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A Self-financing Road System

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Published by
THE INSTITUTE OF ECONOMIC AFFAIRS
1966

First published April 1966

Printed by
IMPRESS (HEREFORD) LIMITED.
Set in Univers 9/10 point, Series 689.

Preface

The Institute is a research and educational trust founded in 1957 to clarify the application of economic theory to business practice and public policy. It is the only independent organisation in Britain that specialises in the micro-economic analysis of existing or potential markets in the private and public sectors of the economy. Apart from full-length studies it has since 1960 published *Hobart Papers* on a wide range of policy problems. Since 1963 it has published *Eaton Papers* on questions more narrowly concerned with information in the British economy and *Occasional Papers* that reprint articles or addresses not otherwise readily available in Britain.

All IEA *Papers* and books incorporate research material, but the focus of interest in some series is in the author's analysis and policy recommendations. In the *Monographs* empirical research is the author's primary contribution, although where practicable he is also invited to indicate policy implications. In *Research Monograph 3* Mr. G. J. Roth (author of *Paying for Parking*[1] and a member of the panel which produced the Smeed Report)[2] draws on his work as a transport economist to consider how far more efficient pricing policies and techniques can economise the use of existing roads, attract additional resources, facilitate a more rational allocation of investment funds and thus improve the British road network.[3] He proposes that the present indirect method of paying for roads by road licence, petrol and purchase taxes, so that motorists hardly relate their payments to their use of the roads, should be replaced by a structure of prices in which motorists are directly charged with 'marginal' private and social costs of wear, tear and congestion which they impose on the road system and other road users. Mr. Roth argues that surpluses from this direct pricing policy should be reinvested where they will maximise the profits of road suppliers. Under this system motorists would be vividly aware of the personal cost to them of using roads, thus encouraging economy and dramatising the discipline of foregoing alternatives: a man in a taxi facing the meter is more conscious of his mounting fare than a motorist paying tax.

Economists differ on the extent to which congestion costs have been or can be measured accurately. But whatever the divergent views on this controversy, Mr. Roth's researches re-

[1] Hobart Paper 33, IEA, 1965.

[2] *Road Pricing: the Economic and Technical Possibilities*, HMSO, 1964.

[3] In a forthcoming study of the economics of town planning and traffic, to be published later this year by the IEA, Mr. D. J. Reynolds argues that, if their currently unmanageable problems are to be simplified and made susceptible to rational economic appraisal, road pricing is essential.

emphasise the growing need for pricing as the most rational, impersonal and non-arbitrary method of allocating a scarce resource efficiently, raising additional finance for its further development and ensuring that it is reinvested where it is most 'needed'.

Roads must in practice be rationed in one way or another: by edict, licence or congestion—or by price.[1] The advantages of a pricing system are being recognised increasingly by economists and others because of its discipline as a rationing device. Sociologists who oppose its application elsewhere (e.g. health and education) on the egalitarian grounds that it constitutes a 'barrier' to consumers would sacrifice these advantages; money grants to people in special need would overcome the barrier with minimum loss of efficiency.

The economics of transport policy is dominated by two questions. First, should roads be priced, and if so, how? Second, should they be supplied by public authority or by competing enterprises, and, if competitively, by public or private suppliers or a mixture of both? Mr. Roth is essentially concerned with the first question. He assumes that all existing roads are to be controlled by self-financing public authorities, and the main interest of his *Monograph* lies in the analysis of alternative pricing policies they could adopt, and of the consequences of each. In a note (page 75), and at several points in his main text, Mr. Roth briefly considers some aspects of competitive road supply. While recognising its advantages he is sceptical of its feasibility in urban areas but argues that it is both possible and desirable in rural areas for both minor roads linking villages and major motorways. The desirability of a unified framework for town roads does not necessarily imply that they must be owned, built or operated by public authority, nor that they should be financed by public capital raised by state or local authority borrowing.

The Institute wishes to thank Professor E. Victor Morgan of the University College of Swansea and Mr. F. G. Pennance of the College of Estate Management for comments on early drafts of the *Monograph*. Like them, the Institute and members of its Advisory Council do not necessarily endorse Mr. Roth's analysis; but when official thinking is drifting to 'integration' in transport that ignores the economic implications of the absence of pricing it is particularly timely as a thought-provoking contribution to the academic and public discussion of the economics of transport.

EDITOR

[1] The case for pricing has been put eloquently and alliteratively by Mr. Mervyn Jones: 'The alternative . . . to compulsion . . . is to exercise persuasion by price . . . to let the motorist decide for himself whether his use of the car is worthwhile and to make sure that he thinks twice about it.' (*New Statesman*, 4 March, 1966.)

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The Author

GABRIEL ROTH was born in Manchester in 1926. He studied civil engineering at Imperial College, London, and economics at Christ's College, Cambridge. After spending his civil engineering apprenticeship with Sir William Halcrow and Partners he went to the Road Research Laboratory as a Rees Jeffereys Fellow to study some of the economic benefits obtainable from road improvements. This work stimulated an interest in the economics of roads and traffic, and eventually he found his way to the Department of Applied Economics in Cambridge where he spent three years investigating the economics of car parking. He is now working in London as a consulting transport economist.

He has written articles on the application of economics to transport and traffic in the *Journal of the Town Planning Institute,* the *Town Planning Review,* and the *Westminster Bank Review.* He has lectured and broadcast on transport economics, was a member of the Smeed Committee on road pricing which reported in 1964, and is the author of *Paying for Parking,* Hobart Paper 33, published by the IEA in 1965, and of *Parking Space for Cars: Assessing the Demand,* Cambridge University Press, 1965.

Aknowledgements

I am indebted to Mr. Gilbert Ponsonby, Professor A. R. Prest, Mr. J. M. Thomson and to the research staff of the IEA for discussions and comments on the early drafts of this *Monograph.*

G. J. R.

ONE

Introduction—Why pay for Roads?

There has been considerable discussion of road finance recently and the appearance of yet another contribution deserves an explanation. Most of the work done hitherto has been based on the assumption that roads should continue to be financed as a welfare service, out of general revenues, without direct connection between the amounts paid for the use of roads and the amounts spent on the roads. The object of this *Monograph* is to examine some of the implications of treating road space as an ordinary commodity, such as office space or theatre seats, and it argues that present methods of road taxation and of allocating funds to road use could be replaced by better ones.

There will be no attempt to build up an 'exact' theory, nor to discuss the validity of the basic economic assumptions. As a starting point, the reader is asked to assume that the principles on which we rely for the allocation of the vast majority of goods and services can be usefully applied to the allocation of road space, and that the objects of charging for the use of the roads are those that we take for granted in the case of most other commodities:

(*a*) To ensure that the best use is made of the existing facilities;

(*b*) To indicate where—and to what extent—the existing facilities need improvement; and

(*c*) To provide sufficient funds—no more and no less—to cover the costs of the facilities for which the charges are made.

Few readers will quarrel with the first two objects. A pricing system should encourage the best use of existing roads and it should provide information on the need for improvement. But many will disagree with the third object. Why should the revenues collected for road use be equal to the costs of the roads?[1] Is there not a case for treating roads as a social service, and supplying them at prices that do not cover their costs ? Conversely, might we not regard road use as a source of general revenues, and charge more for it than its costs ?

[1] 'Costs' include the profits required to attract the necessary resources to the road 'industry'.

The question of subsidies is the easier of the two to deal with. Many of us feel that the distribution of income is unfair and that not everyone obtains the comforts—nor indeed the necessities—he should have. But acceptance of this view need not lead us to support indiscriminate subsidies to road users. Road users come from all classes; those who use roads most—the car owners—belong to the better-off rather than to the poorer sections. There is no evidence that general subsidies to road users would improve the distribution of income or bring benefits to people in most need of them. Until such evidence is forthcoming there is no general case for providing roads at prices that do not cover their costs.

It is sometimes suggested that roads produce 'external economies', i.e. general benefits to the community which are not charged for, and that on this ground roads should not be treated as ordinary economic assets. While it is true that the reduction of transport costs that results from improved communications brings many community benefits, it does not necessarily follow that charges for roads should not be made. This question has been discussed by Mr. D. L. Munby who wrote:

> 'The building of a road involves great indivisible expenditure, and the return on the investment may take a long time to mature. But it is not clear that these facts which are often in the minds of those who talk of external economies, are strictly relevant. They suggest that building a road is a matter for very wide consideration, and rather inevitably a matter for governments and not private enterprise. But because a lot of money is involved, and because the return may only mature when a host of new industrial developments have occurred in the course of time, there is no argument for not charging for the use of the road (perhaps not in the early days), or for not trying to cover cost (in some perhaps long period of time). The risks may be very great, the estimates very faulty. But the matter is not in principle different from other forms of investment. It provides no case for a subsidy, and does not lead to any suggestion that a road the users could not be made to pay for (if an ideal charging system could be devised) would benefit the community more than a power station, which they would be ready to pay for.'[1]

Mr. Munby concludes that only one reason can justify transport subsidies: a need to influence the location of industry. But even this reason does not appear to justify permanent subsidies. A location pattern dependent on permanent transport subsidies cannot be efficient.

Should the price of road use include a contribution to general

[1] 'The Roads as Economic Assets', *Bulletin of the Oxford University Institute of Statistics*, Vol. 22, No. 4, November 1960, p. 273.

revenues ? The stock answer to this question is that 'the government can do what it likes' and that the question is one for politicians, not for economists. But the economic aspect is still important.

In the first place the economist is likely to argue that taxation of road use should be explicit, and voted by Parliament every year as are other taxes.

> 'There is no more justification for taxing transport as such than for taxing gas or electricity. If, however, it is desired that road transport should contribute directly to budgetary taxation [the levy] must be added to the total road transport track costs as a special item, so as to keep it separate from track costs.'[1]

Second, if the government decides to tax transport it should tax all forms of transport equally—rail as well as road. At the moment, government policy is to subsidise transport by rail and to tax transport by road. The effect is to discourage the development of new methods of transport—by road—for which users are queuing up to pay, and to encourage the retention of old methods—by rail—for which users are not prepared to pay. It is difficult to reconcile this policy with the politicians' repeated insistence that we have to modernise our methods to avoid a lower standard of living.

The object of this *Monograph* is to discuss the pricing policy applicable to a self-financing road system. It is *not*, however, essential to the argument that the use of roads should not be subsidised or taxed. If it is thought that road revenues should contribute to general taxation, or that road users should be subsidised, there need be no difficulty in superimposing the required taxes or subsidies on a structure designed as a self-financing one. It is this structure that I hope to sketch in the following pages.

The costs of providing and using roads will be considered in Section 2, pricing principles in Section 3 and methods of charging for roads in Section 4. A self-financing road system based on user cost pricing will be discussed in Section 5, and some of the consequences of user cost pricing in Section 6.

Although the principles of road finance are not difficult, or at least not more difficult than the principles of financing any other public service, road planning involves many complex problems of measurement and assessment. It is not suggested that economic theory can 'solve' all our transport problems. The point I want to make is that the application of basic economic ideas can help planners and engineers in their task of providing the kind of road system for which the users are prepared to pay. My object is to suggest general principles, not detailed plans.

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[1] Sir H. Osborne Mance, 'Road Finance', *Journal of the Institute of Transport*, July 1959.

TWO

The Costs of Roads

When considering the costs of roads, it is important to distinguish between the *costs of providing roads* and the *costs that arise out of journeys.*

The costs of providing roads are the *fixed* costs that have to be incurred to make road journeys possible but which do not vary in the short run with the amount of road use. They are often described as capital costs, indirect costs, and by other names. Costs that arise out of journeys are *variable*—fuel, time, wear-and-tear of the road surface, and so on. They are often described as direct or running costs.

The essential distinction is that the fixed costs of providing roads cannot be avoided by avoiding journeys. Once you have built your road you cannot get any money back by keeping it idle. On the other hand, the costs arising out of journeys can be avoided by avoiding journeys. There is no clear demarcation line between the two. Consider, for example, the costs of lighting a road; the cost of lamp standards is clearly one of the costs of providing the road in the first place; the cost of electric current is an avoidable cost that need be incurred only if journeys take place. But what of the electric light bulbs ? In the short run they can be considered as unavoidable costs, but when the time comes to replace them their costs can be avoided.

The difference between the unavoidable costs of providing roads and the avoidable costs that arise out of journeys is not one of principle but of degree. Even the costs of making the road can be avoided when the time comes to renew it. Thus the costs arising out of journeys can be more accurately described as short term, and the costs of providing roads as long-term. Most road costs can be classified without difficulty into the short-term or the long term category.

The costs of providing roads

The costs that have to be incurred in order to provide roads are the rental value of the space on which the road is built, the labour and materials used in its construction and the interest on the capital tied up in it. After the road is built it is necessary to

spend money on maintaining it, cleaning it and administering its use. A few words may be said on each of these items.

(a) *Rent for the use of land.* The appropriate rent to pay for a piece of land used as a road is the rent it could earn in an alternative use, on the assumption that the rest of the road system continued in its existing function. It is sometimes suggested that it is not reasonable to charge rent for road space, because if it were not for the roads, the value of all the property in the neighbourhood would be insignificant. This argument is not convincing. Rental values in any district are due to the presence of shops, buildings, and land uses of different kinds, but this is no reason for holding that some land uses should not be charged for. The value of property in London is probably enhanced by the availability of electricity and water supplies. But this is no reason why electricity sub-stations and water pumping stations should be excused the payment of rent for the space used by their installations.

> 'In ordinary accounting, land required for motor vehicle use which has already been paid for, including land used for streets, is treated as a free good. This is true also of park land and other land already owned by governmental jurisdictions which is converted to motor vehicle use. However, for purposes of policy analysis, the imputed value of such land, that is, the amount that it would command in alternative uses, should be considered in computing the costs of motor vehicle transportation.'[1]

The rental value of land varies within very wide limits. Agricultural land might be worth £2—£15 per acre per year while the rental value of urban land can reach £500 to £50,000 per acre per year.

(b) *Construction costs*, i.e. the labour and material used in road construction. R. F. F. Dawson[2] examined a sample of 205 road improvement schemes and found that the costs of roadworks (which he defined as the total costs of road construction *less* the costs of land, bridges and subways, and ancillary works) vary less than the costs of land. Thus in 88 per cent of all the schemes he examined the cost of roadworks came to less than £1·5 per square foot and in 71 per cent to less than £1 per square foot. In six schemes roadworks cost more than £3 per square foot. The variation in the cost of roadworks is shown in Table I.

On average, the costs per mile of a single carriageway in urban areas (roadworks only) came to £84,000.

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[1] Lyle C. Fitch and Associates, *Urban Transportation and Public Policy*, Chandler Publishing Co., San Francisco, 1963.

[2] *An Analysis of the Cost of Road Improvement Schemes*, Road Research Technical Paper No. 50, HMSO, 1961.

Table 1

THE COST OF ROADWORKS

Percentage distribution of schemes among different cost ranges

Cost of roadworks (£ per sq. ft.)	percentage of schemes		
	Urban	Rural	All areas
0·20—0·39	3·4	10·7	7·1
0·40—0·59	11·5	41·0	26·4
0·60—0·79	19·8	19·8	19·8
0·80—0·99	20·5	15·1	17·8
1·00—1·49	23·6	9·7	16·6
1·50—1·99	11·3	3·7	7·4
2·00—2·49	4·3	—	2·1
2·50—2·99	—	—	—
3·00 and over	5·6	—	2·8
Mean per sq. ft.	0·88	0·65	0·73
Mean per scheme	1·34	0·69	1·01

Source: Road Research Technical Paper No. 50, *op. cit.*

Contrary to popular impression, there is no serious disagreement among experts on the extra costs that have to be incurred to accommodate heavy lorries on trunk roads. The Ministry of Transport calculated that the total savings in road construction costs obtainable by the exclusion of heavy lorries are of the order of 17½ per cent.[1] These figures are well documented and supported by other calculations carried out in Britain and in the USA. An assertion that over 70 per cent of the construction costs of motorways are due to heavy lorries was made by the British Railways Board in 1964.[2] The value of this assertion depends on the evidence on which it is based and the BRB has not yet published its evidence.

(c) *Interest on capital.* The capital assets locked up in roads represent resources that could have been used for other purposes. In order to prevent waste in the use of these resources it is desirable that interest on capital invested should be charged to the users as a cost. If an enterprise relies on private investment it has no option but to pay interest charges—it cannot raise money without paying for it.[3] It is now accepted by the government that the nationalised industries must also show a return on their capital,[4]

[1] Evidence to the Committee on Carriers' Licensing, 1964.

[2] 'A Study of the Relative True Costs of Road and Rail Freight Transport over Trunk Routes', British Railways Board, 1964.

[3] If it raises the money out of its own resources it loses the interest that this money could earn in an alternative investment.

[4] *The Financial and Economic Obligations of the Nationalised Industries*, Cmnd. 1337, HMSO, 1961.

though it has not been made clear which assets are required to earn interest and the rate of interest that should be payable.

As a first approximation it may be assumed that the appropriate rate of interest for any enterprise is the lowest rate which will induce people to invest their money in it.

(d) *Maintenance and administration.* It is in this category that it is difficult to separate the fixed costs of providing roads from the costs that arise out of journeys. For example, if the road surface is worn as a result of use, the resulting maintenance is clearly a cost arising out of road use. On the other hand, some maintenance is also necessary to make good or to prevent deterioration due to weather conditions.

For the purpose of this *Monograph* it will be assumed that only the costs of maintenance due to weather and vegetation come under the category of the fixed costs of providing roads. The costs of making good wear-and-tear due to vehicles, the costs of lighting, of traffic control, of police and of accidents will all be considered as costs which arise out of journeys and which can be avoided by avoiding journeys.

The costs arising out of journeys

It is convenient to distinguish between four classes of costs that arise out of journeys:

(a) *Private costs.* The costs borne directly by those who make journeys, or by those on whose behalf journeys are made.

(b) *Road use costs.* The costs of wear-and-tear of the road, lighting, traffic control, and all the costs of the road system arising directly out of road use.

(c) *Congestion costs.* The costs imposed by road users upon one another under conditions of congestion.

(d) *Community costs.* The costs imposed by road users on the community at large.

Private costs

These costs are paid for directly by road users—or by their employers—without giving rise to any special problems. But it is important to have some idea about how these costs vary with traffic conditions. The variation can be described on the basis of two relationships:

(a) The effects of changes in traffic volumes on traffic speeds.

(b) The effects of changes in traffic speeds on the private costs of road use.

The relationship between the volume of traffic and its speed under conditions of congestion has been investigated in a number of cities. Generally speaking, as the volume of cars increases the average speed falls. An example can be seen in

Figure 1 which shows the relationship between speeds and volumes on main roads in Central London. The graphs were obtained by measuring traffic speeds at different times of the day and plotting the speeds against the traffic volumes at those times. 'Running speeds' are the speeds of cars while on the move, while 'journey speeds' take account of stops at traffic

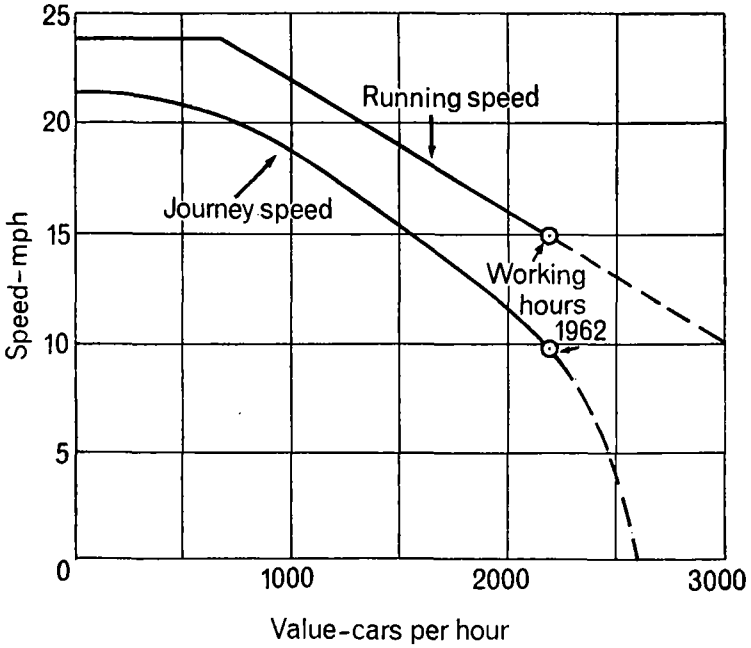

Figure 1. Relation between speed and amount of traffic on main roads in central London.

Source: Prof. R. J. Smeed, 'The Traffic Problem in Towns', *The Town Planning Review,* Vol. XXXV (2), 1964, pp. 133-158. (Crown copyright. Reproduced by permission of the Controller of Her Majesty's Stationery Office).

lights, etc. It will be seen that within the speed range 10—20 miles an hour the relationship between speed and volume is roughly linear. Mr. J. M. Thomson has described this speed-volume relationship in central London by the formula

$$V=28—0{\cdot}0089q$$

where q is the flow in PCUs[1] per hour and V the speed in miles per hour.

[1] PCU stands for 'passenger car unit'. It represents the amount of congestion caused by vehicles of different kinds, in comparison with the congestion caused by a car. Thus the PCU of a lorry might be 2, and of a motorcycle 0·5.

Table 2

AVERAGE TOTAL COSTS PER VEHICLE-MILE EXCLUDING TAX PAYMENTS AND INSURANCE

Costs in pence per mile for different ranges of speed V

Class of vehicle	Non-working time excluded		Non-working time valued at average income	
	V<40 mile/h	40<V<50 mile/h	V<40 mile/h	40<V<50 mile/h
Car	$3{\cdot}8+\frac{102}{V}$	$4{\cdot}4+\frac{78}{V}$	$3{\cdot}8+\frac{276}{V}$	$4{\cdot}4+\frac{252}{V}$
Commercial:				
Light	$3{\cdot}7+\frac{99}{V}$	$4{\cdot}0+\frac{87}{V}$	$3{\cdot}7+\frac{99}{V}$	$4{\cdot}0+\frac{87}{V}$
	V<30 mile/h	30<V<40 mile/h	V<30 mile/h	30<V<40 mile/h
Medium	$5{\cdot}0+\frac{116}{V}$	$5{\cdot}9+\frac{88}{V}$	$5{\cdot}0+\frac{116}{V}$	$5{\cdot}9+\frac{88}{V}$
Heavy	$7{\cdot}0+\frac{142}{V}$	$7{\cdot}8+\frac{118}{V}$	$7{\cdot}0+\frac{142}{V}$	$7{\cdot}8+\frac{118}{V}$
Public service vehicle	$9{\cdot}5+\frac{273}{V}$	$10{\cdot}6+\frac{239}{V}$	$9{\cdot}5+\frac{1256}{V}$	$10{\cdot}6+\frac{1222}{V}$
	V<37 mile/h	37<V<45 mile/h	V<37 mile/h	37<V<45 mile/h
Average vehicle	$4{\cdot}3+\frac{114}{V}$	$4{\cdot}9+\frac{93}{V}$	$4{\cdot}3+\frac{276}{V}$	$4{\cdot}9+\frac{255}{V}$

Source: R. F. F. Dawson, 'Vehicle Operating Costs in 1962', *op. cit.*

Vehicle costs contain elements that are independent of journey time and elements that vary with it. The main element that varies with time is of course the cost of time itself. Every journey involves a loss of time, and the magnitude of the loss depends on the alternative use to which the time can be put. Different people value time differently, and even the same person will value time differently under different circumstances. A man hoping to get a good seat at the football stadium might be prepared to hire a taxi to take him to the game, but be quite content to walk home afterwards.

The relationship between traffic speeds and private costs can be described by the following formula:

$$\text{cost}=a+\frac{b}{\text{speed}}.$$

The constants a and b differ for different speed ranges and for different vehicles. Mr. R. F. F. Dawson evaluated some of these constants[1] and some of his results are shown in Table 2.

Table 2 is divided into two sections. In the first two columns the value of non-working time is excluded, and in the third and fourth column it is included, being valued at the travellers' average income. (Travellers with no income were assigned the average income of the other travellers.) As the figures refer to the use of real resources, they do not include fuel tax, vehicle licences and purchase tax on cars. Nor do they include insurance costs.

The average costs in pence per vehicle mile are based on the average composition of traffic on all roads in 1961 (68 per cent cars, 4 per cent buses, 14 per cent light commercial vehicles and 14 per cent other commercial vehicles), and on the relationship between the speeds of the different classes of vehicle.[2]

Road use costs

Almost all the published information on road costs is about average costs. Figures are obtained by dividing the total expenditure incurred over the whole country, or over broad categories of roads, by the estimated vehicle mileage on those roads.

The total costs of maintaining and running the British road system in 1962 were calculated by the Ministry of Transport for the Committee on Carriers' Licensing (the Geddes Committee) and the totals for trunk and classified roads are shown in Tables 3(a) and 3(b). The figures in Table 3(a) were produced on a basis less favourable, and the figures in Table 3(b) on a basis more favourable, to heavy vehicles. Taken together, the tables represent a range within which the Ministry expects the true costs to lie.

From the sample survey of the roads and traffic of Great Britain conducted by the Road Research Laboratory in 1960,[3] and from subsequent statistics published by the Ministry of Transport,[4] it is possible to estimate the vehicle mileage travelled by vehicles of each category on trunk and classified roads. By dividing the total costs due to each category of vehicles by the vehicle mileage covered by that category the costs per vehicle-mile can be obtained, and these are shown in italics in the tables.

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[1] 'Vehicle Operating Costs in 1962', *Traffic Engineering and Control*, 1963, 4 (9), pp. 498-499, 514.

[2] For a fuller discussion of this point see Dr. G. Charlesworth and Mr. J. L. Paisley, 'The Economic Assessment of returns from Roadworks', *Proceedings of the Institution of Civil Engineers*, 1959, 14 (November), pp. 229-54.

[3] *Sample survey of the roads and traffic of Great Britain*, Road Research Technical Paper No. 62, HMSO, 1962.

[4] *Highway Statistics 1964*, Ministry of Transport, HMSO, 1965.

Table 3

(a) Road use costs on trunk and classified roads in 1962 on a basis less favourable to heavy vehicles

(£ millions. Figures in brackets represent pence per 100 miles)

Category of vehicle	Maintenance, repair, sign posting, etc.	Cleansing and snow clearing	Lighting	Accidents (costs not covered by insurance)	Policing	Highway administration	Total
Cars and taxis	14·3	17·3	4·5	3·9	25·3	6·1	71·4
	(8)	(10)	(3)	(2)	(14)	(3)	(40)
Motor cycles	0·9	1·9	0·5	0·4	1·4	0·5	5·6
	(5)	(10)	(3)	(2)	(7)	(3)	(30)
Buses and coaches	2·7	0·9	0·2	0·2	3·8	0·9	8·7
	(30)	(10)	(3)	(2)	(42)	(10)	(97)
Light vans	2·4	2·8	0·8	0·6	4·0	1·0	11·6
	(8)	(10)	(3)	(2)	(14)	(3)	(40)
Other goods vehicles	24·7	4·1	1·0	0·9	16·5	4·5	51·7
	(66)	(10)	(3)	(2)	(42)	(12)	(135)
Total	45·0	27·0	7·0	6·0	51·0	13·0	149·0

(b) Road use costs on trunk and classified roads in 1961 on basis more favourable to heavy vehicles

Cars and taxis	18·5	17·3	4·5	3·9	32·8	6·1	83·1
	(11)	(10)	(3)	(2)	(19)	(3)	(48)
Motor cycles	1·4	1·9	0·5	0·4	3·5	0·5	8·2
	(8)	(10)	(3)	(2)	(19)	(3)	(45)
Buses and coaches	3·0	0·9	0·2	0·2	1·6	0·9	6·8
	(33)	(10)	(3)	(2)	(19)	(10)	(77)
Light vans	3·0	2·8	0·8	0·6	5·2	1·0	13·4
	(11)	(10)	(3)	(2)	(19)	(3)	(48)
Other goods vehicles	19·1	4·1	1·0	0·9	7·9	4·5	37·5
	(50)	(10)	(3)	(2)	(19)	(12)	(96)
Totals	45·0	27·0	7·0	6·0	51·0	13·0	149·0

Source: Ministry of Transport's Evidence to the Committee on Carriers' Licensing. Figures for 'Light vans' and all figures in brackets calculated by the author.

These figures probably present a true picture of road use costs per vehicle mile on urban roads and on main rural roads, i.e. on the busy half of the British road system that carries 95 per cent of vehicle mileage. They are probably not relevant to the under-used half of the British road system which carries only 5 per cent of the total vehicle mileage.

The main weakness in the estimates of road use costs lies in the absence of detailed statistics. We require more information about the cost incurred on individual stretches of road and on the classes of vehicles that give rise to those costs. This is particularly important in the case of certain classes of heavy lorries.

Congestion costs

'Congestion' can be said to occur when road users impede the movements—and raise the costs—of one another. For example, cars slow each other down, pedestrians slow down cars when they cross the roads, and cars in their turn delay pedestrians. It is convenient to distinguish between two classes of congestion costs:

(i) The costs imposed on, and by, cyclists and pedestrians.

(ii) The costs imposed by motor vehicles on one another.

In order to calculate the congestion costs resulting from a particular journey it is necessary to know the effect of an *additional* unit of traffic on other road users. No information is available on the first category of congestion costs—the costs imposed on or by cyclists or pedestrians. But there is considerable information about the congestion costs imposed by vehicles on one another.

An approximate estimate of the effect of one vehicle in delaying the traffic can be calculated from the knowledge of the speed/flow characteristics of the road network, i.e. the effect on traffic speeds of changes in traffic flows. The costs of congestion are the costs of delay. They include higher labour costs, loss of peoples' time, higher fuel and running costs, and lower utilisation of vehicles and their loads. These costs have been measured in some detail by the Road Research Laboratory, and estimates for central London show that when the traffic is slowed down by congestion the costs imposed by an 'average' car on other vehicles vary as shown in Table 4.

These figures apply to an 'average' vehicle when the traffic is composed of 68 per cent cars, 4 per cent buses, 14 per cent light commercials, 14 per cent heavy commercials; 33 per cent of the costs are losses of paid working time, 53 per cent losses of non-working time (valued at three-quarters of working time), 6 per cent increased vehicle running costs, and 8 per cent the result of lower utilisation of vehicles and their loads.

Table 4

THE COSTS IMPOSED ON THE REST OF THE TRAFFIC BY AN 'AVERAGE' VEHICLE IN CENTRAL LONDON

Traffic speed (miles per hour)	Costs due to one additional vehicle-mile (shillings and pence per mile)	
	s.	d.
20		5
18		7
16		11
14	1	4
12	2	2
10	3	5
8	6	0

Source: Road Pricing: The Economic and Technical Possibilities, HMSO, 1964.

Table 4 may be better understood if regarded in the following way:

Imagine a stream of traffic moving at a speed of, say, 10 miles an hour. Let an additional vehicle join the stream; in doing so, it will slow down all the other vehicles. It has been shown that in the conditions prevailing in central London an additional vehicle-mile adds a total of 11 minutes to the travel time of all the vehicles.[1] This time loss is closely correlated to the increase in journey costs, 11 minutes' delay being equivalent to journey costs of 3s. 5d. Similar calculations can be made for other speeds.

The main source of doubt in these calculations relates to the valuation of time, particularly non-working time.[2] The value of time varies from one individual to another, but when we consider the large numbers involved on congested streets it is apparent that average figures may legitimately be used. The problem is how to obtain average figures for the valuation of journey time. The figures given in Table 4 are based on calculations made at the Road Research Laboratory from observations in London. Other valuations will give different results but will not affect the principles of the calculation.

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[1] For a mathematical explanation see R. J. Smeed, 'The Problem of Traffic in Towns', *Manchester Statistical Society,* January 1962. The time loss depends only on the traffic speed, and is independent of the number of vehicles making up the traffic stream.

[2] The valuation of non-working time raises many difficult problems. One would expect individuals to value non-working time at their net marginal rate of pay. For, if they did not, many would attempt to increase or decrease their hours of work. On the other hand, evidence collected by Prof. M. E. Beesley suggests that commuters value their travelling time at a third of their average wage. ('The Value of Time Spent in Travelling: Some New Evidence', *Economica,* May 1965.)

While for the purpose of illustration it was assumed that the costs imposed on the traffic stream are due to an additional car joining it, it would be more accurate to say that these costs are imposed both by and on every vehicle in the stream; early and late comers impose the same costs on one another and there is no reason to believe that those who come early are more worthy than those who come late.

The congestion costs of 4d. to 6s. a mile are far in excess of the 1d. to 2d. a mile paid in fuel tax by most private cars. When congestion costs arise in industry (due to shortages of one factor or another) they are charged to the consumer in the form of higher prices. On congested roads these costs are very high, and their importance is in no way diminished by the fact that they are inflicted on other road users.

Congestion costs arise out of scarcity—the scarcity of road space. This scarcity can enable the owners of a congested road to levy a 'rent' from the users, a rent equivalent to the rents chargeable by land owners, theatre and hotel operators and all who own scarce resources and make them available to others. It is evident that the benefits obtainable from a congested road are largest when the rent required from each user just equals the congestion costs resulting from his presence. For if the rent demanded falls short of the congestion costs imposed, some users will be attracted to the road even if the benefits to them fall short of the costs inflicted by them on others. While if the rent demanded is in excess of the costs imposed on others, some potential users will be unnecessarily debarred from using the road.[1]

Congestion costs on rural roads

Very little is known about the cost of congestion *outside* cities. In a paper prepared for the Geddes Committee on Carriers' Licensing,[2] Mr. J. M. Thomson worked out the congestion costs on the 34 census points used by the Ministry of Transport for its sample surveys of road traffic. The costs of delay imposed on traffic varied from 0·04d. to 2·44d. per heavy vehicle-mile, with an

[1] This can be illustrated by a numerical example. If a rent of 1s. per mile is charged, and if—under the conditions prevailing when this rent is charged—each vehicle imposes costs of 2s. a mile on the others, the rent is too low and congestion excessive. If the rent is raised to 2s. per mile, some vehicles will be forced off the road, traffic speeds will rise, and congestion costs might fall to 1s. a mile. In that case 2s. would be too high a rent, with traffic unnecessarily restricted. A rent of 1s. 6d. per mile, giving rise to traffic speeds at which congestion costs are 1s. 6d. per mile, might be the optimal one (see also page 54).

[2] 'The Costs arising from the Use of Roads by Goods Vehicles', Road Research Laboratory Note No. LN/751/JMT, January 1965 (unpublished).

average of 1·3d. The equivalent costs for a private car would probably vary between 0·01d. and 0·81d. per vehicle mile, with an average of 0·4d.

Community costs

This name can be used to describe the costs inflicted by road users not on one another but on the community at large.[1] Examples are the costs of noise, fumes, danger of accidents and loss of amenity. The existence of these community costs raises a large variety of problems.

In the first place there is the problem of evaluation. How much is silence worth? How much will shoppers pay to shop in a traffic-free precinct? How much will people pay to avoid diesel fumes? These are matters on which many people feel strongly but on which there is little direct numerical evidence.

A second class of problem concerns the relationship between the amount of road use and the community costs resulting from it. As a first approximation one might assume that the level of noise or of air pollution is proportional to the number of vehicles causing it. But one cannot assume that a relationship of this kind also holds where questions of safety and amenity are concerned. A road carrying 1,000 vehicles an hour will not necessarily be ten times as risky for pedestrians as a road carrying 100 vehicles an hour. From the point of view of, say, a parent having to send a child to school, the possibility of only a few cars passing in each hour will necessitate the same precautions as the existence of higher flows. For this sort of reason it is obvious that many community costs arise out of the existence of the road itself, and are not much dependent on the level of traffic in it. They are costs that arise out of the provision of roads, rather than as a result of journeys.

If it were possible to establish the magnitude of these community costs, what then ? Should compensation be paid by road users to those whom they disturb ? It is not possible to generalise about this. The intrusion of the motor-car can cause losses, and to the authors of the Buchanan Report it seemed

> 'a questionable ordering of social priorities that one group of people should find their established amenities ruined in order (in effect) to enable another group of people to use their cars.'[2]

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[1] These costs were called 'social costs' in the Smeed Report on road pricing, 'environmental costs' in the Buchanan Report and 'intangible costs' by J. M. W. Stewart in *A Pricing System for Roads.*

[2] *Traffic in Towns,* HMSO, 1963.

Professor M. E. Beesley and Mr. J. F. Cain accepted 'as a principle' that

> 'the sums needed to compensate the chief "environmental" losers should be regarded as a cost to be added to the cost of road improvements. This principle should extend to all forms of intervention in the existing network—establishing one-way systems, etc., which, though having little or no capital costs, have adverse effects on environmental values: the sums needed to compensate for these should be regarded as a charge upon the total investment budget . . . compensation should *actually be paid*.'[1]

But the position is not clear cut. Professor R. H. Coase has pointed out[2] that the compensation problem is a reciprocal one:

> 'To avoid the harm to B would inflict harm on A. The real question that has to be decided is: should A be allowed to harm B or should B be allowed to harm A? The problem is to avoid the more serious harm'.

Professor Coase concludes that 'when an economist is comparing alternative social arrangements, the proper procedure is to compare the total social product yielded by these different arrangements'. He shows that a practicable system of compensation will not necessarily maximise the social product. For example, if road users had to compensate the residents whom they disturb, it might not be economical for the road to be built at all. This might, or might not, be in the social interest.

How then can we decide which of 'different social arrangements' will maximise the 'social product'? Consider vehicle noise. One possibility, advocated by the authors of *Traffic in Towns,* would be for the government to fix absolute 'environmental standards' which would define the permissible noise levels in urban areas. This approach has its attractions—particularly if it is noise made by other people that is restricted—but how do we agree on the permissible noise levels, and how do we enforce such a standard ? Should we tax the use of noisy vehicles ? Or should we offer cash bonuses to those who silence their vehicles ?

Alternatively, should we abandon absolute standards and rely on 'environmental compensation', with householders being compensated for the fall in the value of their property due to the noisy traffic ? This approach also has its possibilities, but it might result in too many people living in noisy conditions, because there would not be sufficient incentive to move away from them.

It is not proposed to explore the problems of community costs in this *Monograph*, if only because there is no numerical

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[1] 'An Appraisal of Traffic in Towns', *Urban Studies*, November 1964.

[2] *Journal of Law and Economics*, Vol. III, October 1960, p. 1.

evidence on the magnitude of the factors involved. As an individual, I would like Parliament to legislate against noisy motor cars, but I am not in a position to justify this wish on economic grounds; I do not know what it would cost to silence cars nor how much I would be prepared to pay for silence. This *Monograph* will argue that road users should pay *at least* the road use costs and the congestion costs that arise out of their journeys. The question of the extent to which community costs should be paid for by road users is left as an open one. No doubt others will fill this gap in due course.

THREE

Pricing Policies

How can these costs be met ? First we must agree on a pricing policy and then (in the following section) we can examine charging methods.

A number of pricing policies can be applied to a public service such as roads. We shall first detail the alternatives and then discuss each one separately.

(a) *Arbitrary pricing*

The service is financed from the proceeds of general taxation, with no attempt to relate the amounts spent on the service to the revenues collected from users. This is the system currently used to finance roads, education, health, and some other services.

(b) *Average cost pricing*

The total costs of the service are divided among the users but with no attempt to charge individual users the costs incurred by the service on their behalf.

(c) *Marginal cost pricing*

The user is charged only the *extra* costs that arise as a result of his usage. It is necessary to distinguish the case in which the user is charged only the extra costs borne by the *supplier*, from that in which he is also charged the costs imposed on *third parties*. The former case arises when goods are produced under conditions of competition, and can therefore be called *competitive pricing*; the latter case is sometimes termed '*marginal social cost pricing*'. However, it was seen in the previous section that to charge for all costs inflicted on third parties raises a great many problems that cannot be dealt with here, and it is therefore proposed to discuss in detail only one type of marginal social cost pricing, the case in which users are charged the *costs imposed on the supplier and on one another*. This will be called *user cost pricing*.

Competitive pricing. Where goods are produced under conditions of perfect competition, suppliers will maximise their profits if they increase their production to the point at which the cost of producing an additional unit just equals the additional revenue obtained by the sale of that unit. For if production is restricted below this point, some profit will be foregone, while if production is pushed beyond it, some units will be produced at a loss.

User cost pricing. Users are charged the costs imposed on the supplier, and also the costs imposed on one another which were described in the previous section as 'congestion costs'. These congestion charges can be regarded as a rent paid to the supplier to ensure that the demand for scarce facilities is matched by the available supply. Such a charge is on a par with payments made for hotel rooms, theatre seats and other congested facilities.

(d) *Monopoly pricing*

Competition is restricted and this enables the suppliers to fix prices at levels which will maximise their profits. There are good and well known reasons for assuming that this policy is contrary to public interest.

Monopoly pricing differs from the user cost pricing in that it aims to maximise the profits of the supplier, while under user cost pricing the object is to maximise the productivity of the facility being charged for. The practical difference lies in the extent of the restriction. For example, if user cost pricing were applied to a hotel, the owner would aim at restricing bookings to the extent that all rooms were occupied and that there was no waiting list. Under monopoly pricing the hotel owner aiming to maximise his profits might find it to his interest to charge a price so high that some of his rooms were hardly ever let.[1] Similarly with roads, a monopolist might find it to his interest to restrict traffic unduly by charging more than user cost or else to charge less than user cost and to profit from excessive congestion.

Roads under arbitrary pricing

It is difficult to generalise about the position of road users under arbitrary pricing. Where no attempt is made to relate prices to costs, it is likely that some users will pay more than the costs incurred on their behalf and that some will pay less. It is not possible to say *a priori* whether under arbitrary pricing road users in total will pay more or less than the cost to the community of providing roads. There are good reasons for believing that at the moment the total paid in tax by road users in Britain exceeds the costs of the roads to the community. It will be suggested later (page 73) that in 1964 the amounts paid by *road users* in Britain exclusive of purchase tax, exceeded the costs of the roads by about £200million.[2]

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[1] This implies that a smaller hotel might have been a better commercial proposition. Roads often have excess capacity in their early years, but it is undesirable to discourage the use of such roads by charges that exceed user costs.

[2] Professor A. R. Prest, using different criteria, calculated that in 1961 the amounts paid *by motorists* exceeded the costs of the road system by £96 million, exclusive of purchase tax. See 'Some Aspects of Road Finance in the UK', *Manchester School,* September 1963. Professor Prest's figures excluded 'diffused and community costs'.

However, it might be argued that the disadvantageous tax position of road users is not inherent in the arbitrary pricing system used for the roads, but results from shortcomings in the representations made on their behalf. This is a subject on which it is not possible to be dogmatic, but my view is that the predicament of British road users is inherent in the arbitrary nature of the system.

An observer looking at the allocation of funds in our society cannot fail to be struck by the apparent ease with which bodies such as electricity boards, water boards and other *selling* organisations manage to rause funds, as compared with the almost capricious way in which funds are allocated to health, education and services that do not sell their products. The reason for this is not that administrators care only for things that are bought and sold; on the contrary, they are sure to be in favour of health and of education also. The answer is that services that sell are able to utilise consumer choice to attract the funds required to satisfy consumer needs. On the other hand, our health, education and welfare services are generally unable to attract funds by means of consumer choice; people are not encouraged to pay more in order to obtain better facilities. The needs of these services are assessed by the central government and their funds allocated by administrative means as a result of political decisions.

Roads in Britain are treated as a welfare service; their use is not sold to the public and the funds raised from road taxation are not necessarily made available for investment in roads. If the road 'industry' were put on a 'commercial' basis, with one or many suppliers empowered to raise revenues and invest surpluses in accordance with the economic principles that govern the optimum use of resources, much of the difficulty of raising funds for road improvement and urban renewal would disappear.

The rest of this *Monograph* will examine some of the alternatives to arbitrary pricing on the roads. Consider first a system of average cost pricing, whereby the total costs of the road system are assessed and divided among users in proportion to vehicle-mileage, ton-mileage or some other agreed measure.

Roads under average cost pricing

As was seen in Section 2, the costs arising out of the use of congested roads are of the order of shillings per mile, while the costs arising out of the use of uncongested roads amount to only fractions of a penny per mile. Any attempt to price the use of roads without taking these differences into account is bound to result in users of uncongested roads being overcharged and in users of congested roads being undercharged. The result is that, under a system of this kind, the demand for road space in congested

areas appears virtually limitless, and the provision of adequate road capacity a physical and economic impossibility.[1]

The point was put as follows by Thomas B. Deen:

> 'When all users of both high cost and low cost facilities pay the same tax, the result is equivalent to the situation of an electric company which decides to bill customers not on the basis of individual consumption, but by measuring total power usage for the community and charging each consumer an equal part of the total bill. Not only is this inequitable; more importantly, it would eliminate the incentive for conserving electricity. Many new houses would, doubtlessly, be heated with electricity, since an individual's cost would not be increased by a decision to install electric heat. Demand for power would soar, and new investment would be needed for new generating facilities. There would be no real basis for determining the proportion of total resources which should be devoted to power generation.'[2]

'There would be no real basis for determining the proportion of total resources which should be devoted to power generation.' This would be one of the main consequences of averaging the costs of power among those who use high-cost and low-cost facilities. The same difficulty arises when the costs of roads are averaged among users.

The main discrepancy between costs and charges arises in urban areas, where motorists are charged only a fraction of the costs that arise out of their use of roads. What effect does this have on road investment in urban areas? One possibility is that investment in urban roads is expanded beyond the optimal limits, in an attempt to meet the requirements for the available facilities that are provided too cheaply. Professor James M. Buchanan, the American economist, when analysing a similar situation in the National Health Service, suggested that under-investment is more likely to result:

> 'The British experience strongly suggests that, rather than responding to 'needs' through increases in aggregate supply, governments have chosen to allow the quality of services to deteriorate rapidly, both in some appropriate, physically-measurable sense and in terms of congestion costs imposed on prospective consumers.'[3]

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[1] 'It seems clear that the present, or suppressed, traffic demand in London and the probable growth in demand are so great that they will rapidly absorb any increased road capacity that may be made available.' (*Report of the Working Party on Piccadilly Circus*, HMSO, 1965, para. 670.)

[2] 'Fiscal Policies and Transportation Planning', *Traffic Quarterly*, January 1963.

[3] *The Inconsistencies of the National Health Service*, Occasional Paper 7, IEA, November 1965, p. 9.

The basic point made by Professor Buchanan (not to be confused with Professor C. D. Buchanan, the town planner, who did not make this point in his report on *Traffic in Towns*) is that where services are provided at prices below their cost there is a conflict between the interests of the individual in his capacity as the user and in his capacity as a provider of the service (taxpayer). In his capacity as a user, the individual

> 'will not find it personally advantageous to restrict his own demands, although he may fully appreciate that the value of these services to him is less than the cost imposed on the whole community in supplying them. . . . If he decides, privately and personally, to reduce his own demands on the services, for reasons of "social conscience", he will be acting irrationally. But since his behaviour will not, in itself, modify the behaviour of others in the aggregate, he will be foregoing opportunities for personal gains, however slight, without benefiting others to any measurable extent.'[1]

On the other hand, when the same individual, acting through his Member of Parliament, is faced with the choice of allocating funds for urban roads, he will attempt to balance total costs against total benefits in each sector of the economy. In this situation he will not give high priority to facilities for which users might not be prepared to pay, and will refuse to vote the vast sums required for the relief of traffic congestion in towns. His choice will be for a quantity of investment in roads much lower than that which would be required to satisfy his own apparent needs at the low prices prevailing.

This conflict between the individual in his capacity as the consumer of a public service and in his capacity as the taxpayer who finances it is at the root of many of the difficulties that afflict the public sector in Britain today. The obvious way of mitigating them is to remove this conflict, and to introduce pricing systems which place on the individual the responsibility for meeting the costs that result from his choices.

> 'Ideally, urban transportation fiscal policies would be designed so that each consumer (user) would be called upon to pay only the costs of the transportation services which he consumes. Implicit in such a policy is the concept of transportation as a commodity or service not fundamentally different from electric power, water,[2] or food, in that each consumer pays for these items in direct proportion to the quality and quantity of the service (or commodity) which he himself uses.'[3]

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[1] *The Inconsistencies of the National Health Service,* p. 13.

[2] Water is metered in many parts of the world, including most of the USA.

[3] Thomas B. Deen, *op. cit.*

Roads under marginal cost pricing

Preliminary considerations

Marginal cost pricing—charging the user only the extra costs resulting from a particular use—has many economic advantages. If applied generally it would ensure that the production of any commodity would be expanded to the point—and only the point—at which the cost of producing an additional unit would equal the price that users would be prepared to pay for it. Under certain theoretical conditions this pricing system results in the best distribution of resources. One may therefore ask why marginal costs are not charged throughout the economy. There are four factors which can make it difficult to finance a service by charging marginal costs.

First, if only marginal costs are charged, the service may not raise sufficient revenues to meet all its costs. For example, if on a railway only the wages and fuel used on a journey are considered to be 'marginal', and if only they are charged to the consumer, there would be no money to meet the track costs.

Secondly, in a large organisation it is sometimes very expensive to identify the costs resulting from different services, and therefore average costs of some kind have to be charged. For example, if the post office were to attempt to make a different charge for different inland destinations of letters, the cost of collecting the small differentials is likely to be out of all proportion to any savings made. But even in the post office, special charges are imposed to meet special costs. For example, the charges for letters going abroad are higher than for inland ones; the charges for heavy items are higher than for light ones; and special charges are made for services such as letter registration and telegrams.

Thirdly, some costs are imposed on third parties and those who bear these costs may not be able to collect them. For example, householders using inferior fuel may impose costs in the form of soot on their neighbours, who are not in a position to charge the users of inferior fuel the extra laundry costs. Similarly, a service might confer benefits on third parties who cannot be made to contribute to the cost.

Fourthly, some services—such as hospital services—cannot be financed by marginal cost pricing because of the unpredictable way in which users are liable to require expensive treatment. There are good reasons for financing at least some hospital services on an insurance basis, which is a form of average cost pricing.

Much has been written on the merits and demerits of marginal cost pricing,[1] and the subject cannot be gone into deeply in this

[1] For an instructive starting point see N. Ruggles, 'The Welfare Basis of the Marginal Cost Pricing Principle' and 'Recent Developments in the Theory of Marginal Cost Pricing', *Review of Economic Studies*, Vol. XVII, 1949–50.

Monograph. Suffice it to say that many economists believe that it is likely to be superior to other methods of pricing when the revenues raised are high enough to cover the total costs, when there are no special difficulties in assessing or charging all substantial marginal costs, when production yields constant returns to scale,[1] and when marginal costs are charged in competing services. To what extent are these conditions satisfied in the 'roads sector'?

It will be shown later that the revenues raised by a system of marginal cost pricing would exceed the total costs of the present road system, so long as congestion costs are included in marginal costs. Therefore the first condition would apply.

The second condition also applies, as there are no special difficulties in assessing road and congestion costs and it is likely that adequate charging methods can be developed to cover them. There are difficulties in assessing some of the costs that result from the road system, for example the costs arising out of noise, fumes and disturbance, but these do not undermine the case for charging the marginal costs that can be assessed.

Third, it is not easy to say whether the transport facilities provided by roads are produced under constant, increasing, or decreasing returns to scale. Where roads 'produce' transport services under conditions of increasing returns, there could be a case for charging users less than marginal costs; and where production is under decreasing returns there could be a case for charging more than marginal costs. As data on this matter is scanty, we shall proceed on the assumption that the production of transport services takes place under constant returns to scale, and elucidate the conclusions to which this assumption leads. The results can then be adjusted to take account of the cases where increasing or decreasing returns are shown to exist.

The fourth condition, of marginal costs being charged in competing services, is not fulfilled at the moment as the railways do not base their charges on marginal costs. But there do not appear to be any good reasons why marginal cost pricing should not be applied to services that compete with roads. It is therefore worth taking a closer look at marginal cost pricing in its application to roads. Consider first of all the operation of marginal cost pricing under conditions of competition.

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[1] Production is said to take place under conditions of 'constant returns to scale' if a given increase in all the factors of production results in an increase in output of *the same* proportion. 'Increasing returns' are obtained when production increases *more* than in proportion to an increase in production factors, and 'decreasing returns' when production increases *less* than in proportion to an increase in production factors.

Roads under competitive pricing

To what extent could competition take place in the provision of roads ? The essence of competition is the absence of restriction to the entry of new suppliers. In the case of connecting roads, i.e. roads whose function is to connect one point with another, competition is feasible and was common in Britain in the turnpike period. Such competition can be compared to that which used to take place between railway companies in Britain.

Under conditions of competition, road suppliers would attempt to maximise their profits, and road users to choose the cheapest routes. If any road supplier were to make abnormally high profits, additional suppliers would be attracted to expand the road system in this area and such expansion would continue until normal profits were earned.[1] In this way competition among profit-seeking road suppliers would be likely to lead to the provision of a road network most suited to the needs of road users.

While it is possible to envisage competition in the provision of roads connecting points at long distances apart, the position is different with access roads. In cities and in villages roads are used not only for the passage of vehicles but also to provide access to homes, shops and factories. In most cases access is provided by one road only, and the provision of further roads is impossible because of the technical layout of built-up areas. In these circumstances competition in any area is effectively impossible. Any firm or individual owning an access road would be in a monopoly position.

It follows from this that competitive pricing cannot be applied in built-up areas, the areas in which changes in road charging methods are most urgently needed. The subject of competition in road provision is taken further on pages 75-79. Meanwhile, it is necessary to consider the situation that arises when one road supplier is in a monopoly position in a given area. What should his pricing policy be? It will be argued in this *Monograph* that *user cost pricing* is likely to produce the optimum use of existing roads, and the optimum investment in new ones.

Roads under user cost pricing

Three basic rules

It will be recalled that under user cost pricing users are charged the costs arising out of the use of roads, comprising the costs (such as wear-and-tear) suffered by the supplier and the congestion costs imposed on other road users which would be the equivalent of a rental payment levied to ensure that the highest

[1] Normal profits are those which are just sufficient to keep all existing operators in an industry without attracting any new ones.

possible productivity is obtained from scarce road space. The policy of a road supplier running his roads on the basis of user cost pricing would be guided by the following three rules:

(a) He should charge all road users amounts approximating to the main costs, including congestion costs, arising out of their use of roads, no more and no less.

(b) He should pay the costs incurred in providing his roads, based on the current value of the resources consumed.

(c) He should expand those parts of the system on which revenues exceed outgoings; he should contract (or at least not expand) those parts on which outgoings exceed revenues, unless users are prepared to pay more than the costs arising out of road use or unless subsidies are provided by public authorities.

The application of rule (a) would ensure that the best use is made of the existing road system; no-one would be debarred from using the road if his benefits exceed the costs imposed on the system; and uses would be discouraged if the costs resulting from them exceed the benefits.

Rule (b) will apply in similar fashion to the activities of the road supplier. If he had to pay for resources in terms of their value in alternative uses, and if other users of resources had to pay for them on the same basis, an optimal use of resources would result, for no factor would be used for roads if given a higher valuation in another use.

Rule (c) follows the investment process in other industries. In the short run the price of a product under competitive conditions tends to equal the short-run costs of producing an additional (or 'marginal') unit. If this price exceeds average production costs, and gives an 'abnormally high' profit to the producers, new producers are attracted to the industry, thereby expanding output and lowering the price. Long-run equilibrium is reached when the process of expansion forces the price down to the level of the average cost. Similarly, the optimum size of a road system would be reached when its costs to the community just equalled the revenues raised by charges equal to user costs.

A formal proof of this rule has been given recently by Professor H. B. Mohring and by Professor R. H. Strotz, who discuss the conditions under which it can be applied.[1] Professor Mohring writes:

'To maximise the benefits derived from an existing road network, the highway authority must levy tolls equal to the

[1] Herbert Mohring, 'Relation between Optimum Congestion Tolls and Present Highway User Charges'; Robert H. Strotz, 'Principles of Urban Transportation Pricing', both papers published by the Highway Research Board in *Highway Research Record*, No. 47, 1965.

difference between short-run marginal and average congestion costs. If the resulting toll collections are greater than the total costs of the system (including, it should be emphasised, an interest charge equal to the market rate of return on capital invested in the system), expanding the system, thereby lowering both average and marginal vehicle operating costs and hence optimum tolls, is in order. A long-run optimum highway network results if this process of system expansion and toll reduction is continued to the point where network costs (again including the market return on invested capital) equal toll collections.

'Strictly speaking, a long-run optimum highway system requires that tolls equal capital costs only if the production of highway services involves constant returns to scale.'

Mr. D. L. Munby made the same point in 1960:[1]

'A congested road may be making a surplus over its cost of construction, etc. We would continue improving roads until such a surplus disappeared.'

The surplus would 'disappear' for two reasons: on the one hand the improvement would raise the cost of the road system; on the other it would reduce congestion, and hence the price payable by the users.

Contributions from non-motorists

Roads are used not only by motor vehicles but also by pedestrians and cyclists; by public utilities for gas, electricity, telephone and water mains; and they provide access to properties of different kinds. What is the appropriate payment in such cases?

Road use costs resulting from the passage of a cyclist are probably nil as far as road wear-and-tear is concerned. On the other hand, cyclists cause their share of traffic control costs and can give rise to congestion costs. Pedestrians can also cause traffic control and congestion costs and they enjoy the exclusive use of the pavement which should be charged wholly to them.

One could go further into the question of the charges which should be payable by pedestrians and cyclists under different circumstances, but the only point that need be made at this stage is that under user cost pricing there would be a case for charging pedestrians and cyclists *something* for road use. In practice an appropriate contribution could be made by means of a property tax, i.e. from local authority rates.

The case of public utilities which use the road for their mains is more difficult. It could be said that as the land under the road

[1] 'The Roads as Economic Assets', *Bulletin of the Oxford University Institute of Statistics*, November 1960.

has no alternative use, there is no economic case for charging for it. If this view were accepted, public utilities should be charged the disturbance costs that arise when they lay the mains, but no more. On the other hand it could be argued that the space occupied by a road is used jointly for a number of purposes, and that public utilities should therefore be required to bear a share of the rent payable by a road supplier for the use of land.

Profits from street parking

Under the present law, any profits from street parking must be used for the provision of off-street parking spaces. This law has no economic logic; if a piece of land can earn a rent, the rent is properly payable to the owner of the land. In the case of street space, the rent (i.e. the profits from meter parking) should be payable to the local authority which (for all practical purposes) owns the street.

If the streets were the responsibility of a road supplier the profits from street parking should be payable to him.

The treatment of profits and losses

It is clear that if a road system were operated on user cost pricing principles, its income at the early stages would not necessarily equal its expenditure. The income would consist of the user costs payable by vehicle owners, to which might be added certain items of rent such as revenues from parking meters, contributions from public utilities and from non-motorists. The expenditure would consist of the current value of the resources devoted to the road, i.e. rent for its space, payment of construction costs and an interest charge on its unamortised assets. The balance would either be positive, indicating a need to expand the road system, or negative, indicating a need to contract it.

A road supplier is likely to find himself making profits on some roads and losses on others. On lightly used roads he will almost certainly make losses, as the revenues receivable from users would be unlikely to cover the maintenance costs. How should these profits or losses be treated?

Under competitive conditions, the treatment of profits would raise no problem. Profits would go to the road suppliers who succeeded in making them, and the existence of these profits would attract more road suppliers into the industry until profits became 'normal' for all suppliers.[1]

The difficulty with the disposal of profits arises if the road supplier is in a monopoly position, for example, if we are considering a road authority in a city. A London road authority might find itself making large profits in Oxford Street. What should it

[1] See footnote, page 31.

do with them? The standard answer is that Oxford Street is profitable because it is too narrow, and that it should be widened. But road widening is very expensive, and it could be that while Oxford Street yields a profit, the profit is not large enough to justify immediate widening. What then should be done with the surplus?

The answer that would commend itself to road users is that the profits should be spent on other road schemes in the area, and this course appears to be justified. The requirement that the road authority has to pay interest on its invested capital will discourage investment in low-priority schemes. It would be equitable to use profits made in Oxford Street for schemes to benefit those who contributed to these profits—for example, on road improvements to relieve the congestion in Oxford Street. It would never be possible to ensure that all monies collected in congestion charges from a particular group are spent for the benefit of that group only; but it should be possible to avoid gross anomalies, such as the use of funds raised by congestion charges in London for the relief of congestion in other areas.

In general, a road supplier should try to maximise his profits, subject to the proviso that he should not use monopoly power to obtain monopoly profits. He should therefore invest his surpluses in schemes which bring in the maximum net revenues per unit of expenditure. In doing so he would have to take into account expenditures and revenues over the whole life of the investment. The difficulties involved in spending money on road schemes are formidable, but they are not different in kind from the difficulties facing every organisation with money to spend on large-scale works.

Far more difficult is the problem of roads which cannot be paid for by charging only the costs arising out of use. This is unlikely to trouble road suppliers in urban areas, but might be acute in the case of lightly used country roads.

According to rule (c), the sections that do not cover their costs should be contracted, thus making them more congested and therefore profitable. Unfortunately, there is here a technical snag; a road is indivisible and cannot be contracted beyond a certain amount. If it only carries traffic to 100th of its capacity, it cannot be narrowed down to 100th of its width and made to run at full capacity.

If an uncongested road cannot be made to cover its costs even by reducing its maintenance standards, the supplier could do either of two things as an alternative to abandonment:

(a) *He could charge more than user costs.* This would be economically justifiable if the revenues obtainable in this way

were sufficient to pay for the asset over its life. If faced with the choice, some users might prefer to pay more than marginal costs rather than lose the road.

(b) *He could seek a subsidy from regional or central funds.* A situation might occur (as has occurred on branch railway lines) in which no system of charging could raise sufficient funds to cover the maintenance costs of a little-used road. In that event a cost-benefit study might show that the losses to local people resulting from closure might exceed the losses the authority would have to incur to keep the road open. In these conditions a subsidy could be economically desirable, though it is difficult to envisage circumstances that would justify *permanent* subsidies of this nature. The subsidy should be a charge on the local community and be paid for out of local taxation; it should not be debited to the road supplier.

Comparison with other pricing systems

The essential point about user cost pricing is that it requires users to pay the costs that arise from their journeys, no more and no less. *The total costs of providing the road system are not relevant to user cost pricing.* This is why the conclusions of this *Monograph* differ from those of a number of recent studies, all of which started off by calculating the total cost of the road system and then allocated it among users.

Under user cost pricing, the total cost of the road system comes into the picture only indirectly. If it is found that the revenues raised by a system of user cost charging exceed the costs of the road system, the road 'industry' will make a profit and should be expanded. Similarly, if it is found that the amounts collected in user cost charges fall short of the total costs of the road system, this would be a sign that the road 'industry' is too large and should be contracted. Only when the road sector is neither more nor less profitable than other parts of the economy will the revenues from user cost charges exactly equal the costs of providing the system.

The advantages of user cost pricing over other methods of pricing are twofold. In the first place it is more likely to lead to the efficient utilisation of existing facilities, as road users would be encouraged by low charges to use uncongested roads and discouraged by high charges from using congested ones. Second, user cost pricing provides its own built-in criterion for investment —the criterion of profitability. Charging systems that start by taking the existing costs of the road system as given, and allocating the total costs among users, give no guidance as to which sections of the system should be expanded and which should be contracted. Under user cost pricing this guidance is given by the existence of profits or losses.

ADDENDUM: COST-BENEFIT ANALYSIS

In the previous section the phrase 'cost-benefit study' was used. What is the nature of these studies which have attracted much attention recently, particularly following the calculations of Professor M. E. Beesley and Mr. C. D. Foster of the benefits expected from the Victoria Underground Line in London?[1]

Cost-benefit studies were used in Oregon in the 1930s to help road engineers select a route for a road between two points.[2] In order to choose between a number of alternatives, the costs of each were worked out, and the benefits in terms of savings in time, fuel, tyre wear, and all other costs that could be measured. The route that showed the highest ratio of benefit to cost was then considered to be the best.

These early studies were strictly a comparison between *methods* all of which were designed to achieve the same end. There was no attempt to explore second order effects—for example, the effect of a particular route in stimulating the business of restaurants alongside it—nor was the effect of generated traffic considered.

The measurements pioneered in Oregon were developed in a number of places, notably by Mr. D. J. Reynolds at the British Road Research Laboratory.[3] The method was used to test the economic desirability of the London to Birmingham motorway (though the study was put in hand *after* the decision to construct the motorway had already been taken) and is now one of the standard tools of the Ministry of Transport. It should be noted, however, that the method is necessary only when it deals with a product—such as road space—which is not allocated by means of a price system. If a product is allocated by prices which reflect all the important costs, it is not necessary to use a cost-benefit analysis to reach decisions on investment. It is possible—and usually easier—to use a cost-*profit* criterion; to measure not the benefits resulting from the investment but the profits to the producer.

A cost-profit calculation measures only the profits to the company making the investment—the benefits to the users are ignored; a cost-benefit analysis, by its very nature, attempts to take account of the benefits to the users, and also the losses to other producers. Therefore an investment which gives a cost-profit ratio of, say, 10 per cent is likely to give a different cost-benefit

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[1] 'Estimating the Social Benefit of Constructing an Underground Railway in London', *Journal of the Royal Statistical Society*, Vol. 126, Part 1, 1963, pp. 46-78.

[2] C. B. McCullough and J. Beakey, 'The Economics of Highway Planning', Technical Bulletin 7, Oregon State Highway Commission, 1937.

[3] *The Assessment of Priority for Road Improvements*, Road Research Technical Paper No. 48, HMSO, 1960.

ratio. This discrepancy is particularly important in transport, as the benefits from railway and air investment are invariably expressed in terms of cost-profit ratios, while the benefits from road investments are expressed in cost-benefit ratios. How are the two to be compared with one another?

It is agreed by all workers on this subject that no direct comparison is possible with our present state of knowledge. If we want to compare a road with a rail investment, we have to express the advantages of both in terms of cost-profit ratios, or else in terms of cost-benefit ratios. In *The Transport Problem*[1] Mr. C. D. Foster argues that we should obtain valid comparisons by expressing the benefits of railway investments in terms of cost-benefit ratios. He also suggests that other public utilities should learn to justify their investments in terms of cost-benefit ratios and so enable the government to use the nation's scarce capital resources to best advantage.

It may be that Mr. Foster is right, but the difficulties in cost-benefit analysis are so formidable that the alternative approach, of assessing the benefits of road investment by means of cost-profit ratios, appears more promising. This approach does of course imply the establishment of an efficient road pricing system, but the difficulties of doing so may be less than the difficulties in cost-benefit analysis. This is because it is much easier to measure the profits of a producer than the benefits accruing to all beneficiaries, direct and indirect, present and future, not to mention the losses to other producers and to their customers. There may be areas in which the measurement of profits is difficult or inappropriate (for example, in riverworks), but I see no reason to believe that transport is one of them.

Why then should we use cost-benefit analysis in the case of the little-used road? The reason is that a pricing system cannot by itself tell us whether a large indivisible item should be retained or not. The ideal would probably be to have a road of smaller size which could be used to full capacity, but for technical reasons roads can only be supplied in fairly large lumps and we have to choose between having one that is too big or having no road at all. The road that is now too big, that is, under-utilised, may nevertheless be worth 'saving' because of the people who have grown to depend on it. Therefore in a case such as this—Dr. Beeching's branch lines, for example—a cost-benefit study can be extremely helpful.

But this point does not arise when a new project is being planned. For when we are planning for the future, we should *not* set out to produce a road or a railway line that will not, over its lifetime, cover its cost and yield a profit. Much has been written

[1] Blackie & Son, 1963.

about the new Victoria Line in London, and how it is not expected to show a commercial return but is yet desirable on grounds of 'social benefit'. But this is only half the story. As was clearly stated by Foster and Beesley in their paper, if London Transport were to charge fares high enough to equate the demand for space with the supply, there would be a very strong *commercial* case for providing more underground lines.[1] The Victoria Line had to be 'justified' by a cost-benefit study becauses fares on the Underground are too low.[2]

Cost-benefit analysis may be a useful tool for the assessment of the relative merits of some alternative investments, particularly where the price mechanism cannot be used. But where the price mechanism can be used, a cost-*profit* analysis appears to be the easier tool to handle.[3]

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[1] 'The two overwhelming reasons why the financial and social returns diverge are (i) the pricing policy of the Underground system and (ii) relative prices on road and rail in London. . . . These arguments would indicate raising the price of public and private urban road transport until each covered its real costs, when there could hardly be any doubt that it would pay to build the Victoria Line.' (*Op. cit.*, p. 47.)

[2] One of the main reasons that public transport fares are too low is that the private car user is not charged enough for using the road. London Transport Executive is only too well aware that the imposition of economic charges for public transport would result in a further loss of traffic to the private car.

[3] For wide-ranging surveys of cost-benefit analysis see particularly A. R. Prest and Ralph Turvey, 'Cost Benefit Analysis: A Survey', *Economic Journal*, December 1965 and G. H. Peters, *Cost-Benefit Analysis and Public Expenditure*, Eaton Paper 8, IEA, 1966.

FOUR

Methods of Charging

The implementation of pricing policies depends on the charging methods available. It is useful to distinguish between *direct* and *indirect* methods of charging for roads. Direct methods involve charging for the use of the roads as such; indirect methods involve charging for something (such as fuel) used in association with roads.

Indirect charging methods

Fuel tax

The fuel tax was introduced in Britain by Lloyd George in 1909 to make motorists bear the costs of the new roads made necessary by the motor-car. At first it was levied at the rate of 3d. a gallon. Early in 1966 it was 3s. 3d. a gallon. The rate of tax since its introduction, is shown in Table 5, and the revenue collected by it in Figure 2.

The fuel tax is not difficult to collect. The cost of collection is estimated to be under £1 million a year. Its main drawback is that the vehicle owners fortunate enough to use diesel engines are at an advantage, because diesel engines are more economical in the use of fuel than are petrol engines.

Tyre tax

This tax, used abroad but not in Britain, is similar in its function to the fuel tax. It is a tax on vehicle usage and has the advantage that it does not discriminate in favour of diesel-engined cars. Its great disadvantage is that it discourages vehicle owners from changing their tyres, and in this way it can be said to act against the interest of safe driving. For this reason it will be considered no further in this *Monograph*.

Annual licences

The annual licence, which was also introduced in 1909, is used all over the world as a method of raising revenue from vehicle users. The level of the tax since 1910 is shown in Table 5 and the total revenues collected in licences since their introduction are plotted in Figure 2.

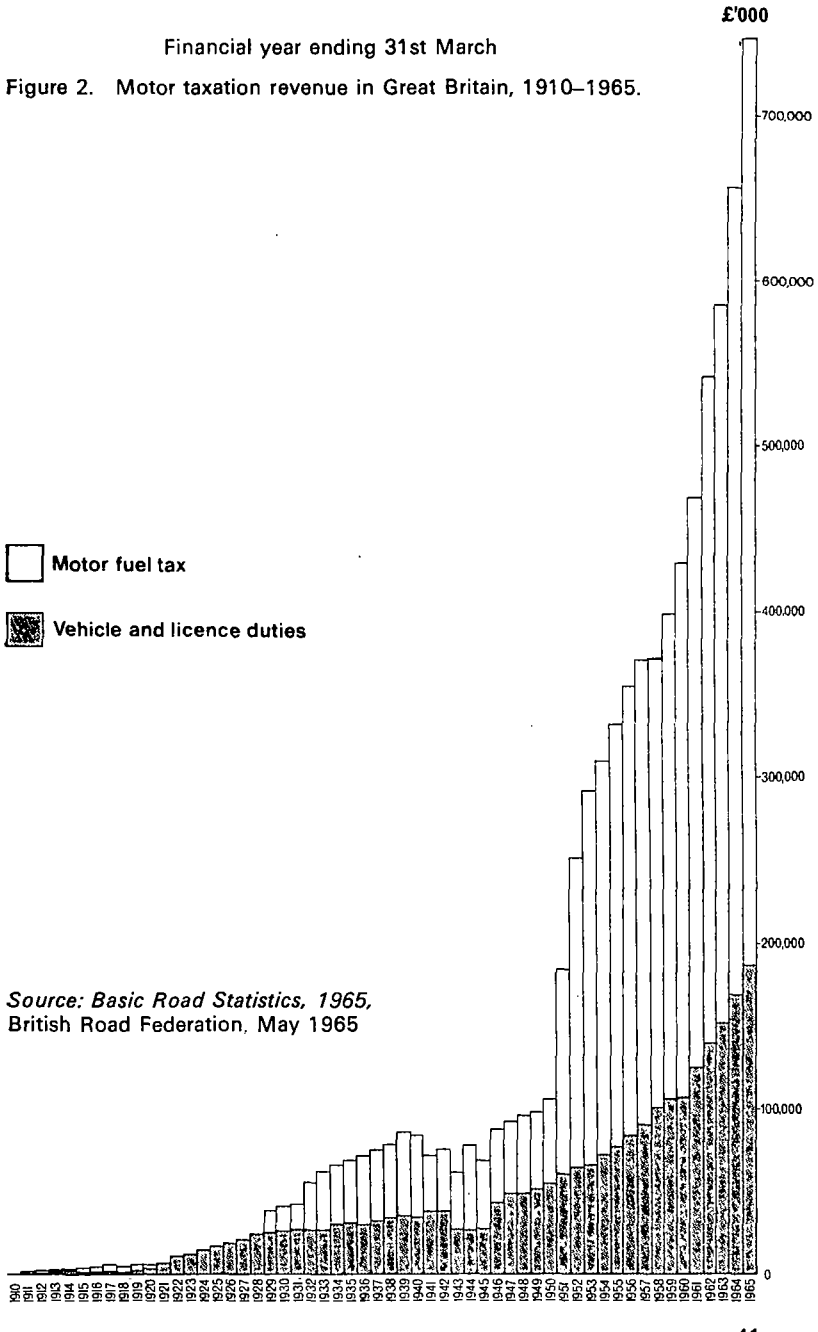

Figure 2. Motor taxation revenue in Great Britain, 1910–1965.

Source: Basic Road Statistics, 1965,
British Road Federation, May 1965

Table 5 shows that until 1948 the licence duty in Britain varied with engine capacity, the more powerful cars being taxed at a higher rate than the less powerful ones. These differentials inhibited the production of high-powered cars and were therefore abolished. Recently there have been proposals to base licence fees on vehicle lengths, with a view to encourage the use of small cars. As the length of private cars has little effect on the congestion they cause—and even less on road use costs—there is little economic merit in this idea.

Purchase tax

Purchase tax or sales taxes on cars could be used as a method of charging for roads. However, in Britain the rate of purchase tax on cars goes up or down in line with purchase tax rates on other commodities. It is difficult to regard this tax as a payment for the use of roads, and it has no special merit in this connection. This *Monograph* will therefore treat purchase tax on cars as a method of raising general revenues. This is in line with the treatment of purchase tax on other commodities; for example, the revenue from the tax on electric fires is not credited to the electricity boards.

Parking taxes

It has been suggested recently that a tax on parking space in city centres could provide the necessary 'restraint' to the usage of scarce road space and also a source of funds for road investment.

A parking tax should not be confused with payment to cover the cost of parking, nor with charges for street parking aimed at equating the demand with the supply. What is proposed is a tax which would require users of parking spaces to pay *more* than the costs of providing such spaces. Thus the authors of the Buchanan Report stated:

> 'It would not, we think, be sufficient to say that "economic charges" (i.e. charges related to the securing of a reasonable return from the capital cost of providing the parking space) should be levied for parking, we think it necessary to levy whatever charges the circumstances demand.'[1]

There are a number of serious difficulties involved in this proposal.

In the first place the imposition of a tax on parking (as distinct from requiring vehicles to pay parking costs in full) would have undesirable effects on the pattern of traffic in towns; local traffic would be arbitrarily taxed and discouraged while non-stopping traffic would be untaxed and encouraged. Secondly, it would be very difficult to relate the proceeds of parking taxes to investment needs, as the tax would be collected at the place of parking, rather than on the congested road. Thirdly, surpluses obtained

[1] *Traffic in Towns, op. cit.*, para. 452.

Table 5

A. MOTOR VEHICLE LICENCE DUTY RATES SINCE 1910

The principal changes in the licence duties on cars and petrol- or diesel-engined goods vehicles since 1910 are as follows:

Cars

January 1910	£2 2s. 0d. to £42; based on R.A.C. h.p. rating.
January 1921	£1 per h.p.
January 1935	15s. 0d. per h.p.
January 1940	£1 5s. 0d. per h.p.
January 1947	£1 per 100 c.c. Cars registered on or after 1/1/47.
January 1948	£10 flat rate. Cars registered on or after 1/1/47.
January 1953	£12 10s. 0d. flat rate. All cars.
April 1961	£15 flat rate.
April 1965	£17 10s. 0d. flat rate.

Goods Vehicles

January 1910	As cars.
January 1921	£10 to £30 (4 tons and over): based on unladen weight.
January 1927	£10 to £60 (5 tons and over).
January 1929	£8 to £48 (5 tons and over): vehicles with pneumatic tyres only.
January 1934	£10 to £50 (+ £20 per ton over 4 tons)—petrol engined.
	£35 to £150 (+ £25 per ton over 7 tons)—diesel engined.
August 1935	Differential tax on diesel engined vehicles abolished.
January 1946	£10 to £50 (+ £5 per ¼ ton over 4 tons).
April 1961	£12 to £60 (+ £6 per ¼ ton over 4 tons).
April 1965	£18 to £90 (+ £9 per ¼ ton over 4 tons).

B. MOTOR FUEL TAX RATES SINCE 1910

Year	Rate of tax Pence per gallon	Operative date
1910	3d.	30.4.09
1916	6d.	22.9.15
1921	Tax repealed	1.1.21
1929	4d.	25.4.28
1932	6d.	28.4.31
1933	8d.	11.9.31
1939	9d.	27.4.38
1951	1/6d.	19.4.50
1952	1/10½d.	10.4.51
1953	2/6d.	11.3.52
1957	3/6d.	4.12.56
1958	2/6d.	9.4.57
1962	2/9d.	28.7.61
1965	3/3d.	11.11.64

Source: British Road Statistics 1965, British Road Federation, May 1965.

from the use of off-street parking spaces should normally go to provide more parking facilities. There should therefore be no surpluses—other than from parking meters—available for investment in roads.[1]

Daily licences

Daily licences or 'stickers' are currently used in Spain and Portugal as a method of charging for street parking. They are sold by attendants (who are remunerated by commission) and must be displayed on the windscreens of parked vehicles. The Smeed Committee suggested that stickers of this kind could also be used to charge for road space in congested areas during busy periods.

These stickers could be purchased in books having, say, one year's supply, which could be sold to motorists either direct or through garages. Each sticker would show clearly the date of its validity, and an important feature of this proposal is that any stickers not torn out of the book would be returnable and rebated. In this way motorists would have an incentive to economise in the use of their stickers. Provision could also be made for stickers to be sold for periods such as a month or a week or even for one day only.

The sticker system would be simple and cheap, its main disadvantage being that it would not allow much discrimination between different areas, nor between peak hours and other times. This discrimination could be obtained by making the scheme more complicated, i.e. by having different coloured stickers for different zones. For example, the centres of London and Glasgow could be designated 'red' zones which would require stickers bought at a high price, while the centres of other towns, and some areas round the centres of London and Glasgow, could be designated 'blue' zones and require blue stickers costing less than the red ones. Similar variations in colour could be used to vary charges for different times of the day.

Direct charging methods

Toll gates

Toll gates have a very long history.[2] They were abolished in London only in 1871, but are still used on a number of bridges, tunnels and ferries. Some examples of toll rates are given in Table 6.

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[1] See G. J. Roth, *Paying for Parking*, Hobart Paper 33, IEA, 1965.

[2] 'On April the 11th (1653) I went to take the air in Hyde Park. There every coach was made to pay a shilling and sixpence for every horse, by the sordid fellow who had purchased it of the so-called state.' (From *John Evelyn's Diary*, edited by Philip Francis, The Folio Society, London, 1963, p. 90.) The turnpike companies did not enjoy popular esteem, but they created a country-wide network of roads which held their own until the coming of the railways.

Table 6

TOLLS ON BRIDGES AND TUNNELS IN GREAT BRITAIN

Name	Car		Motor-cycle	
	s.	d.	s.	d.
Clifton Bridge	1	0		5
Dunham Bridge	1	0		6
Forth Bridge	2	6	2	6
Lymington Bridge		6		1
Middlesbrough Bridge		6		2
Shoreham Bridge		6		3
Penrhyndeudraeth Bridge	1	0		9
Portmadoc Bridge		6		6
Sandwich Bridge	1	0		6
Selby Bridge		9		3
Swinford Bridge		5		2
Shard Bridge		3		3
Tamar Bridge	2	0		6
Warburton Bridge	1	0		6
Whitchurch Bridge		6		3
Whitney Bridge		4½		3
Dartford-Purfleet tunnel	2	6	1	0
Mersey tunnel	1	6		6

Source: Automobile Association.

Motorway tolls are used in the USA and in some European countries to finance new high-capacity roads. The money is usually collected in cash in toll booths, but season tickets are also sold. Some examples of the rates charged on these toll roads are given in Table 7.

Motorway tolls are regarded merely as a means of raising revenue. It is usually stipulated that toll facilities should become 'free' as soon as their construction costs are covered by the toll revenues. These tolls do not encourage the best utilisation of the existing road system; on the contrary, they tend to discourage the use of new roads and to encourage congestion of the old ones. This point was illustrated by Professor William Vickrey in his comment on the pricing practices for the East River crossings to Long Island and Brooklyn:

> 'Here the peculiar political logic is that the older bridges are in some sense paid for, and hence must be free, while tolls must be charged on the newer facilities. The result is that considerable traffic is diverted from the newer facilities that have relatively adequate and less congested approaches to the older bridges such as the Manhattan and the Queensboro bridges, which dump their traffic right in the middle of some of the worst congestion in New York. The construction of the proposed

Table 7

TOLLS ON TOLL ROADS IN THE UNITED STATES

Car and truck tolls in cents per mile: costs for full-length journey

A. *Tolls based on number of axles*[1]	Mileage	Cars	Commercial vehicles by number of axles				Buses
			2 axles, 4 tyres	2 axles, 6 tyres	3 axles	4, 5 or 6 axles	
Colorado—Denver-Boulder Turnpike	17	1·44	2·88	2·88	3·76	5·06	—
Connecticut Turnpike	129	1·55	1·55	2·21	3·14	3·91	4·07
Florida—Sunshine State Parkway	109	2·20	2·20	3·44	3·94	5·05	—
Illinois—North-West Tollway (South Beliot-Elgin)	52	2·02	2·02	2·60	3·03	5·55	—
Illinois Tollway (Elgin-O'Hare Field)	24	1·67	1·67	2·29	3·12	3·12	—
Illinois—Tri-State Tollway	83	2·17	2·17	2·89	3·61	3·61	—
Illinois—East-West Tollway	28	1·43	1·43	1·96	2·68	2·68	—
Indiana—Northern Indiana Toll Road	157	1·27	1·78	1·78	3·57	7·13	11·94
Kansas Turnpike	236	1·61	1·61	2·29	3·22	3·67	3·05
Kentucky Turnpike	40	1·50	1·50	2·25	3·38	4·50	—
Massachusetts Turnpike	123	1·99	1·99	3·54	4·51	5·57	5·57
New Hampshire—Frederick E. Everett Highway	40	1·25	1·25	2·50	3·75	—	—
Spaulding Highway	23	1·30	1·30	2·61	3·91	—	—

New Hampshire Turnpike	15	1·33	1·33	2·67	4·00	—	—
New Jersey Turnpike	118	1·48	1·48	2·80	3·47	4·24	2·80
New Jersey—Garden State Parkway (only part, 90 miles, open to trucks)	173	1·59	1·50	based on weight	4·50	6·00	4·34
New York State Thruway	472	1·58	1·58	2·26	3·95	4·93	3·45
Oklahoma—Turner Turnpike	86	1·63	2·32	3·49	4·07	4·65	3·49
Oklahoma—Will Rogers Turnpike	88	1·65	2·22	3·41	3·98	4·55	3·41
Texas Turnpike	30	1·67	1·67	2·50	3·33	6·52	—
Virginia—Richmond-Petersburg Turnpike	35	2·02	2·02	2·31	3·17	4·03	—
West Virginia Turnpike	88	2·24	2·30	3·45	7·47	7·47	7·47

B. *Tolls based on weight of vehicle*[1]	Mileage	Cars and taxis	Commercial vehicles by laden weight: Up to 3 tons	3 to 7 tons	7 to 10 tons	10 to 24 tons	Buses
Maine Turnpike	106	2·03	2·03	2·69	4·01		4·72
Ohio Turnpike	241	1·45	1·45	2·07	2·70	3·89	2·70
Pennsylvania Turnpike	444	1·08	1·08	1·95	2·62	4·50	2·62

Source: Truck Tolls on Bridges, Ferries, Tunnels and Turnpikes, prepared by American Trucking Associations, Inc., November 1960. (Quoted by the Transport Holding Company in its evidence to the Committee on Carriers' Licensing.)

[1] Most toll charges are based on number of axles: there is no precise correspondence between numbers of axles and weight of vehicle in the US. Nor is there any exact correspondence between the gross weights of the average US and UK vehicles—both the private car and the heavy goods vehicle tend to be much larger and heavier in the United States.

express-way across lower Manhattan from the Holland Tunnel to the Manhattan and Williamsburgh bridges would be at least less urgent, if not actually unwarranted, in view of its enormous cost, if, as would seem possible, traffic could be diverted from the Manhattan Bridge to the Brooklyn-Battery tunnel by imposing tolls on the Manhattan and other East River Bridges and reducing or removing the toll on the tunnel.

'The delusion still persists that the primary rôle of pricing should always be that of financing the service rather than that of promoting economy in its use, whereas in practice there are many alternative ways of financing, but no device which can function quite as effectively and smoothly as a properly designed price structure in controlling use and providing a guide to the efficient deployment of capital.'[1] (My italics.)

Vehicle metering devices

In 1962, the Minister of Transport appointed a committee of engineers, economists and traffic experts under the chairmanship of Dr. (now Professor) R. J. Smeed 'To study and report on the technical feasibility of various methods of improving the pricing system relating to the use of roads, and on relevant economic considerations.' This committee reported its findings in the summer of 1963, and its report was published in 1964 under the title *Road Pricing: the Economic and Technical Possibilities*.[2]

The Smeed Committee's examination of charging methods was based on 17 'operational requirements for a road pricing system'. The following points cover the most important:

Charges should be flexible and closely related to the amount of use made of the roads. People who often use congested roads should pay more for them than those who do not. This could be achieved by making the charges proportional to distance travelled on congested roads, or to the time spent on them. It should be possible to vary the charges as between periods of peak congestion and other times, and to allow road use at very little charge when there is no congestion, i.e. at night. Vehicles causing heavy congestion—lorries for example—should be charged more.

Another important requirement is that intending drivers should be able to discover the charges payable before making a journey, as the object of road pricing is to influence the decision of people *before* they use congested roads, and therefore any system that imposed heavy charges without giving prior warning

[1] 'Pricing in Urban and Suburban Transport', paper read at the meeting on Pricing and Resource Allocation in Transportation and Public Utilities, 28 December, 1962.

[2] HMSO, 1964.

would fail in its main purpose. The charging method should be cheap to work, easily enforceable and acceptable to the public as being simple and fair. The state should not have to issue invoices to millions of road users nor become responsible for debt collection. Payment in advance would therefore be essential except in rare cases. Equipment should be secure, robust and reliable. There would be no room for delicate instrumentation. The system should be capable of nationwide installation and provision must be made for it to accommodate an estimated vehicle population of 30 million by the end of the century.

The system should preferably be applicable to charging parked as well as moving vehicles so that it could take the place of parking meters, and reduce enforcement and collection costs. It should also allow for occasional users such as visitors from abroad and car users who visit priced areas only rarely. These people should be covered by the scheme with the minimum of formality and delay.

Finally, and perhaps most important from one viewpoint, the charging method should indicate the strength of demand for road space in different places and at different times of day, and it should enable the payments made over alternative routes to be known in some detail.

The first requirement, that charges should be closely related to the use of congested roads, makes it necessary to have a meter. The Smeed Committee considered two types:

(i) *Off-vehicle meters*: remote control units actuated *by* vehicles but situated at a central computing station. This type of meter can be compared to telephone meters.

(ii) *On-vehicle meters:* meters designed to record *on* vehicles. This type of meter can be compared to taxi meters.

Off-vehicle meters are more costly than on-vehicle ones, and as they had no special advantages they were rejected. But the Committee described six on-vehicle meter systems which, it considered, might be developed into charging methods capable of fulfilling most of the operational requirements. The metering systems recommended for further study can be divided into two types: 'point pricing' and 'continuous pricing'. Under point pricing, vehicles would be charged as and when they pass fixed pricing points which would activate their meters. Under continuous pricing, vehicles would be charged while within pricing zones.

Point pricing

The meter carried by the vehicle under point pricing would count electrical impulses generated by electrical cables carrying very low currents and laid across the road at the pricing points. The cables would be energised all the time so that any vehicle

passing over them would receive the appropriate impulse. (Provision could be made to ensure that any vehicle stopping over the cable would not receive more than one impulse.) Impulse transmitting cables need not be laid singly; they could be laid in groups of, say, 5 or 10, and so arranged that either the full number or only some of the cables would be energised at any one time.

The vehicle meter would probably be the size and shape of a small book. It would be near the ground to pick up the signals and could form part of the number plate. In its simplest form, the meter would probably be in the form of a 'solid state' counter, of the form used in computers.[1]

Two methods of payment are possible. Either a meter could be sold with a given capacity and exchanged when exhausted, or else the meter could be fixed permanently to the vehicle and taken at intervals to authorised meter stations to be read and paid for. In both cases there would be no difficulty about pre-payment. Meters might cost £5 to £15 depending on the visual indication provided and the road equipment might be approximately £250 per pricing point. The number of pricing points required to cover the whole of Britain was estimated to be 20,000.[2]

Continuous pricing

Under systems of continous pricing, pricing zones would have to be designated, and vehicles would be charged according to the time or distance travelled in those zones. The main problems are how to switch the meters on and off at the entrances to the zones, and how to obtain payment.

Switching the meters on or off could be done either manually by the driver or automatically by electrical impulses transmitted at the borders of the pricing zones. In both cases meters of this kind would have to carry a light or some other indication to show when they are switched on. It would be possible to have different zones, for example, high-priced 'red' zones in the most congested areas and lower-priced 'blue' zones in less congested areas. Charges could be varied with the time of the day: a zone could be 'red' during the peak traffic hours, 'blue' during the rest of the day and free at night. In that case the meters could be made to show a red light when in a 'red' zone, and a blue light when in a 'blue' zone.

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[1] The 'solid state' counter has no moving parts nor does it show any visible sign of counting; it consists of a number of segments which can be electrically charged or discharged and in that way it can count in binary numbers. Although such a meter could not be read in the ordinary way, it could be made to change colour when exhausted, or when almost exhausted, and in that way would show whether it was run down.

[2] This figure may be compared with the number of road intersections controlled by traffic lights of which there are about 4,000.

Payment could be made by means of electrical timers. The pricing meters could receive their main power supply from car batteries, but the connection to the battery could be by means of a sealed unit incorporating a relay. This relay would only effect a connection if a special kind of battery or other electrical timer was inserted into a slot to activate the relay. The battery could be similar to a coin in size and shape and would be designed to actuate the relay for a minimum number of hours. In the case of different prices being set for different pricing zones, it would be possible to arrange for the timing unit to last for, say, 10 hours in a 'blue' zone or, say, 5 hours in a 'red' zone.

The batteries, or other types of electrical timers, could be sold through garages and ordinary shops, the road congestion tax being included in their price. By skilful design of the battery and the meter it would be possible to make it difficult and expensive to forge the electrical timing units.

Another possibility would be to use a clockwork timer. This would have to be wound up—or exchanged—when run down, on payment of the appropriate road charge at an authorised depot.

The possible cost would be 30s. for a manual meter, £3 to £5 for an automatic one and £10 for a clockwork one. The electric timing units might possibly cost between 1s. and 2s. each and the road equipment for the automatic meters £50 per point.

The technical conclusions of the Smeed Report have not, to my knowledge, been challenged, and it may therefore be assumed that there are no major technical difficulties in charging road prices which would roughly approximate to the congestion costs imposed by vehicles on other road users. The costs of such systems would be small compared to the benefits that are estimated to result from their use.

FIVE

The Application of User Cost Pricing

We have now had a brief look at the costs of roads, at the pricing principles that might be relevant and at the methods available for raising revenues. Could roads be provided on the basis of user cost pricing? In what ways should revenues be raised? What would the income and expenditure of a road supplier look like under present conditions?

The organisational framework

It is clear that any attempt to treat road space as an economic asset instead of as a 'free good' would require fundamental changes in the organisation of our road system. These changes would have legal, administrative and political implications which should be considered by experts in those fields. All that can be done here is to consider some of the implications of the economic requirements which would be:

(a) User cost pricing and investment policies should be applied consistently to all roads.

(b) The total costs of any section of the road system should be covered by payments collected from those who use it.

One way of satisfying these conditions would be to have roads supplied by firms in competition with one another. If road suppliers were enabled to raise revenues from users, either with the aid of metering devices or by being credited with the petrol tax 'earned' on their roads, there would arise the interesting possibility of competition in road provision. Competition would satisfy the two conditions laid down above, namely that it would bring about user cost pricing and investment policies and would eventually result in costs just being covered by revenues, as the existence of 'abnormally' high revenues would attract further suppliers until only 'normal' profits were earned on all the competing roads.

But, as was mentioned in Section 3, access roads in built-up areas cannot be supplied competitively, and therefore urban and village street systems must be run by monopolies. Furthermore, it was seen that within each town or village there would often be a case for using the surpluses 'earned' on some roads to expand others. Only a public authority could be entrusted with the power of raising sulpluses under monopoly conditions, and it therefore

seems that the reorganisation of the road system on the basis of user pricing would necessitate the setting up of public road authorities empowered to raise revenues and invest surpluses.

What areas should these authorities cover? Size for its own sake should be avoided, but there is a minimum area below which transport planning cannot be effective.

Professor E. Victor Morgan has suggested[1] the establishment of a National Highways Board on the lines of the gas and electricity industries with a strong central organisation and a number of regional divisions, possibly based on the present offices of the Ministry of Transport Divisional Road Engineers.[2] To these ten authorities there would have to be added one for the London area, one for Scotland and one responsible for trunk routes, making 13 authorities in all. They would replace the 1,287 highway authorities which exist in Britain in 1966.

Professor Morgan assumed that the National Highways Board would be responsible only for motorways and expressways, for the present trunk and classified roads in rural areas, and for any new or existing urban roads which may be classified as 'primary distributors'. He suggested that other roads should remain the responsibility of local authorities. This division of responsibility would make it difficult to allocate funds in a satisfactory manner between main roads and local roads. This is an important point, as it is possible that we are spending too much on maintaining our existing minor roads and too little on building new major ones. However, Professor Morgan was not concerned with the organisational details of the proposed National Highways Board nor even with its exact functions. Should a national or a regional roads board be concerned only with planning or should it also provide the roads? Alternatively, should it be established only as a planning body empowered to issue concessions or licences to firms who would provide the roads and charge for them? If a roads board both planned and provided roads, should it be given a monopoly in its area?

These are matters which require the attention of people skilled in administration, but it is clear that the answer to the last question must be an emphatic 'no'. Under our present system of treating roads as a welfare service it is not easy to envisage a private company starting up in the road business. But once roads were run on user cost principles, with payments for roads divorced

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[1] *Economic and Financial Aspects of Road Improvements*, Roads Campaign Council, London, 1965.

[2] Eastern (office at Bedford); West Midland (Birmingham); Northern (Newcastle-upon-Tyne); Yorkshire and Humberside (Leeds); East Midland (Nottingham); South Midland (Cheltenham); North Western (Manchester); South Eastern (Guildford); South Western (Exeter); Wales and Monmouthshire (Cardiff).

from the system of general taxation, there is no reason why roads should not be provided as a commercial venture. In that case there would be every reason for welcoming such competition and for allowing private companies to be credited with the fuel and other taxes 'earned' on their roads, the amounts payable being determined by sample traffic counts.

Determination of road prices

It is one thing to accept the principle of user cost pricing, but quite another to lay down the prices to be charged. Prices would have to be fixed by trial and error, especially in the early stages. This is because the right prices should equal user costs under the conditions prevailing *after* the introduction of the new prices. For example, although Table 4 suggests that at speeds of 10 miles an hour the congestion costs imposed by a typical vehicle in London are 3s. 5d. a mile, the introduction of such a charge would force off a large proportion of the traffic and reduce congestion costs to a negligible figure; a charge of 1s. 3d. a mile might be the appropriate one. In practice there would be much to be said for pitching charges on the low side at the beginning to enable users to adjust their habits to the new conditions with the minimum of disturbance.

As far as practicable, prices should be varied so as to take account of differences in user costs between different times of the day and between different places. Complicated schedules would not be understood by road users and would therefore not achieve their purpose. But simple rules such as differentiation between peak travel times and other times would be desirable. It would also be beneficial to raise charges during regular and well defined events that increase road congestion, for example, the London motor show and the Christmas shopping weeks. The imposition of extra charges at such times serves the dual purpose of moving some traffic from peak to off-peak periods and of raising the extra revenue required to provide peak facilities.

The idea of 'congestion charges' has been attacked as unfair, on the grounds that road users already pay for congestion in terms of delay and frustration, and that the imposition of a 'congestion tax' would add insult to injury. But this objection, though at first sight reasonable, cannot be sustained. The imposition of additional charges at peak times is beneficial in that it promotes the better use of scarce resources. Peak charges are taken for granted in the telephone and electricity services, although for good psychological reasons they are described in terms of 'off-peak reductions' rather than of 'peak-hour increases'. But the principle is the same.

People who take their holidays in August are forced to put up with congestion *and* with high hotel charges. These high 'seasonal'

charges serve the useful economic purpose of encouraging those who can take their holidays 'off-season' to do so, and this gives some relief from congestion to those who must holiday in August. In so far as the August peak cannot be shifted, peak charges enable the hotels to provide the facilities which are required only by the peak users.

Choice of charging methods

We have seen that in accordance with the principles of user cost pricing, a road supplier should charge road users the costs arising out of journeys, which comprise: (a) the road use costs (i.e. wear-and-tear, traffic control, cleaning and administration) and (b) the congestion costs, the road network being at its right size when the revenues from congestion charges just equal the capital costs of the system. How should the revenues be raised?

If we examine the methods available, it will be evident that the fuel tax is probably the most suitable means with which to recover road use costs. A charge of 10d. a gallon will probably be about right for private cars. However, a tax of this magnitude would not be sufficient to cover the road use costs resulting from the passage of heavy vehicles, particularly diesel-engined vehicles. In such cases an additional licence fee would be appropriate, and this fee should be increased for diesel-engined vehicles and indeed for other vehicles—battery—operated ones for example—that do not use petrol.

Congestion charges in cities cannot be collected by means of a fuel tax because the additional fuel consumed under conditions of congestion would not produce more than a fraction of the required charge. In order to raise congestion revenues it would be necessary to devise new means of road taxation, of the kind proposed to the Smeed Committee on road pricing or else to use daily licences (stickers).

Congestion costs outside cities could be recovered either by one of the new methods developed for towns—when they are developed—or else by a tax on fuel. It was seen in Section 2 that the congestion costs on rural roads are less than 0·5d. per mile for a private car, and this amount could easily be raised by means of a fuel tax. Unfortunately a fuel tax designed to raise even small amounts on congested rural roads would be too high on uncongested ones. Nevertheless, until new methods of road pricing are developed there does not appear to be any alternative to raising fuel tax to a level which would cover not only road use costs but also some congestion costs on rural roads. It will be suggested later (page 62) that an appropriate fuel tax to cover congestion costs in places where traffic speeds exceed 16 miles an hour might be a further fuel tax of 1s. 2d. a gallon, making a total fuel tax of 2s. 0d. a gallon.

Charging for the use of motorways

It was mentioned on page 45 that the imposition of high charges on new roads discourages their use and does not help to promote an efficient use of the road system. If the road system is considered as a network, it is usually preferable to finance new links by tolls on the existing (congested) links, rather than by tolls on the new ones. A hotel proprietor may finance a new wing for his hotel out of the revenues obtained from the existing rooms. He will not levy additional charges on the new rooms solely on the grounds that 'they have to be paid for'. He will look upon his hotel as a complete unit, and fix his tariff in such a way as to maximise the occupancy of all his rooms.

It follows that a road authority acting on user cost principles would not attempt to finance motorways by means of special tolls. Ideally, capital for new motorways should be paid for out of tolls on existing congested through routes. Until this becomes practicable, it would be better to finance motorways out of the proceeds of a fuel tax levied on all the through routes, congested and uncongested alike. This method of financing might not provide sufficient inducement to shift traffic from congested to uncongested routes, but at least it would not have a perverse effect on road utilisation.

Income and expenditure of British roads under user cost pricing

In order to illustrate the implications of user cost pricing, the following example is given. It is an estimate of the costs of the British road system in 1964 and of the income that would be payable under a system of user cost pricing. These figures can be regarded as the income and expenditure of the road 'industry' in Britain if it were financed on a user cost basis. The figures relate to the year ending 31 March, 1964 and are taken for the whole of Great Britain because none are readily available for any part of it. The figures in italics refer to the income and surplus at the taxation rates that actually prevailed in 1964.

Some of the items in Table 8, particularly the revenue from congestion taxes, are based on very rough calculations, and the figures do not purport to be anything more than plausible values provided for the purpose of illustration. The figures were obtained as follows:

Expenditure

Road use costs

In its evidence to the Committee on Carriers' Licensing, the Ministry of Transport calculated that in 1962 the costs of maintaining and operating the road system in Britain were: maintenance

Table 8

UK ROADS IN 1964: ESTIMATES OF INCOME AND EXPENDITURE UNDER USER COST PRICING

Expenditure	£ million		Income	£ million	
Road use costs:			Fuel taxation	163	(*486*)
Maintenance and repair	58		Licence duties	32	(*171*)
Cleansing and snow clearing	34		Congestion taxes	624	(*0*)
Lighting	8		Payments by rate-payers	205	(*170*)
Costs of accidents not covered by insurance	8		Payments by public utilities	18	(*18*)
Policing	63				
Highway administration	24				
		195			
Maintenance and repair not due to road use		21			
Interest on capital		110			
Rent for road space		72			
Rates		40			
Surplus of income over the costs of the 1964 road system		604 (*407*)			
		£1,042			£1,042

and repair, etc., £72 million; cleansing and snow clearing, £31 million; lighting (only the costs incurred on trunk roads, and on classified roads by county boroughs), £7 million; costs of road accidents not covered by insurance, £7 million; policing, £57 million; highway administration, £22 million. These figures were uplifted by 10 per cent to allow for cost increases between 1962 and 1964. The proportion of maintenance and repair costs that is due to weather and not to the passage of motor vehicles is not known. For the purpose of the Table it was assumed to be about 25 per cent, that is £21 million out of £79 million.

Interest on capital invested

According to calculations made by the Transport Holding Company[1] the capital value of the road system in 1962 (calculated as expenditure on capital works since 1909 less amounts amortised on a 40-year basis) was £900 million. If the 1964 figure be taken as £1,100 million, and interest charged at 10 per cent, the amount to be debited for this item is £110 million.[2] Roads last longer than 40 years, but there is always the risk of obsolescence

[1] Memorandum to the Committee on Carriers' Licensing, October 1964.

[2] A more precise calculation would require a deduction to be made for expenditure on land purchase, which is covered by the item 'rent for road space'.

due to population movement or to the emergence of new transport methods.

Rent

In order to estimate the rental value of road space, it is necessary to know:

(a) the area of land in Britain devoted to roads, and

(b) the rental value of the land adjacent to the roads.

Given the area of road space and the evaluation of adjacent land, it would be possible to estimate the total annual value of road space, each increment of space being valued on the assumption that the rest of the road space continued to be used as a road. An estimate of the area of road in Great Britain in 1960 can be obtained from the 1,000-point sample survey carried out by the Road Research Laboratory in that year.[1]

The sample survey gives the total length of roads fronting different types of development in urban areas. The figures are reproduced in the first two columns of Table 9. The survey also shows that in urban areas the average carriageway width (that is, excluding the pedestrian pavements) of trunk and Class I roads is 29 ft. and of other roads 21 ft. These widths, when multiplied by the appropriate lengths, give the acreage of carriageway fronting different types of development, and this acreage is shown in the third column of the Table.

In order to assess the annual rental value of the carriageway area, it is necessary to estimate the value of land for the different types of development. The values selected are tabulated in the fourth column of the Table; they are very rough, but are more likely to be on the high than on the low side. The most critical figure is the assumed rental value of land used by 'offices' and 'public buildings' in urban areas. The figure of £10,000 a year implies a capital value of about £150,000 an acre. It is reported that land in central London can change hands at prices of £1 million an acre but prices of this magnitude are extremely rare and do not as a rule apply to large areas. A more reliable guide might be obtained from a recent report[2] that 270 acres of the Grosvenor Estate were valued in 1963 for death duty purposes at £20 million. If we assume that roads and pavements accounted for 70 acres out of the 270, this leaves 200 acres valued at £20 million or £100,000 an acre. As the Grosvenor Estate includes some of the most valuable land in London, the figure of £10,000 an acre per year for urban land developed as offices and public buildings does not appear to be low. The rental value appropriate to each

[1] *Sample survey of the roads and traffic of Great Britain*, Road Research Technical Paper No. 62, HMSO, 1962.

[2] *Sunday Times*, 20 February, 1966.

Table 9

ANNUAL RENTAL VALUE OF URBAN CARRIAGEWAY SPACE IN GREAT BRITAIN

Type of development	Miles of fronting road: Trunk + Class I Average width 29 ft.	Miles of fronting road: Other Average width 21 ft.	Carriageway area (acres)	Average rental value: £ per acre per year	Total rental value £ per year
No building or access	2,953	14,952	48,440	50	2,422,000
Houses, flats	3,507	31,156	91,634	200	18,326,800
Shops, garages, factories	1,314	1,163	7,579	2,000	15,158,000
Offices, public buildings	233	999	3,362	10,000	33,620,000
Total	8,007	48,270	151,015		69,527,800

Source: For road widths and mileages: *Sample Survey of the Roads and Traffic of Great Britain, op. cit.*

type of development is shown in the fifth column of the Table, the total being £69,527,000 a year.

The figure for rural areas can be obtained in a similar manner. The total acreage of rural roads is about 243,200 acres. At a high valuation of £10 an acre the annual rental value of carriageway space in rural areas comes to £2,432,000 which when added to the figure for urban roads gives a grand total of £71,959,000 or about £72 million per year.

Rates

If roads are to be treated as an ordinary commodity, a figure for rates must be included, at least in urban areas. As agricultural land is completely derated there may be a case for rating only urban roads, but in view of the relatively low valuation of rural road space this point is unimportant.

According to 'extremely rough calculations' made three years ago by Professor A. R. Prest,[1] the order of magnitude of this item might now be £40 million a year if full rates were paid on urban roads only.

Income

Fuel tax

On the assumption that fuel tax and licence duties should raise sufficient revenues to meet the road use costs, the total that would have to be raised from these two taxes would be £195 million. According to figures published by the Petroleum Information Bureau,[2] the amount of motor fuel used in 1964 was 3,909 million gallons. On this basis a tax of 10d. a gallon would raise £163 million.

Licence duties

At 5s. a licence, the total collected from all vehicles would be £3 million. The appropriate additional amount from heavy vehicles, to meet extra wear-and-tear caused by them, might be £29 million. This figure can be justified by the Ministry of Transport's estimate that in 1962 the capital cost of the roads 'ascribed exclusively to heavy vehicles' was £26·6 million. The total from this source is thus £32 million.

Congestion taxes

In order to calculate the income from this source it is necessary to know (a) the number of vehicle miles travelled in Britain by different classes of vehicles, (b) the vehicle mileage travelled at

[1] In 'Some Aspects of Road Finance in the UK', *Manchester School*, September 1963.

[2] *United Kingdom Petroleum Industry Statistics.*

different speeds, and (c) the effect of the congestion tax on the speed distribution. Information on all these matters is very sketchy, and the following calculations can produce nothing better than a plausible figure.

Estimates of the total vehicle mileage travelled in Britain are published by the Ministry of Transport. Table 10 shows the totals for each class of vehicle in column 1, and the PCU weighting[1] of each class in column 2. The third column gives the mileage in terms of PCU miles which is the relevant figure for congestion taxation.

Table 10

ESTIMATED TRAFFIC ON ALL ROADS IN GREAT BRITAIN, 1964

(Thousand-million vehicle or PCU miles)

	Vehicle mileage	PCU value	PCU mileage
Cars and taxis	62·0	1·0	62·0
Motor bicycles	4·7	0·5	2·3
Buses and coaches	2·5	2·5	6·3
Goods vehicles under 30 cwt. unladen weight	10·3	1·5	15·5
Other goods vehicles	11·8	2·5	29·5
All motor vehicles	91·3		115·6

Source: For vehicle-miles: Ministry of Transport, *Highway Statistics 1964.*

In a paper presented in 1963,[2] Mr. J. C. Tanner calculated that 7 per cent of motor vehicle miles in 1961 was at speeds of 12 miles an hour or less, and a further 7 per cent was at speeds of under 16 miles an hour but over 12 miles an hour, while a further 14 per cent was at speeds of less than 20 miles an hour but over 16 miles an hour. If we assume that vehicles in the slowest group would pay a congestion tax of 8d. a mile, that vehicles in the next slowest group would pay a congestion tax of 6d. a mile, while vehicles travelling at 16 to 19 miles an hour would pay 4d. a mile, and if we further assume that the effect of the congestion tax would be to cut out 5 per cent of vehicle miles from the roads altogether and to shift 20 per cent to the speed group which pays

[1] The PCU weighting is an indication of the congestion caused by vehicles in the different classes, as compared to the congestion caused by a passenger car. Thus a motorcycle usually causes less congestion than a private car, so its PCU value is less than 1 ; buses and lorries cause more congestion than private cars and their PCU values vary between 2 and 4.

[2] 'Pricing the use of Roads—a Mathematical and Numerical Study', *Proceedings of the Second International Symposium on the Theory of Road Traffic Flow*, London, 1963, published by the OECD, Paris, 1965.

a lower tax, then the total tax collected in the conditions prevailing in 1964 would be £624 million.

The 4d. a mile congestion tax levied on the vehicles in the speed group 16-19 miles an hour would necessitate the metering of vehicles over wide areas. Until the equipment for this becomes available, this revenue—amounting to £229 million—could be raised by means of a fuel tax. The appropriate rate would be 1s. 2d. a gallon. This would be additional to the fuel tax of 10d. a gallon required to pay for road use costs. Under this arrangement the total paid in fuel and congestion taxes would be £787 million as in Table 8, but the amount collected by the fuel tax would rise by £229 million, from £163 million to £392 million, while the amount collected by congestion taxation would fall by £229 million from £624 million to £395 million.

Property taxes (contribution from rate funds)

It was suggested previously (page 33) that there is a case for charging non-motorists for the use of roads, as they provide facilities for pedestrians, cyclists, and access to properties of different kinds. One way of assessing a reasonable level of payment from non-motorists would be to base it on the level of road expenditure before the advent of the motor car, say in the decade 1891—1900. The average annual amount spent in that period on roads and bridges was about £11·7 million[1] or 0·78 per cent of net national income. On this basis the annual figure appropriate to 1964 (net national income £26,234 million) would be £205 million.

The contribution from ratepayers actually made in 1964 was made up from the following items: of the £156 million spent by local authorities on road works which were not covered by grants from the Ministry of Transport, 14 per cent can be deducted to allow for the deficiency grants payable to local authorities by the central government. This gives a net figure of £134 million. Of the £63 million spent by local authorities on the policing of roads, half was covered by a grant from the central government and the balance by the 14 per cent deficiency grant, leaving a net amount of £27 million. The net amounts spent on lighting and highway administration were assumed to be £9 million, giving a total of £170 million as the contribution of ratepayers to the costs of the road system in 1964.

Contributions from public utilities for road use

It was suggested in Section 3 that as road space is used not only for roads, but also jointly for electricity, gas, water and telephone mains, there is a case for obtaining a rental payment from these

[1] According to figures collated by Dr. B. R. Mitchell of the Department of Applied Economics, University of Cambridge.

public utilities for the space used jointly with the roads. There is no rational way of assessing the shares of the different interests involved; any solution would depend in practice on the bargaining skills of the people concerned. However, there can be no argument about the liability of public utilities to pay the disturbance costs that arise when road traffic is disrupted by the laying of mains, etc.

As a first approximation, let it be assumed that the total payable by other public utilities for road use would be 25 per cent of the rent payable by road authorities for the use of land. This would give a total of £18 million per year.

Surplus of income over the costs of the 1964 road system

The items listed above show a difference between income and expenditure of £604 million. This is the surplus of income payable under a system of user cost pricing over the costs of the 1964 road system. It can be compared with the notional surplus of £407 million made under the tax system of 1964, and with the actual expenditure on new construction and road improvement of £196 million in 1964.[1] The existence of this surplus shows that there is a strong case for expanding the road system, particularly in the urban areas, where the bulk of the surplus would occur.

Nevertheless, we cannot assume that the surplus collected in any year should determine the level of road investment *in that year*. Roads last for many years, and the investment decisions of road suppliers should be determined by the expected profitability of the investments, and not by the surpluses that happen to occur at the time decisions are made. If future road revenues are expected to rise, there may be a case for investing more than the current surplus; if there is reason to believe that road revenues will fall, the amount invested should be less than the current surplus. However, all the evidence suggests that the demand for road space will increase rapidly in the next 20 years, and it is therefore likely that the surpluses earned by user cost pricing on British roads under-estimate rather than over-estimate the investment in roads that should be made now.

[1] Calculated as total expenditure on road construction, improvement and maintenance (as given in *Highway Statistics 1964*) *less* the £79 million attributable to maintenance alone, following the Ministry of Transport's evidence to the Committee on Carriers' Licensing (p. 57).

SIX

The Consequences of User Cost Pricing

The treatment of roads in accordance with the economic principles described in the previous sections would have profound effects on road users, transport operators, and town planning, particularly in city development and the preservation of the urban environment.

Road users

If road users were required to pay the costs arising out of their use of roads, they would find driving in congested areas more expensive than now, but driving conditions would be much improved. Through traffic would tend to keep out of cities; commuters would be encouraged to share cars; delivery to shops would tend to take place outside the times of peak congestion. Land uses requiring exceptionally large amounts of road transport—warehouses, for example—would tend to move out of city centres. In uncongested areas road users would find driving less expensive and somewhat more congested than at present.

Some people living in town centres may not be able to run their cars if required to pay for the road space. The effect of a road pricing scheme on residents in congested areas could depend to a large extent on the charging method. For example, a 'point pricing' scheme could allow cars to be parked all day in side streets without charge; but a 'zone pricing' scheme under which vehicles had to pay while being on the public highway in certain zones at certain periods could affect street parking.

Even if a considerable number of the people who now run cars in city centres were forced to give them up, it is unlikely that hardship would be caused other than in exceptional cases. The weaker section of the community—the very young, the very old, the weak, the poor, the disabled—are dependent on public transport and in so far as higher road charges might be expected to stimulate bus services, its introduction would be more likely to relieve hardship than to aggravate it.

More serious would be the effect on people living in rural areas and who for one reason or another are unable to use private cars. Road pricing may hasten a decline of rural bus services. But they are already in a precarious state, many of them owing their

survival to the profits earned on urban routes. The preservation of rural public transport must depend on a new outlook and new measures. Either these services will have to be financed by subsidy (as recommended by the Jack Committee) or else the licensing system will have to be relaxed so as to enable small operators and part-time drivers to provide a service to their neighbours.[1]

The effects of more efficient road pricing on road users as a class is likely to be beneficial. According to calculations made by the Smeed Committee, its introduction would result in road users gaining £100 to £150 million a year from a better utilisation of the road system, even at the traffic volumes prevailing in 1961.

Buses

On many city streets the bus is a more efficient carrier than the private car, particularly in the rush hours. For example, in their paper 'An Exploratory Comparison of the Advantages of Cars and Buses for Travel in Urban Areas'[2] Professor R. J. Smeed and Mr. J. G. Wardrop wrote:

> 'Confining attention to people travelling by car and bus . . . in normal working hours, if they were all to travel by bus at the present occupancy, the vehicular journey speed for the average passenger would rise by 24 per cent; it would fall by 20 per cent if the proportion travelling by car increased from the present 30 per cent to 40. During the evening peak hour the vehicular journey speed for the average passenger would increase by 40 per cent if everybody travelled by bus. The road system in Central London could not take the traffic if 60 per cent of the people who now travel by bus and car were to travel by car at the present occupancy of 1·5 persons.'

This being the case, the question naturally arises—though it rarely appears to be asked—why is it that despite its obvious advantages, the bus is continually losing ground to the private car, both in this country and throughout the world? There are a number of reasons, and the *absence* of road pricing is one of them: the supreme merit of the bus is that it is economical in its use of road space; although it might cause as much congestion as three cars, it can carry 70 to 80 passengers at a time, while most private cars carry one person only. But so long as road users do not have to pay the costs of the scarce space that they occupy, there is no advantage to them in avoiding a waste of space.

If people crossing the Atlantic were offered the choice of a single cabin or of sharing with seven others, and if the fare was the same in both cases, most people would choose the single

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[1] For a discussion of rural bus services see John Hibbs, *Transport for Passengers*, Hobart Paper 23, IEA, 1963.

[2] *Journal of the Institute of Transport*, January 1964.

cabin. The same situation obtains on the streets. And once people start moving from buses to cars, the process is self-accelerating, for bus companies suffer both falling revenue and rising operating costs as a result of the increase in private car usage. They are therefore forced to raise their fares or to reduce the quality of their service and thus drive more people from public to private transport.

How would better road pricing affect buses in towns? Bus operators would no doubt argue that they should be exempt from a road congestion tax and there are some reasons which can be put forward in favour of exemption. For example, it can be held that one of the main objects of road pricing in cities is to transfer travellers from private cars to buses, and that it would therefore be desirable to give buses the greatest possible advantage over private cars. However, there are fundamental objections to granting buses special treatment. If buses were to pay their share, how much would it be? What benefits could bus operators expect to receive in return?

The appropriate charge for a bus would depend on the amount of congestion that it causes to traffic. If one bus causes the same congestion as two private cars, it should pay twice as much as a private car. The amount of congestion caused by a bus, in relation to the amount of congestion caused by a car, is its 'PCU value' (see page 14). PCU values are not constant; they vary with traffic conditions and with other factors. Any PCU value used as a basis for a pricing factor would inevitably be an average value. Average values varying from 1·75 to 3 have been suggested. It therefore appears that the bus should be charged not less than 1·75 times and not more than 3 times as much as the private car.

What benefits would the bus get? First, there could be a saving in existing taxes—in fuel tax and in vehicle taxation. Secondly, vehicle speeds should rise by 20 or 25 per cent, which would lead to a saving in the number of buses required and also to a saving in fuel (in congested streets fuel consumption rises with the amount of time spent on the journey). Thirdly, buses would benefit from an increased demand as a result of some car users transferring to public transport, which would increase their occupancy.

It is not possible to say with any certainty whether buses would achieve a net loss or a net gain in revenue as a result of these changes in road taxation. Estimates were made of the effects of road pricing upon the London central bus fleet by Mr. J. M. Thomson for the Smeed committee.[1] He concluded that the road

[1] 'The Economic Effects of Road Pricing upon the London Central Bus Fleet', Road Research Laboratory, PRP26, November 1962 (unpublished).

charges payable by the central bus fleet might be as low as £2·9 million per year or as high as £10·6 million, and that the total savings could be as low as £2·4 million or as high as £6·3 million a year.

Even if the result of road pricing were to be a net increase in taxation payable by bus fleets in towns, the operators would have no difficulty in passing it on to their passengers, as the road charge *per bus passenger* would be extremely small. Furthermore, all bus companies have vehicles that are used only in the peak hours and are idle most of the day. Even under present conditions it would be desirable for the operators to raise their charges in the peak hours so as to collect from the peak-hour user the costs attributable to him. Such a surcharge would increase revenues, and would also have the desirable result of shifting some travellers from the peak to the off-peak period. At the moment bus companies are unable to impose peak-hour surcharges for fear they would drive more of their customers into private cars. But once the private car user was faced with meeting the costs resulting from his car journey he would often prefer to travel by bus even if it meant paying a peak-hour surcharge.

It may therefore be concluded that stricter road pricing is likely to bring about considerable benefits to bus services in urban areas even if bus operators had to pay congestion taxes. On the other hand, it would undoubtedly increase the competitive position of the private car on uncongested roads, and would therefore weaken the position of buses in rural areas. But it is difficult to see rural bus services surviving in their present form even if road taxation remains as it is.

The railways

To be economically and politically acceptable, user cost pricing would have to be applied to air transport, to waterways, and—most important of all—to the railways, as well as roads.

Very little is known about marginal costs associated with railway operations, but on the face of it it does not appear that user cost pricing would be an impracticable way of financing railways. Under such a pricing system railways would charge very high rates to peak-hour users—congestion charges in fact—and use the revenues to expand their peak services. In areas in which user costs are insufficient to meet track costs the railways would contract. A financial policy of this kind would not be dissimilar from the policy that the railways appear to be trying to carry out at the moment. There is therefore no obvious reason for believing that the existence of the railways weakens the case for user cost pricing. On the contrary, provided that congestion charges are charged for peak services, the railways may benefit from it.

There would of course be 'political difficulties' in raising commuter fares to economic levels, but, as is not uncommon elsewhere, politicians exaggerate them. The popularity of first-class seats on some railway services suggests that many people are prepared to pay an extra fee to travel in comfort. The complaints of commuters are as much against the wretched travel conditions in the peak hour as against the raising of fares. It is the combination of rising fares and falling standards that drives travellers from public to private transport. Commuters are also taxpayers, and a resolute government would not shrink from the proposition that people who use expensive facilities should be prepared to bear the costs that result from their choices.

In practice, many fare rises would be passed on to employers, who in their turn would attempt to pass the increases to their customers in the form of higher prices. It is not possible to generalise about the final incidence of increases in travel costs. It is on the whole desirable that a substantial part of them should fall on employers, as it is they who determine the location of workplaces and the hours of work. The introduction of differential fares, with high peak-hour charges and low off-peak ones, might induce employers to 'stagger' working hours and encourage some of them to move their businesses out of London. This in itself could bring about substantial reductions in travel costs.

Town planning

The economist and the town planner have, or should have, identical aims: to make the best use of resources. There should therefore be no conflict between the economic and town planning approach to urban problems. On the contrary, the understanding of economic forces and the use of prices is indispensable for those occupied with the difficult problem of planning the use of land.

How do town planners tackle the transport problem? Different planners have different approaches, but in Britain the profession undoubtedly regards the Buchanan report on *Traffic in Towns* as a good example of the town planning approach. It dealt with the long-term problems arising out of the need to re-plan our cities for the motor age. Its main principles can be summarised as follows:

1. The starting point of the traffic problem is the city as a generator of traffic. Traffic must not be regarded as an end in itself —to be 'kept moving'—but as resulting from the activities carried out in the city.

2. It is not possible to accommodate large numbers of vehicles in cities and to retain civilised life there without a substantial investment in road improvement. Given the standard of 'environment', the amount of 'accessibility' that can be provided depends on the amount we are prepared to spend.

3. The design of the car-age city should be based on the separation of activities. Through traffic should be separated from local traffic; cars should be separated from pedestrians. These design problems call for a new type of skill—'traffic architecture'.

4. In so far as large cities are concerned, there are physical limitations to the number of vehicles that can be accommodated, and even if there were no limit to expenditure it would be necessary to impose restrictions on some journeys by car. Plans should allow for the accommodation of the 'essential' traffic, but a proportion of the 'optional' traffic might have to be diverted to other means of transport or to other places.

There is no necessary conflict between these four 'Buchanan principles' and the economic approach sketched in this *Monograph.* On the contrary, the economic approach could help the town planners in a number of ways. For example, the Buchanan report left a number of very important questions unanswered. Among them are the following:

1. How are we to define the 'essential' city traffic?
2. What is the most suitable method for keeping 'inessential' traffic out of cities?
3. How much should the community spend on improving its urban road systems?
4. Where will the money come from?

Economic methods can help to fill in each of these four gaps.

1. *Defining the 'essential' journey.* Planners tend to distinguish between 'essential' and 'inessential' uses by means of classifications into journey purposes. For example, the Buchanan report suggests that 'essential purposes' are those connected with 'trade, business and industry' while the use of cars for 'private pleasure and convenience' is not 'essential' but 'optional'. Some planners go further and classify shoppers as being neither 'essential' nor 'optional' but 'desirable'. Economists prefer to distinguish between the 'essential' and the 'inessential', not by reference to the purpose of the journey but by measuring the benefits and losses arising from it. To the economist there is a presumption that a journey is worth making if the benefits resulting from it are larger than the costs. The Smeed report suggested as 'a useful guiding principle' that

> 'journeys should not be made if they are valued at less than the costs or losses they cause to other people; similarly journeys should not be restrained if they are valued at more than the costs they cause'.

It is idle to pretend that the value of a journey can *always* be measured by the price that the road user would be prepared to pay for it. Income distribution is imperfect, and special concessions

might be appropriate to some road users (for example, the disabled) and special restraints might be appropriate to others (for example, motorists who use company cars for private purposes). Nevertheless, as a starting point, the principle that the 'inessential' user is the person who is not prepared to pay the costs arising from his journeys might be more helpful to planners than classifications based on journey purposes.

2. *Method of restraint.* In addition to enabling potential road users to class themselves as 'essential' or 'inessential', the economic approach also offers a method of selection whereby people who value their journeys highly are allowed to use congested streets while those who do not are kept out. The method of doing this—which is acceptable in most other fields—is to confront road users with prices based on the costs resulting from their journeys and letting *them* decide whether it is worth their while to pay. If congestion taxes prove to be practicable, they would be superior as a method of restraint to permit systems or parking restrictions.

3. *How much should be spent on improving roads in cities?* It is in investment that economic methods can make a particularly useful contribution to planning. It would be childish to claim that by themselves they could 'solve' problems that have baffled town planners for generations. Any investment decision covering a period of 30 or more years into the future is bound to contain an element of guesswork and intuition. An experienced town planner is more likely to have the right intuition than most other people. Nevertheless, the knowledge of what people are prepared to pay indicates the intensity of demand and is an invaluable aid to estimating requirements for the future.

4. *Sources of funds.* There is no hint in the Buchanan Report on where the money for urban road provision should come from. One estimate[1] suggests that the total required to 'implement Buchanan' is £18,000 million. If there are any town planners whose road projects are cut back for lack of funds, let them reflect on the advantages that could accrue to their work if those responsible for the provision of roads in cities were allowed to act as space selling organisations rather than as welfare services.

City development

One of the main objections to the imposition of higher charges for the use of congested streets is that there would result in cities losing their attractiveness as centres of population, industry and commerce. To what extent is this objection justified?

In London and many other cities it is clearly impossible to provide enough road facilities for *all* the traffic to flow without

[1] C. D. Foster, *The Statist*, 21 February, 1964.

restriction or congestion and at no charge. Therefore the alternative to restraint by price must be restraint by congestion or by regulation. The question to be considered is not merely whether higher charges for the use of congested streets would have an adverse effect on city development. The real question is would the restraint of traffic by high charges have a more adverse effect on city development than restraint of traffic by congestion or by other means?

The first thing to be said about this is that raising the price of road space in city centres need not necessarily result in a reduction in the number of *people* coming to the city. A reduction in the number of *cars* is to be expected, but as car occupancy (which now averages 1·5 people per car) would probably rise, and as passengers may be expected to shift from private to public transport, higher road prices will not necessarily reduce the number of *people* coming to the centre.

Secondly, if a commodity or service is scarce, its allocation by means of a high price is likely to be less harmful than allocation by permits or congestion. This is because the high price, with all its disadvantages, is the most efficient method known of allocating the scarce resource to those whose demands are most urgent. Office space in parts of the City of London is probably the most expensive in the world. But can it be seriously suggested that the City would have benefited from a system of rent control, with cheap space being offered to firms on a waiting list?

Higher prices for the use of city streets would influence commercial development in the centre; there would be a tendency for occupations associated with large road requirements to leave city centres and to make way for occupations requiring less road usage. For example, a rise in the price of road space in the area of Covent Garden might encourage more of the fruit and vegetable trade to be conducted by sample, the goods themselves being handled on the outskirts of London. Developments of this kind would surely be beneficial.

Another important effect of 'rationing by price' is the encouragement of users who place a high money valuation on their time. Under the present system, with both road space and parking space rationed by time-wasting congestion, there is a tendency for the available facilities to be used to excess by people who do not worry too much about wasting their time. Those who value their time highly are more likely to quit the city and make a fresh start elsewhere. As the latter class includes the more vigorous elements—the impatient, the 'pushers', the young men with 'ants in their pants'—their discouragement can have very serious effects on city development. A policy of allocating parking space by price would help to attract those who are prepared to pay most to be in the centre. On the whole, this should benefit the city.

There is plenty of American evidence to show that traffic congestion can kill the development of city centres. For example, many of the important activities conducted in the centre of Boston have now moved to the outskirts. But the effect of allocating street space to those who are prepared to pay for it would be completely different from the effect of allocating it to those prepared to queue for it. Mr. D. J. Reynolds has suggested[1] that if city transport became more expensive, city centres would tend to be more concentrated and smaller. This may well be true, but town planners would not regard these effects as adverse. Cities came into being because they afforded convenient access for purposes connected with trade, manufacture and social intercourse. The present danger to cities is from the poor accessibility that results from undercharging for scarce transport facilities. The better accessibility that would result from high road charges is more likely to stimulate the city than to depress it.

The general community

The establishment of a self-financing system for roads based on user cost pricing would bring about big changes in the financial relationships between road users and the rest of the community.

In the first place there would be a change—probably a rise—in the total road revenues collected from road users. Secondly, there would be a change—probably a fall—in the contribution of road users to the general revenue, i.e. there would be a change in the *difference* between the amounts collected in tax from road users and the amounts currently spent on the road system.

The total revenues collected will depend to a large extent on the reaction of road users to congestion charges. If these charges result in a drastic reduction in the use of congested roads, little will be collected, but congestion will be relieved. At the other extreme, if road users pay substantial charges rather than be priced off congested roads, congestion will not be relieved, but large revenues will be raised which could be made available for improving the road system. The calculations in Section 5 suggest that in Britain as a whole the imposition of user cost pricing would result in an increase of about £200 million in the revenues collected from road users.

Since the end of the war in 1945, road users in Britain have made substantial contributions to the general revenue. It is not easy to estimate the size of this contribution because some of the costs, particularly the capital costs of the road system, are difficult to assess.

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[1] 'Planning, Transport and Economic Forces', *Journal of the Town Planning Institute*, November 1961.

According to Table 8 the road 'industry' made a notional surplus of £407 million in 1964, of which £196 million was spent on expanding the road system. This suggests that in 1964 road users contributed £211 million to the general revenue, in addition to the £120 million collected in purchase tax. It follows that had road revenues been separated from general revenues in 1964, the Exchequer would have suffered a revenue loss of about £211 million; this means that public expenditure would have had to have been curtailed to this extent, or else it would have been necessary to raise £211 million by other means.[1]

We all have our favourite notions of which taxes ought to be altered and which items of expenditure might be dispensed with. Road users would no doubt face with equanimity the prospect of £211 million being shifted from their shoulders to those of others. However, this *Monograph* is not concerned with the problem of raising taxation to meet general expenditure. We can if necessary accept that road users should have contributed £211 million (or any other figure) to the general revenue in 1964, without altering the pricing and investment principles proposed here. This would result in the surplus available for retention in the road 'industry' in 1964 falling from £604 million to £393 million. The practical effect of this would be to slow down the rate at which the road system could be expanded.

The important point is that the contribution—if any—from the road industry to general revenues should follow the generally recognised principles of taxation. It is one thing for government to tax the earnings of industry for its general purposes. It is quite another to discriminate against a major sector of the economy by appropriating *all* its revenues and returning to it arbitrary amounts bearing little relationship to needs.

The community as a whole would benefit substantially from the new system even if it were to result in road users contributing a smaller amount to the general revenue. First, it would benefit from the higher efficiency in the use of scarce road space, following the introduction of road pricing. Secondly, under user cost pricing it would be possible to calculate the profitability of road investment in the terms that are used to calculate the profitability of factories, power stations, railway undertakings and other claimants for investment funds. The importance of this kind of comparison is that high-yielding road investments would no longer be neglected and low-yielding ones would be less likely to be undertaken. It is not suggested that the assessment of the profitability of investment in roads will be easy—the difficulties of reading into the future would remain; but basing

[1] Secondary effects, such as the effects of changes in fuel prices on the amounts consumed, and the resulting changes in tax revenue, are ignored.

road investment decisions on commercial rather than on other criteria would help considerably to assess the desirability of alternative schemes and would also enable the necessary funds to be collected from the users of the new facilities.

It may be added that if road investment is to be financed by revenues from congestion charges, there would—at least in the early stages—be no problems of floating 'road loans' and creating inflationary pressures in the process. Road users who pay congestion taxes would spend correspondingly less on other goods, and the use of those funds for road improvement would not be inflationary. The basic effect would be the diversion of funds from *current* expenditure in other fields to expenditure on roads. As this diversion would be the result of the free choice of the consumers concerned, there would be strong reasons for considering it socially beneficial.

Meeting physical shortages

It might be objected that this discussion of the finances of roads is pointless because the road authorities would be unable to obtain the physical resources required for their expansion programme. This is not so. If the road authorities were to bid for the use of scarce resources they would raise the price of the scarce materials and eventually increase their supply.[1] The government may have reason to value the construction of houses, factories or hospitals more than the construction of roads and, if so, it might be tempted to resort to physical rationing schemes in order to reserve resources for its chosen projects. It is to be hoped that any temptation to allocate resources in this way would be resisted, except where an explicit case is made out.

If we hold that it is consumer choice that should establish the relative value of a service or of a commodity, we should accept that it is consumer choice that also establishes the proportion of resources committed to different productive activities. If road users show by their payments that they are prepared to outbid others for scarce materials, this should be taken as a sign that road building deserves high priority.

One cannot but wonder what the position of Britain would have been today had the government in the railway age used the shortages of labour and materials as reasons for protecting the canals against competition from more modern methods of transport.

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[1] Suppliers of some important road materials state that, if given an assured market for their products, they could meet any foreseeable demand without increasing prices. See Mr. Richard Moore's and Mr. Nicholas Pettinati's *Roads and Resources*, British Road Federation, 1966.

A Note on Competition in the Provision of Roads

The main object of this *Monograph* is to consider the pricing policies applicable to roads and to show that a policy based on user cost pricing would be practicable and would have important advantages over the arbitrary pricing system that we have today. However,

> 'The legislative framework of the transport industries should be designed so that it encourages a ceaseless search for more efficient administration and techniques, a speedy adjustment to changed circumstances and a flexibility of rate making and financial operations.'[1]

A 'ceaseless search for more efficient administration and techniques' requires further consideration of the possibility of roads being supplied on a competitive basis.

It was shown in Section 5 that competition in the supply of roads would be likely to lead to the optimal allocation of traffic on existing roads and to the right amount of investment in road improvement. Under a competitive system no supplier would charge less than marginal costs nor, in the long run, could he charge more, as the earning of abnormally high profits would result in more roads being provided with a consequential fall in prices and in profits. What then are the objections to competition in the provision of roads? They may be summarised as follows:

1 The present pricing methods cannot enable private road suppliers to charge efficiently for the use of roads.
2 The positioning of main roads cannot be divorced from planning the location of industry and population, and decisions of this kind can only be taken at government level.
3 Road safety might be imperilled if roads were supplied on a competitive basis.
4 Access roads are by their nature monopolies, and competition in their provision is technically impracticable.

But there are also objections to a monopoly in road provision. Will a monopolistic road authority have incentives to reduce its

[1] A. A. Walters, *Economic Development and the Administration and Regulation of Transport*, Discussion Paper No. 5 (Series B), Faculty of Commerce and Social Science, University of Birmingham, September 1964.

costs? Will it provide 'speedy adjustment to changed circumstances'?—Or 'a flexibility of rate making and financial operations'? Will it be able to overcome political pressures to policies which are against its economic interests? It is impossible to answer these questions with an unqualified 'yes', and it is therefore worth seeing whether the objections to competition in road supply can be overcome and whether there is any room for competition in this field.

We are so used to regard roads as being provided by public authorities that the idea of private road suppliers seems at first sight far-fetched. But it is in practice a very real possibility. In addition to such obvious opportunities for enterprise as the infamous Exeter By-Pass, there exists the possibility of converting large stretches of railway line to good quality roads or 'bus-ways'. This is not the place to discuss the claim of the Railway Conversion League that the whole railway network can be converted to a road network at a comparatively low cost;[1] suffice it to say that some sections of the railway network can indubitably be converted to useful roads.[2] The conversion of railways to roads illustrates the possibility of competition in road provision. Should such competition be allowed to take place in the face of objection from a regional road monopoly? Or should the road authority be given the power to decide which roads should be provided in its area?

Let us consider the objections to competition in further detail.

1. Absence of suitable charging methods

Under the present system of paying for roads, suppliers are not in a position to charge road users and this effectively prevents competition in the supply of road space. Even if toll roads were allowed, their promoters would be at a disadvantage because users of the toll roads would have to pay a toll in addition to the payment of other road taxes.

However, the reforms in road taxation suggested in this *Monograph* could eventually overcome this difficulty. Once it is decided to treat all or part of fuel tax as payment for the use of roads, road suppliers could be credited with the fuel tax 'earned' on their roads. Furthermore, if cars were metered for the payment of congestion taxes, private suppliers could also be credited with the congestion taxes 'earned' on their roads. The absence of suitable charging systems is therefore not an objection in principle to competition in the supply of roads, but a difficulty that could be surmounted in time.

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[1] *The Case for transforming Britain's Railways into Motor Roads*, Railway Conversion League, 24-28 Clapham High St., London, S.W.4, 1966.

[2] Brigadier T. I. Lloyd, 'Economic Assessment of a Rail-to-Road Conversion', *The Engineer*, 27 September, 1963, p. 517.

2. National planning of main routes

While a well-organised Ministry of Transport *should* be in a better position than private suppliers to decide where to build main roads, it does not necessarily follow that state planning will produce the best network. Road investment in Britain has been under public control for the last 50 years and the results have not been encouraging. The Ministry of Transport has failed to devise investment criteria which would apply to both urban and rural roads, nor are there common criteria for the comparison of investments in roads and railways. Furthermore, even if the Ministry of Transport were able to make rational investment decisions, such decisions would always be subject to change at the behest of other government planning bodies, which might have other opinions on investment priorities.

If, however, we accept the view that planning of main routes should be a government responsibility, does it follow that roads should not be supplied on a competitive basis? Not necessarily. In the first place there is no reason why the body responsible for planning the location of main routes should also be responsible for supplying them. Under the present arrangements the Ministry of Transport does not build the roads: it invites private contractors to tender for the right to build them. It may be possible to carry this procedure a stage further, and to allow private firms to provide *and operate* the routes selected by the Ministry. One way of doing this would be for the Ministry to calculate the prices that may be charged on a user cost basis and to invite firms to tender for concessions to operate the roads and to receive the revenues. It would then be up to the suppliers to make their roads as attractive as possible so as to maximise their profits.

Furthermore, even if the main network were publicly operated' private suppliers could provide roads secondary to it. In this way commercial firms could be given an incentive to by-pass notorious bottle-necks. It might be objected that such roads could compete with the roads planned by the Ministry, or operated in the same area by a public authority, and threaten their financial viability. If this situation were to occur, it would suggest that the Ministry's plan was at fault, and would strengthen rather than weaken the case for competition in the supply of roads.

3. Safety

The state should give a lead in promoting high standards of road safety. This is not a matter that can be left to a decision of road suppliers who might stand to gain by reducing expenditure on safety measures. Standards of safety should be laid down by government decision and would have to be followed by all road suppliers.

'In principle the government's decisions should be based on some sort of average of individual evaluations of "safety". . . . Probably the only procedure practically possible is for governments to ensure that there is no great discrepancy between various outlets of expenditure on accident prevention.'[1]

Thus, if it is known that an additional £100,000 spent on road safety can save more lives than the expenditure of the same amount on accident prevention in the home, then the government should insist that this amount be spent by road suppliers. Much work is needed on the evaluation of accident prevention,[2] but the need to set safety standards for roads does not provide an argument against competition in road provision.

4. Technical monopolies

Where roads provide access, as distinct from passage, they are in practice monopolies. This position applies in all towns and villages where, for technical reasons, it is not possible to provide a choice of routes to homes, shops, or factories.

Two questions arise. In the first place, would the social advantage be served by allowing road suppliers to maximise their profits in monopoly conditions? If not, is there a case for allowing private suppliers to provide road space as a monopoly with prices fixed by a public authority?

It can be shown that where a road is supplied under monopoly conditions, the price that will maximise the profits of the supplier will be higher than the 'user cost' defined in Section 2. Therefore if suppliers were granted monopolies without restraint on prices, and if they charged prices that would maximise their profits, traffic would be unduly restricted. Prices on access roads—which in practice include all but through routes—should therefore be fixed by a governmental body. The correct price is user cost, road-use costs plus congestion costs.

It would be pleasant to assume that a governmental body could fix the correct prices, but experience suggests that prices fixed by public bodies would tend to be 'sticky': they would not respond to changes in economic circumstances. If experience in Britain is taken as a guide, it may be expected that prices fixed by governmental bodies would be too low, and would result in excessive congestion and a shortage in the funds required to relieve it.[3] In real life the choice probably lies between allowing

[1] A. A. Walters, *op. cit.*

[2] D. J. Reynolds, 'The Cost of Road Accidents', *Journal of the Royal Statistical Society*, Vol. 119, Part IV, 1965, p. 393.

[3] In January 1966 the West Midland Gas Board was unable to supply some of its industrial customers, and many factories came to a standstill. Although the Board knew well in advance that its reserves were inadequate, it did not raise the price of gas.

private monopolies to charge more than user cost with traffic being unduly restricted, or to have governmental bodies fixing prices at below user cost with traffic being unduly congested.

A further difficulty is that even if the right user charges were imposed, suppliers of congested road space might still make monopoly profits for which there would be no economic justification. A road supplier having a monopoly of roads in a city might invest his profits on expanding the road system in his area, but he might prefer to buy a yacht or a string of racehorses. One way of dealing with this problem would be to sell concessions to road suppliers in city areas. But this could only be done after a few years of user cost pricing; in the early stages there would be no basis for evaluating the worth of such concessions.

It may thus be concluded that while the use of efficient road charging methods could allow the introduction of competition in the supply of through roads, subject to the government being responsible for safety standards and for planning the main routes, competition in the provision of access roads does not seem to be possible under any circumstances. The charging of the correct prices in towns can only come about through governmental regulation. There are many reasons for preferring small monopolies to large ones, and it is possible to envisage a regional road authority fixing the prices in its area and setting up suppliers on a city or village basis. Arrangements of this kind would not give users a choice between alternative road suppliers in *their* areas, but they would enable the efficiency of different sections of the road system to be compared with one another and would increase the scope for the introduction of new ideas and methods in road design, building, financing, maintenance and other aspects.

It should be emphasised that developments of this kind need not involve a return of the turnpike system with road users having to stop at area boundaries to pay their dues. The road system is a network and it would be out of the question to require users to make money payments when moving from one section to another. This discussion of the possibility of competition in road provision assumes that in all cases payment will be collected by a governmental agency by means of fuel taxes, licence fees and congestion taxes. The allocation of the funds collected to the different road authorities would be on the basis of traffic counts which would provide information on the amount of revenue 'earned' on different sections of the road system. Information of this kind is of course an essential aid to road planning, whatever the system of paying for roads.

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