15.20 if they are for private use in the metropolitan area. This represents a reduction of nearly 200 per cent.

Registration charges and excise tax

In 1972 the total revenue collected in Queensland from excise tax on motor spirits ($59m) and registration charges ($28m) amounted to $87 million. The second application of the model is used to illustrate an alternative method of collecting this revenue.

If this revenue is to be collected according to 'what the traffic will bear', the aggregate score may be related to the total collections. Each point would have a value of $11.82 per unit (i.e. $87m divided by 7.362m).

To compare the results of this model with the existing system it is first necessary to make assumptions regarding average annual mileage and average fuel consumption. Then it would be possible to estimate the current contribution from each vehicle.

However, the collection of all revenue as a fixed charge is likely to result over time, in fewer cars being more intensively used, thereby reducing the 'fixed cost' per mile to the user. It seems unlikely that this will be regarded as a realistic alternative to the existing charging method, or to that previously proposed.

It seems unlikely that the traffic will bear such large lump sum charges, no matter how carefully they are calculated. Therefore it is not considered worthwhile to provide further detail for this method of application.

Further development of the model: collection of total revenue on a per mile basis

As mentioned previously, severe problems exist with the collection of total revenue (excise and registrations) by a fixed charge. The following adaptation of the model illustrates the collection taking into consideration the mileage completed by each vehicle in an accounting period (in this case one year).

Clearly, the odometer, which records vehicle mileage only, is unable to register the difference between city and country or congested and uncongested running, as no record is available of the speed at which those miles are run.

To collect the total revenue for Queensland some idea of the average mileage covered each year is required. For Queensland all vehicles, excluding buses, average 9,900 miles per annum[1]. The mileages for each major category are as follows:

Cars and station wagons	9,900 miles
Light trucks (open)	9,600 miles
Light trucks (closed)	11,500 miles

Large trucks and articulated vehicles exceed this considerably. For instance, trucks with a capacity greater than 16 tons cover 39,800 miles per annum on average. To illustrate the calculation of a per mile charge from the modified model, the annual average distance travelled for all vehicles is assumed to be 10,000 miles.

As previously mentioned the total revenue collected from the excise tax on fuel and registration charges was $87 million in 1972 and the charge for each point for Queensland was $11.82. The new formulation becomes:

$$\text{Cost (\$ per annum)} = \frac{\text{Point Score x Mileage x 0.1182}}{100}$$

Thus the model will result in the per mile costs being in direct relationship with previously calculated point scores i.e.

Point scores:

New Jaguar, private use Brisbane	60 points
New Valiant, private use Brisbane	20 points
Valiant, 4 year old Brisbane	11 points
Old car Brisbane	4 points

(1) Commonwealth Bureau of Census and Statistics, Motor Vehicle Survey, ref. no. 14.4, 30 Sept. 1971.

The range in per mile charges is 4 to 60 (i.e. 15 to 1) i.e. for new Jaguar 7.092¢ per mile
for old car 0.4728¢ per mile.

This appears to be a very substantial differential in the per mile variable charge by different vehicle types. However the present effect of fuel consumption must be considered. For example, at 30 miles per gallon and with an excise tax of 17.3¢ per gallon the rate is 0.577¢ per mile, while at 15 miles per gallon the rate is 1.154¢ per mile.

The effective range of this system is greater than the range of the present system but will be comparatively less than 1 to 15 because vehicles in higher price categories have generally higher fuel consumptions.

Consider the following example: the cost under the present system of running an old Mini Minor doing 10,000 miles per year and assuming 35 miles per gallon is approximately $67.

i.e. excise tax $49.42 (1)
registration charge $17.25

The proposed system would yield:

$$4.0 \times \frac{10,000}{100} \times 0.1182 \doteqdot \$47$$

This result contains a strong incentive to cover less miles. In the above case the cost of 5000 miles would be approximately $23.50 compared with about $42 under the present system.

This model also has a great impact on trucks. Consider a V8 petrol driven vehicle averaging 10 miles per gallon and operating for 40,000 miles per year. Under the present charging system the cost will be about $772, made up of $692 excise and about $80 registration.

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(1) 17.3 cents per gallon used throughout.

Under the suggested approach the charge is $3546 made up in the following way:

Point score -

Value	70
Use	3
Area of use (say)	2
Total	75

This yields a charge of 8.87¢ per mile.

For a large truck the cost per mile compared with that of an old car could be in the ratio of 135 to 4. However this is not likely to be important - substitution of an old car for a new large truck is not easy.

However there may be substitution of old trucks for new ones, as at the extremes the per mile relationships vary between 135 and 5 points and so the per mile charge will vary between the same limits.

Thus this approach exhibits difficulties in terms of the collection of total revenue. It is likely to encourage a very different vehicle mix after its introduction compared with the existing vehicle mix. In other words, the existing charges are 'what the traffic will not bear' and so an alteration of the weights for trucks is appropriate. Alternatively, the problem of retaining the same weighting structure for both trucks and cars may be overcome using a two part tariff.

COLLECTION OF TOTAL REVENUE(1) USING A TWO PART TARIFF

The first part of the tariff is a fixed charge designed to collect $28 million(2). Each point score

(1) Existing excise taxes and registration charges.

(2) This is equivalent to total registration revenues raised in Queensland in 1972.

has a value of \$3.80[1]. The point score is calculated on the basis of what the market will bear.

The second part of the tariff is the fuel tax component. It should have a per mile charge differential no greater than, say, 1 to 4 over the whole vehicle population. To achieve this the point score should have upper and lower limits of 60 and 15, respectively. The imposition of these limits necessitates the recalculation of the point scores. As the major item here is value, all vehicles with a value less than 12 points are rated in the 15 point class[2]. For the Queensland vehicle population, the aggregate point score generated for characteristics other than value (i.e. performance, area and type of use) amounts to 3.345 million points. Using the limits and recalculating the value points, an aggregate of 7.278 million was obtained.

The total point score for Queensland thus becomes 10.623 million. These points are then used to collect the \$59 million presently collected in excise taxes. The charge for each point is therefore \$5.55 per annum, or 0.056¢ per mile, if a mean mileage of 10,000 is assumed. This results in a variable charge of 3.36¢ per mile for any vehicle, with an aggregate point score of at least 60. A vehicle with an aggregate score of less than 15 is charged 0.84¢ per mile.

<u>Sensitivity test for variable charge</u>

The reduction of the lower limit by five results in a range of 60 - 10 points. The point score for the value characteristic would fall to 5.001 million. The aggregate point score then equals 8.346 million yielding a value for each point of \$7.07 or 0.0707¢ per mile.

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(1) Refer to p.49.

(2) This represents an approximation as no data are available for individual vehicles. But it is assumed that on average other characteristics amount to 3 points.

High valued vehicles would therefore be rated at 4.24¢ per mile, while the low value vehicle would attract a charge of 0.707¢ per mile.

If a range of 60 - 20 is considered the point score of the value component equals 8.396 million. The aggregate point score then equals 11.741 million. Each point would then have the value of $5.025 or 0.0503¢ per mile.

High valued vehicles would then incur a charge of 3.02¢ per mile, while the cost to low valued vehicles would be 1.00¢ per mile.

<u>Comparison of two part tariff with the existing situation</u>

Consider a new Jaguar (or any other expensive vehicle) for private use in the Brisbane area, motoring 10,000 miles per year. The point score for this vehicle is 60. The <u>fixed charge</u> is given by:

60 x $3.80 per point = $228

The <u>variable charge</u> is 3.36¢ per mile (on the basis that the maximum range in variable charges is 1 to 4) or $336 p.a. The total charge is therefore $564.

This compares with the present situation of:

Registration charge approximately $60

Excise tax (assuming 14 miles per gallon) is approximately $123

Aggregate cost approximately $183.

Therefore the two part tariff would increase the charge by $381.

The charges for the new Valiant/Holden/ Falcon class for private use in the BMA are:

Point score = 20
Fixed charge = $76
Variable charge = 20 x 0.056¢ x 10,000 = $112
Aggregate = $188

Under the existing system for the same class of vehicle in the same area the charges would be:

Fixed charge (registration) ≑ $45
Variable charge (assuming 18 miles per gallon) = $96
Aggregate = $141

Thus the two-part tariff represents an increase of $47.

The impact of the two-part tariff on the truck market now needs to be considered with particular emphasis on the substitution effect.

The point score for any truck must lie within the range 15 to 60. Because of the artificial discontinuities established in the value table, the upper limit (60 points) would occur at a value approximating $8,000 for all trucks with a purchase price greater than $8,000. Thus the variable charge is the same. Similarly, at the lower limit (15 points) of the scale, trucks with a value below $4,000 incur the same variable cost. Consequently, the variable charge provides no incentive to the owner either to substitute downwards or to keep trucks longer once their value has fallen below $4,000. Therefore this method of charging will not cause substitution in this range. Similarly at values greater than $8,000 all trucks are rated identically and so the choice of truck will not be influenced by this variable charge. The vehicle mix in this end of the market will be the same as now.

This represents an inefficiency as far as the model is concerned. It fails to capture some of the consumer surpluses generated by the more highly priced vehicles.

Discussion of the possible substitutions within the limits remains. Due to the exponential nature of the value weighting curve(1), the substitution effect is more pronounced in the upper classes within the limits. Consider the following two vehicle classes with variable charge of 0.056¢ per mile per point:

$5001-6,000 truck class - 24 points
i.e. 1.34¢ per mile

$4001-4,500 truck class - 19 points
i.e. 1.06¢ per mile.

Thus if the higher valued vehicle did not have quality attributes (performance, load capacity, down time charges) greater than 0.28¢ per mile adjusted for capital charges, there is an incentive to substitute downwards. However on the other hand, there may be an incentive to substitute upwards if the quality attributes are of a greater value than 0.28¢ per mile (adjusted for capital). In this case a surplus is produced which the taxing authority has not captured.

At the extreme, consider a vehicle falling just below the upper limit i.e. $8,000 (say $7,500) and attracting 46 points. The per mile variable charge will be 2.58¢ per mile compared with 1.06¢ in the $4,000-4,500 class. Thus there may be substitution if the capital adjusted quality aspects of the considerably more expensive vehicle do not exceed 1.5¢ per mile.

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(1) See page 48.

Judicious adjustment of the upper and lower limits will effectively eliminate changes in the truck mix before and after the imposition of the variable charge. Additionally, a substantial proportion of the truck market falls in the region above the upper limit and so is not influenced by the variable charge.

The effect of the imposition of the variable charge on the incentive to hold older trucks must now be considered. Running costs are an increasing function of age while the variable charge is a decreasing function of age (value). Any substitution will depend on the exact relationship of these two functions. However, some generalisations can be made. Firstly, there is no incentive to keep a vehicle, considering the variable charge in isolation, once the vehicle is below $4,000. Secondly, no benefit is derived from a decline in the variable charge until the value of the total rig falls below $8,000. This raises the question of whether it would be worth holding a vehicle once its value falls below this level.

Consider a $20,000 rig depreciated at 20 per cent (straight line per year)[1]. It is not until the 4th year of operation that the value of the rig falls below $8,000. The variable charge would then fall from 3.36¢ per mile to 2.58¢ per mile. In the 5th year the variable charge would fall by 1.68¢ per mile, to 0.90¢ per mile.

In the 4th year, a truck has probably moved into the 120,000 - 160,000 mile range and is probably nearing major overhauls. During this year running costs could have risen by more than 0.78¢ per mile on the previous year. Similarly for the 5th year, running costs, particularly in terms of down time, may rise rapidly.

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(1) This is a high rate of depreciation but many hauliers turn over their prime movers once in 5 years.

An additional problem is whether the imposition of the charge results in vehicles being less adequately maintained. The major item determining the variable charge is value of the vehicle and this charge is not determined by reference to a specific vehicle at a specific point in time but rather by the initial value and then the age of the vehicle. Consequently there is no incentive to allow the vehicle to deteriorate rapidly so that it enters a lower value class. In fact the reverse is likely to occur. Maintenance will be undertaken to try to raise the productive capacity of the vehicle relative to its value class. However, as pointed out earlier, maintenance is not costless and thus a truck operator is faced with a clear cut trade-off.

THREE-PART TARIFF

Despite various comments, there is a de facto nexus between fuel tax receipts and road expenditure and these run at about 66 per cent per annum. Thus of the 17.3¢ per gallon about one-third or 5.8¢ per gallon represents a transfer to consolidated revenue. This fact immediately suggests a further model to allow a three-part tariff on motorists. There are other reasons, mentioned later in this section, for considering this model to have advantages over the others.

The total revenue to be collected is:

- $28 m from registration charges ;
- $59 m from excise made up of -

  $40 m for roads and
  $19 m for consolidated revenues.

The method of collection under the three part tariff system of charging is as follows:

(1) The equivalent revenue for registrations is collected as a fixed charge as previously outlined; each point attracting a cost of $3.80 per annum.

(2) The variable charge is levied on a point per mile basis with upper and lower limits (15 to 60). The rate per mile per point will be two-thirds of 0.056¢ i.e. 0.038¢ per point per mile.

(3) The consolidated revenue component, totalling $19 million, can be collected by any suitable means e.g. an excise tax on fuel, or sales taxes. However, because of the convenience and cheapness of collection, a case may be made for a conventional excise tax.

<u>Comparison of three-part tariff with the existing situation</u>

Consider a new Jaguar (or any expensive car). The charge under the three-part tariff becomes:

(1) Fixed charge - 60 points @ $3.80 per point
= $228.

(2) Variable charge = 0.038¢ per mile per point
= 2.28¢ per mile

or $228 per annum (assuming 10,000 miles per annum).

(3) Excise - 714 gallons (assuming 14 miles per gallon) @ 5.8¢ per gallon = $41.4

Thus the total charge is $497. Compared with the current charge of $183[1], this is an increase of $ 314, although compared with the two-part tariff this represents a reduction of $67[2].

For the new Valiant/Holden/Falcon class (point score of 20) a three-part tariff would result in the following charges:

(1) Fixed charge = $76

(2) Variable charge

20 x0.038¢ x 10,000

= $76 per annum (assuming 10,000 miles per annum).

(3) Excise - 556 gallons (assuming 18 miles per gallon) @ 5.8¢ per gallon

= $32.2 p.a.

Thus the total charge is $184. This is about the same as suggested by the two part tariff pricing system[3]. Under the existing system the cost, as calculated before, would be $141[4].

The effect of taking out the consolidated revenue component reduces the variable charge and further weakens any possible substitution between vehicle value classes due to the imposition of this charging method.

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(1) See page 57.
(2) See page 57.
(3) See page 58.
(4) See page 58.

Whether the Australian Government is likely to give serious consideration to a three-part scheme, leaving the first part to the States and collecting the other two parts itself, is not known. The adoption of the mileage charge would, in itself, represent a revolution in attitude. But it is important to continue to point out the advantages of such an approach. The additional advantage of the three-part tariff is that it is then possible to separate the road payment part from the tax part. The importance of this is the clarification of intermodal resource allocation. Railways, in particular, would then pay the fuel tax on the same basis as road users, since it would not include any payment for the use of the roads and would be a simple revenue tax. The rate of tax can be changed independently of the rate of charge for road use, and intermodal bias would be minimised.

CHAPTER 7 - CONCLUSION

It is not part of our present task to investigate the acceptability of the various alternative approaches to road pricing we have put forward here. We have tried to show why a method of charging, based in part on 'what the traffic will bear', is superior to the existing system. The main reasons are that such a pricing system would more closely approximate the workings of the market place, given jointness in supply. It would, admittedly, be still very far from any ideal, but the temptation to make the perfect the enemy of the good must be resisted.

There is obviously a great deal more work and thought to be given to this facet of applied economics. We are confident, however, that our arguments are a move in the right direction. A wider study would include some methods for estimating demand in different parts of the network, and indicate a connection between revenues collected and expenditures on maintenance and improvements in each part of the road system. An 'appropriate' price policy is necessary, together with information about use of the different parts of the road system. With a little imagination, it is possible to argue that a road network, like a rail network, can be disaggregated into component parts, for which revenue and costs are available. Like other public utilities, it is then possible to expand supply (increase quantity/quality of road space) where revenues exceed costs and to decrease supply where costs exceed revenues. Additional calculations can still be made if revenues are regarded as an inadequate guide for supply adjustments.

We conclude with the usual caveat about possible and probable errors in fact and theory. It is easy to lose oversight when attempting to solve some apparently minor but reasonably practical problems. If this work will do no more than stir the thought processess of those who have ceased to think about the problem and starts a few arguments, then it will have achieved its major objective.

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