ECONOMIC RESEARCH CENTRE

SEVENTH ROUND TABLE

(4th-6th March, 1970
4th-5th June, 1970)

REPORT OF THE SEVENTH ROUND TABLE
ON TRANSPORT ECONOMICS
held in Paris, on the following topic:

pricing the use of infrastructure

EUROPEAN CONFERENCE OF MINISTERS OF TRANSPORT

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INTRODUCTION

Pricing the use of infrastructures is one of the major issues of transport policy nowadays. As the volume of traffic increases, infrastructures become saturated and more and more capacity is accordingly needed. This stimulates a whole series of qualitative and quantitative claims which, in the last analysis, entail a growing need for investment.

The topic dealt with at the Seventh Round Table Conference has long been studied by economists. Even before the last war, empirical rules to mitigate unequal treatment in this field were being sought. Since then, theoretical research has made steady progress.

The Round Table had the advantage of comprising some of the leading experts in the theory of infrastructures, but an immediate and practicable solution to such a complex problem obviously cannot be found after a three-day discussion. It must also be borne in mind that pricing is an offshoot of the broader problem of imputation of costs.

Interpretations differ, even on a theoretical level, and there has perhaps been too great a tendency of late to base the whole argument on a single assumption and present it as the economic theory par excellence. The Round Table threw light on this dogmatic approach and this may reasonably be expected to stir up fresh discussion on the subject. The Round Table did in fact look into the background for quite a long way and cannot, by any means, be blamed for not exhausting the issue. It is quite clear that the questions of imputation of costs and pricing remain to be investigated in depth.

Meanwhile, a Seminar of senior officials will try to draw specific lessons from the proceedings of the Seventh Round Table and also take stock of the problems to be re-tackled from a theoretical angle. In this way, a process of useful interchange between theory and practice will begin and so gradually clarify various doubtful points.

It is also quite understandable that, in the course of the debate, stress was laid on the need for a second session to go more deeply into certain aspects. Another introductory report was therefore prepared for this second session.

It is the E.C.M.T.'s pleasant duty to thank once again the Chairman of the Round Table. For having conducted the proceedings so unsparingly and skillfully. Its thanks are also due to all the participants and to the Rapporteurs for having been particularly careful to deal with the problem objectively.

This report will be circulated to all institutes and individuals already on the E.C.M.T. mailing list and to anyone else on request.

The seminar proceedings, however, being essentially concerned with policy issues, will not be widely circulated for the time being.

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PRICING THE USE OF INFRASTRUCTURE

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Theoretically, it is a reflection of the general interest now shown in the economic initiatives taken by governments, which the conventional descriptive or normative diagrams did not take into account since they only compared two entities, the producer and consumer. But modern society no longer accepts this omission and, since Keynes, many writers have tried to fill the gap. One of their themes is "public prices" i.e. the price of assets that governments make available to individuals which includes infrastructure pricing. Moreover, infrastructure's economic role continues to develop at the expense of its former main function, that of providing a public service and military communications.

From a practical standpoint, the overall development of both freight and passenger transport in their various forms has led to very profound changes in the previous situation, which can only become more marked in the future. Moreover, the development of international trade and the desire of certain groups of countries to standardize their transport regulations are an incentive to compare methods of infrastructure pricing and to try to find their common denominator with a view to equalising, and possibly standardizing competition. This is no small undertaking because of the magnitude of conflicting interests, both public and private.

To see clearly into a problem which covers so many aspects a list of the various possible objectives of infrastructure pricing is needed as a guideline. This list is not an end in itself but only a means serving several objectives whose adequacy will have to be examined.

Any classification has to be arbitrary to some extent. Nevertheless, the purpose of infrastructure pricing would, without risk of serious error, seem to be as follows:

(1) To influence the users' choice

With this aim pricing enables overall transport demand to be controlled and distributed among its various forms and links to the best interest of the community. This will be the subject of Part I.

(2) To guide infrastructure managers

In the private sector, prices are a guide not only for the consumer but for the producer provided they allow him to discern profitable operations and provide him with the necessary financial resources to implement them. How can this role be recognised in transport infrastructure? An attempt will be made to answer this question in Part II.

(3) To fit in with general government policy

It is well known that transport is closely linked to the economics of land usage whether it is a question of town planning or so-called land development (a crucial subject for many countries).

Transport pricing is also often an instrument for social transfers. These different aspects will be considered in Part III.

1. INFLUENCING THE CHOICE OF USERS

Like all prices, infrastructure prices are a means of influencing the choice of transport users, final or intermediary, for freight as well as passenger transport. An influence can be exercised through them on overall traffic as well as the share between transport forms. This is traditional and, generally speaking, a question of the optimal allocation of resources.

First, a definition will be given of the basic principle of optimal allocation of resources (Section 1.1) followed by a detailed account of its application to transport infrastructure (Section 1.2). The problems involved in applying the principle will then be examined and finally, an attempt will be made to make an overall assessment of it (Section 1.4).

1.1 The basic principle of the general theory of optimal allocation of resources.

This theory is well known. Let us refer to it briefly keeping close to its description in /1/ and /6/. The main assumptions are as follows:

- The aim of the productive sector is to bring down the costs of production to their lowest level, which it does.
- The distribution of non-salary revenues is optimal.
- Individual satisfaction curves are convex.

On these terms, the necessary and sufficient conditions for optimal allocation of resources, i.e. so that it is not possible to favour one economic entity without disadvantaging another are are follows:

- That there should be a pricing system, the price of a given asset being one and the same for producers and consumers (intermediary or final).
- That in all sectors with falling productivity (also called "differentiated" sectors) the producers should increase their output to the point where selling at marginal cost they meet demand at this price each trying to obtain the maximum profit.
- In sectors with a growing productivity (called "non-differentiated" sectors for in these sectors only one enterprise is involved) the principle governing the selling price is still that of sale at marginal cost, but in this case the contractor no longer has to make it his policy to obtain the maximum profit, which would lead him to sell his product above the optimum price and in quantities below those optimum; the possible deficit should therefore be covered by a "neutral" tax, i.e. one not connected with the behaviour of the contractor.

These findings are well known which is why they have been given briefly. The following remarks are also conventional: obviously, existing economies are not organised on the principle of the optimal allocation of resources. They vary on many points, particularly the lack of identity between production and consumer prices, the perfect competition characteristic of sectors with decreasing productivity and the management of sectors with increasing productivity. Moreover, taxes are generally not "neutral". Does this mean that the theory as a whole is not applicable to an isolated sector? Before hasty conclusions are drawn there are two points for consideration. First, if we refuse to apply the theory in one sector on the grounds that it is not applied in the others we are caught in a vicious circle without any hope of improving the situation. Again, although in fact the conditions of optimal allocation are not strictly fulfilled many of them are not far from being so, and the real situation in this respect can often be considered as being satisfactorily close to what would be ideal. This will often be the case with the rules for production management in the differentiated sector, and also in the non-differentiated sector which is often more or less closely controlled by the State. If some of the conditions are thought to be unreasonable there is nothing to prevent them from being replaced by other more realistic assumptions; the results might be found to be slightly different and the theory itself more complicated but an optimal allocation of resources will still be possible. This is particularly so for the assumption on the optimal distribution of income; if it is thought that it is not fulfilled and that some categories of manufacturer should be favoured more than others, it is easy to take this into consideration(1).

Up to now the theory of optimal allocation of resources has been seen in a static sense. When time is introduced two principles are brought into play:

- The discount rate which is the same for all economic entities and enables comparison to be made between sums of money or profits at different dates. This discount rate, in particular, will help producers in their usual investment operations through the "present value" concept.
- The principle of "it is only the future that counts". The past is continually wiped out; existing resources, workers and capital goods should not be used in terms of why they are there but only according to the future profits accruing.

1.2 The application of the theory of the optimal allocation of resources to transport infrastructure.

(1) The theory of surplus, in particular, makes this very easily possible.

We will examine successively various ways of applying these general principles to transport infrastructure, ranging from the most simple to the most complex:

- no competitive infrastructure and only one category of user;
- no competitive infrastructure and several categories of user;
- competitive infrastructures but only one category of user;
- competitive infrastructures and several categories of user.

1.2.1 No competitive infrastructure and only one category of user.

The price is then divided into three parts:

- The first corresponds to the additional expenditure incurred by the firm through the presence of the marginal user. This additional expenditure concerns the maintenance and operation of the infrastructure. It is mainly technical and can be determined by finding the connection between maintenance and operational expenses and the traffic itself, to which it is linked mathematically.

- The second part will result from all the elements which do not affect users but to which other individual non-users or the community itself may attach importance, such as "disbenefits" (noise and air pollution) or safety risks. An assessment should also be made of the additional "disbenefit" or safety risk involved by one more user. The corresponding estimates will generally be more difficult to make.

- The third part will be determined differently according to whether the concept of physical saturation is meaningful or not for the infrastructure concerned. If so, (as, for example, for car parks) this third part corresponds with what is called in [1] the pure toll, i.e. the supplement which users have to be asked to pay so that demand will be exactly equal to physical capacity; below this, the infrastructure would not be fully used and resources would be wasted; above it, demand would exceed supply, a fraction of the potential users at the price fixed would be satisfied and it is not certain that it would be those for whom the transport was of greatest utility. But cases of physical saturation are few and it is usually possible to put additional traffic into circulation at the expense only of greater discomfort and longer waiting, both for the additional and initial traffic. Each user must therefore be made to pay for the added discomfort and loss of time that his presence inflicts on others. This raises the problem of the monetary assessment of discomfort and delays. These are from now onwards traditional concepts which can be explained by various methods based on the firms' choice between different means of transport providing more or less rapid and comfortable travel at various prices. The next problem is technical; as regards time, for example, it is necessary to know the principle which links the time of the journey to the passenger load of the infrastructure. It is then possible to determine how much longer the other users are delayed due to the introduction of an additional user. The cost to be added to the marginal cost of the operator and to the social ("disbenefit") costs will be the product of total previous time and hour value.

The overall prices calculated on the three foregoing elements are evidently equalising prices: a price may be fixed for each traffic level, but generally speaking it will not lead to a traffic level for which it was fixed. The optimum will only be reached where points meet and it will be reached through successive approximations whether they are the method of calculation itself or whether they are realised, the tariff being progressively adjusted for a certain time before being fixed at the suitable level.

1.2.2 No competitive infrastructure but several categories of user. For example, one route may take both light and heavy vehicles; sometimes passenger and sometimes goods trains travel by rail. The foregoing principles still apply provided that a separate calculation is made for each category of user, the marginal cost of which will generally be different, whether it is the cost to the operator or that assigned to other users or various "disbenefits". It would be easy to see by setting out the calculation process in detail that prices are clearly determined when, without physical saturation, transport conditions worsen as the number of users increases, although this is not so when there is physical saturation. Suppose, for instance, that there are two categories of users; the optimum condition implies that total demand should be exactly equal to capacity supply but leaves undetermined the distribution between the two categories; it may be satisfied by a low price for the first category and a high price for the second, or vice versa, or it may be any position in between these two points, but the theory does not seem to show which of these possibilities should be chosen.

1.2.3 Several competitive infrastructures and only one category of user.

Here it would also be easy to see that the pricing for each infrastructure should be equal to the marginal cost resulting from the traffic using it. This principle which is valid in cases where the physical saturation concept is not applicable is, as before, only true for the optimum. The total volume of traffic and its distribution among the two infrastructures has to be determined, together with the relevant pricing, by a method of successive approximations [1].

In addition, an interesting principle arises in [2] in cases where there are two competing infrastructures for which the concept of physical saturation is meaningful and for which also, the marginal costs for the operator are independent of traffic within each infrastructure. In this case, if demand is below the capacity of the infrastructures as a whole, the pricing should be the same for each of them and equal to the marginal cost of the operator(1) of the infrastructure for which this cost is highest; for this infrastructure there is no pure toll; it can only be applied to the other, and is exactly equal to the difference between the marginal costs of operating both infrastructures.

1.2.4 Several competitive infrastructures with several categories of users.

Here we will take the case where users differ through the value placed on time. It can then be shown [2] that the optimal situation results in the introduction of a toll on the best infrastructure. This involves a division of traffic between users who place a high value on time choosing the best infrastructure despite the toll and users who place a low value on time and prefer to remain on the infrastructure which is less

(1) Plus, possibly, an amount relative to the "disbenefit" factors.

good because a toll is charged on the other. The paradoxical situation then occurs in which the toll on the good infrastructure makes it more expensive than the other and the good infrastructure is less used.

In addition, for the marginal user who has no preference, the difference in the cost of the two infrastructures is exactly equal to the toll.

These findings are, of course, only valid on fairly limited assumptions: first, that total demand is given and is independent of pricing (what is determined in fact is the difference in price between the two infrastructures and not an absolute price) and, in particular, that the distribution of income is optimal which justifies the incentive to users with high time values (and therefore a high toll).

Obviously these findings are inclined to be theoretical and rely closely on fixed assumptions. But they nevertheless show the care that must be taken to apply correctly the theory of the optimal allocation of resources to transport pricing.

In application of these general principles let us briefly examine three special cases. Relating to road infrastructure with very different findings they emphasize the wide range of prices resulting from this theory; it will be assumed in each case that there is no competing infrastructure.

1.2.5 Vehicles for transporting goods in non-urban areas [6]. Application of the general principle leads to an attempt to find the difference in cost to the community when a heavy vehicle of a given type is introduced at a given moment into the traffic on a road section. The items involved are as follows:

- Expenditure on policing. The marginal cost can be assessed by statistical studies relating expenditure on policing the different highways to the traffic on them in total value and composition.

- Expenditure strictly on maintenance, i.e. on road shoulder maintenance, road signs, and repairing the surface. The same methods can be used as for the cost of policing.

- Time wasted by other vehicles; an additional heavy vehicle in traffic means that other vehicles lose speed. This increases with the gradient of the section of the road and decreases as the road widens. The relationship between the speed of the different vehicles to the overall volume and structure of traffic in terms of the nature of the section of the road concerned gives the required loss of time and, by means of the hour values, the required marginal cost.

- Insecurity. These are the added accident risks entailed by the vehicle's presence on the road. By means of statistical studies relating the number of deaths, injured and accidents to the traffic and its composition the added risks can be assessed and translated into francs on the basis of terms of the monetary value of the injured, the deceased and the accident avoided. The marginal risk cost being determined, deduction has to be made of the insurance premium paid on the vehicle which in principle represents the average risk cost(1).

- Strengthening the highway. The passing of axles over the highway is known to reduce its carrying power and bring about gradual structural deterioration. The damage caused by axles varies very rapidly with their weight. The American A.A.S.H.O. tests have shown that the various axles have shown that the various axles have an effect equal to the power of four. On this reckoning an axle of 13 t is roughly equivalent to 20 axles of 6 t. The A.A.S.H.O. has often been criticised, particularly because local conditions differ and the surface of test highways is rather thin and constructed by now obsolete methods. Nevertheless, the findings are beyond question. Each highway has a certain lifetime measured in the number of axle equivalents at the end of which it is completely worn out unless it has been previously reinforced. The reinforcement coatings of sand gravel mix and slag, themselves, have a certain lifetime in axle-equivalents depending on their thickness and the state of the highway before reinforcement. On a given section, the measurement of deflection (subsidence due to the weight on the axle) makes it possible to assess the residual lifetime in axle-equivalents and allowing for the prospects of traffic development, in number of years. The date on which the road will have to be reinforced is known and allowing for technical possibilities and traffic forecasts it is then possible to determine the thickness of the first reinforcement and the dates of subsequent ones.

(1) Provided that the dead and injured values included in the marginal cost which correspond to an assessment from the standpoint of the community, equal those resulting from private sector assessments of loss.

Supposing therefore that an axle of a given weight moves on the road. The date of the first reinforcement will have to be put forward slightly and its thickness increased so that it will be able to last until the date initially fixed for the following reinforcement. These two operations - putting forward the date and increasing the thickness - are expressed by a present value cost which is exactly equal to the required marginal cost of reinforcement.

- Finally, as regards capacity investment, widening of the road or duplication by a new road, the passage of an additional axle on the road will evidently cause neither a change in the date of carrying out this investment nor a change in its nature.

Infrastructure taxation therefore consists of marginal costs for the following elements:

- policing;
- strict maintenance;
- loss of time;
- safety;
- strengthening of the highway.

Calculations made according to different assumptions(1) have shown that among these different items:

- it is not easy to allocate the marginal costs of policing and maintenance as such according to category of vehicle; in any case they are low;
- allocation is equally difficult as regards loss of time and safety costs though these are higher;
- on the other hand, the cost of reinforcement varies very considerably according to the structure of the highway and category of vehicle, more specifically in relation to the weight to the power of four of its axles. The corresponding part of the marginal cost is therefore very low for light vehicles but very high for heavy ones.

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(1) References [6] and [9].

If the marginal costs are compared with the prices represented by "excess tax on motor fuel (that part of the tax on motor fuel above the usual level) generally the "excess" is greater for small vehicles and is less for heavy vehicles. Moreover, for the same total weight the marginal cost varies substantially according to the distribution of this weight among the axles.

1.2.6 Urban traffic. Theoretically, the analysis is the same; the elements composing the marginal cost are the same but their relative importance is different(1):

- the part represented by policing, strict maintenance and risk are still low;
- there is much less reinforcement, mainly because the highways are made of paving stones which are very resistant to heavy weights;
- on the other hand, loss of time is the major element because of the frequency of near congestion during which the introduction of an additional traffic unit considerably slows down the flow of traffic.

This marginal cost, moreover, varies considerably according to the time of day. At night, for example when there is not much traffic, the introduction of an additional vehicle does not impede the traffic; at peak hours however it is quite different.

The numerical assessment tests carried out in various studies have shown that the overall prices which are low and generally less than the surtax on fuel when there is no traffic congestion may become very high and well exceed the fuel surtax when there is congestion.

1.2.7 Pricing of buses in urban areas.

This is not only linked to infrastructure but also to traffic operation, and seems at first sight to pose an insoluable problem. How much does an additional passenger cost? Nothing if the vehicles are not full; otherwise, the total amount of the marginal cost of an additional vehicle. To solve this well known paradox it is necessary to go back to the policy for running a bus system. The frequency and size of the vehicles result from an optimisation between:

(1) See reference [7].

- the cost of the vehicles' infrastructure;
- the cost of running the vehicles;
- the monetary assessment of loss of time (journey and waiting time) and discomfort of the users, bearing in mind their number.

If the number of users increases by one, an optimal policy will bring about a change in the frequency and (within the limit, of course) the size of the vehicle; loss of time and discomfort suffered by other users will also be changed. It is these variations together which make up the marginal cost to be charged to the user. As to be expected this marginal cost will vary according to the time, the transport line and waiting point.

1.3 Problems involved in pricing at marginal cost. The two examples given above are sufficient to show that prices vary considerably depending on the place, time and type of transport vehicle used. A number of equalisations have to be made and it is important to verify that they are sound; practical methods of charging and their adequacy may then be considered.

1.3.1 Equalisations. Logically, prices should vary:

- in time, mainly because of the different degrees of infrastructure congestion. These variations are daily (morning and evening peak periods in urban areas), weekly (week-end traffic on the open road, monthly (annual holiday peak periods) and yearly (long-term traffic growth);
- in space. In an urban underground public transport system the degree of congestion varies considerably according to the station. Likewise, the marginal cost of reinforcement differs according to the route taken;
- according to the vehicule, as shown in the previous example on the pricing of freight transport by road. This variability which is part of the system itself cannot be discounted, for if charges are high during peak periods it is precisely to encourage users to stagger their journey and if the differences are removed the beneficial effect of pricing at marginal cost will be lost.

Two questions arise, therefore:

(a) What is a suitable charge?

(b) What will be the resulting economic loss?

(a) The cost of development has often been suggested as a suitable charge. What does this concept imply? Apparently its terms vary considerably with the author, but presumably it expresses a traffic differential which is no longer instantaneous and no longer an "impulse" in the mathematical sense of the word, as for the calculation of the marginal cost, but covers the entire future. This variation implies a change in overall future expenditure. According to the case, the cost of development is represented as the relationship between:

- future expenditure and total future traffic at present value;
- additional future expenditure at present value and the variation in traffic at present value which causes it;
- future expenditure at present value and future traffic at present value forecast in relation to present traffic.

The third concept is obviously mistaken for it is indeterminate if a stable traffic situation is forecast and negative if a decline in traffic is forecast.

The first concept is the same as an average cost. But it is the second which seems to come nearest to the concept of marginal cost. As, moreover, it gives the price at which it is itself constant in time, this is possibly the correct equalisation over time of pricing at marginal cost. [3] shows that this is so, but care should be taken in determining the additional expenditure resulting from the traffic variations allowed for in the calculation. This must include the change in investment which is meaningful here, for if overall future traffic is increased in the same proportion the date of the investment and its nature will change.

This equalisation over time may be extended by an equalisation in space following a similar method of calculation [4].

This shows also that the development cost obtained equals the average of the exact marginal prices in total space and time covered by the equalisation, weighted by traffic at these prices and taking into account present values for the time equalisation.

(b) How satisfactory is the equalisation obtained? Does it distort the value of pricing at marginal cost? Obviously a perfect reply cannot be given to this very general question. Everything depends on the difference in the prices being equalised. Only two comments are possible - the first is that pricing at marginal cost is an optimum; but optima, as we know, are generally flat, i.e. even quite substantial variations around them result in only low economic losses. More specifically, the economic loss is of secondary importance compared to the variation in price which causes it. The second comment goes back to the calculation made in [2] to determine the relative economic loss due to a variation of x per cent in the price around the optimum where there is an isolated infrastructure without competitor transporting only one category of user.

It equals x^2.

For a 25 per cent price variation the relative loss is only 6 per cent. If the variation is 10 per cent the loss falls to 1 per cent and becomes negligible.

These are encouraging figures: the prices corresponding to the optimum vary considerably, but we know how to equalise them accurately and the economic loss resulting from this equalisation is very likely to remain within reasonable limits.

1.3.2 Practical methods of charging:

- for road vehicles in urban areas;
- for public transport in urban areas;
- for railways;
- for inland waterways.

(a) For road vehicles in urban areas.

A thorough study of this subject was made in [5] and [7]. One can first imagine an almost perfect system involving no equalisation: a magnetic device placed under the highway at regular intervals sends out pulses at constant frequency or, better still, in relation to the number of vehicles on the highway. Vehicles are fitted with a recording device which adds up the pulses; the charge, which could be payable monthly, by meter reading, is in proportion to the number of pulses recorded.

The pulse device could also be fitted to the vehicle, each vehicle having its own type of pulse which would be registered by a recorder under the highway. A central apparatus would aggregate the individual pulses and make out a bill which would be sent to the owner of the vehicle or directly debited to his bank account. This futuristic system does not seem to be beyond the scope of modern techniques and might be put into effect rapidly. But naturally it would have to be put into general use, and fitting out the highways and vehicles might take an appreciable time, although the cost of installation and operation should be reasonable.

However that may be, this is in some respects an ideal system since it allows for perfect differentiation between the road, time and type of vehicle.

A more simple system would be to introduce licences to be affixed on the vehicle's windscreen. In this case it is also possible to differentiate between vehicle, place and time, but it is not possible to go as far as in the first system; although the urban centre could be split into two or three differently priced areas, it might be difficult to adjust the licence to the time. At the most there might be week-end and week-day licences. Pricing would obviously be less exact since the system would have an impact on overall demand but not on its time distribution; but its simplicity, ease of application and the speed with which it could be introduced makes it undeniably attractive.

There is also the possibility of introducing a toll on some roads. Generally speaking, it could only be introduced on new roads because of the magnitude of the installations involved. Certain simplifications are necessary because of the large volume of traffic passing through quickly. The charge must be very simple and the system should be that of open payment (throwing coins into a basket) rather than closed (delivery of a card on entry so that the charge can be calculated on exit). Moreover, it would seem to be difficult, if not impossible to differentiate according to time and as the installations would take up precious land in urban areas this system obviously has many faults. There is also the fact that since tolls can only be introduced on new roads this system is to a large extent anti-economic; on the one hand, new highways are generally the least congested and consequently there is less justification for a toll and on the other, competition between different roads is particularly marked in urban areas, and it is not fair to introduce a charge on one without doing the same for the others. The urban toll is therefore a bad way of influencing the users' choice.

There are also taxes on petrol and tyres, etc., but it does not seem possible to construct them so that there would be the desirable charges with adjustments according to type of vehicle and road congestion. Moreover, any attempt at space allocation would certainly be open to easy fraud.

These are systems for controlling traffic but they all have various disadvantages and the question arises as to whether other expedients such as a tax on possession or parking would not achieve the same purpose more simply.

A tax on possession comes back to introducing either a purchase tax on a vehicle or an annual tax, such as, for instance, a licence. A purchase tax is in itself not feasible as it has no effect on the breakdown of demand by hour and perhaps not even on overall demand should users buy new vehicles less frequently. An annual licence such as the licence used at present in France has not this disadvantage since it can easily be varied according to the vehicle. But that is about the only adjustment that can be made to it. This system is in fact an extreme simplification of the traffic licence described above. Its disadvantage is that it restricts traffic not only in urban areas which it is intended to do, but in the open country which is not necessarily so desirable. In urban areas, parking is a necessary complement to traffic and it might be expected, therefore, that action taken on the former might indirectly affect the latter. To make its pricing effective the majority if not all parking places must be paid for and fines for illegal parking should be sufficiently high. The price structure and level might differ according to the district and if commuter traffic is to be restricted in the town centre, long daytime parking must be heavily taxed, whereas night parking and short daytime parking might be made less expensive. Similarly, car parks at the entrance to the town should be inexpensive to complete the effect of these preventive measures.

(b) In urban areas for public transport.

The Charge on infrastructure might be made at two levels, either directly as a special item in the operator's accounts for public transport or when the fare is paid in the case of private transport.

In the first case, the charge paid by the public transport operator to the manager of the infrastructure can be determined with complete accuracy since the types of vehicle, their journey and timetable are known and it can be reviewed at regular intervals, say annually.

In the second case, the charge is included in the price and can therefore be adjusted only when the latter is adjusted.

There are, however, three kinds of rate:

- a fixed price;
- a price in proportion to the journey time;
- a price in proportion to the distance travelled.

The first system is justified when the majority of users pass through one or several junctions forming bottlenecks in the transport network. Studies seem to show that this is the case with the Paris underground.

The second is certainly more in keeping with the marginalist theory, although more complicated controls are required.

The third is simple and may seem logical.

It would be interesting to adjust these rates on a time of day basis; non-peak and peak rates might be envisaged but it might be difficult to go further.

(c) Pricing outside urban areas.

The licence, toll and pulse systems are possible. But the pulse system would certainly be unsuitable for the purpose since loss of time outside urban areas is not an important factor as regards traffic. The licence system would be more satisfactory and could be introduced on certain routes at peak periods (week-ends and official holidays). However, the most popular system, so far, is that of tolls. Unfortunately this system has been used in the wrong way on new infrastructures where the marginal cost was low because of low maintenance costs, due to their recent construction, and reduced traffic involving small loss of time.

Finally, a fuel tax has the advantage of being simple; the equalisation involved seems admissible because of the low price differentials between one highway and another and one period and another outside urban areas. This tax exists in all countries but has not been introduced for this purpose and is, moreover, generally not high enough.

Taxation on freight transport vehicles comes in a separate category; as we have shown the major pricing element for these vehicles is the charge for reinforcement which varies considerably with the axle weight except for traffic on new roads whose surface is not appreciably affected by the passage of heavy axles. The solution adopted in France following the recommendations of the Commission d'Etude des coûts d'infrastructure (Commission for the study of infrastructure costs /6/ is as follows: an annual licence is obligatory; its cost depends on the maximum total weight of the vehicle and the position of the axles. Part reimbursement of the licence may be made a posteriori by showing proof of journeys made by the vehicle on motorways with tolls. The price of the annual licence is calculated on the basis of the average charge per kilometre and average annual distance covered by the category of vehicle concerned. Despite the significant equalisation involved, this system seems to be satisfactory /6/.

(d) Pricing of railways.

Passenger tickets are delivered at any station. They can therefore be associated with a very refined adjustment in space and special rates for off-peak periods may be envisaged over time.

As regards freight, the problem of peak periods is less acute and the adjustment of time can be avoided.

(e) Pricing of inland waterways.

In this case differentiation can be as refined as desired since the charge is made as the vessel passes through locks, allowing for considerable variation.

1.4 An attempt to assess pricing at marginal cost.

The aim of pricing at marginal cost is to influence demand effectively through infrastructure charges. In this respect several points might be investigated namely:

- Are prices an effective means of influencing demand?
- Are there more effective methods?
- Should the ultimate objective be to influence demand on the basis of the theory of the optimal allocation of resources?

1.4.1 Are prices an effective means of influencing demand?

To decide this question a number of points have to be considered.

The first is that the price of infrastructure sometimes represents only a small proportion of transport costs. There are also the operational costs, taxes and the non-monetary elements taken into account by the user such as speed, reliability, comfort and good service, etc. For instance, the marginal cost in respect of transport by private car outside urban areas, only seems to account for from 10 to 20 per cent of the total cost of transport. It is evident therefore that there have to be very wide variations in infrastructure prices for transport demand to be affected.

Another point for consideration is that of information on prices. A price which is accurately computed but ignored by the public which is only aware of it a posteriori at time of payment would lose its incentive. The price must therefore be simple and well known. This, in particular, throws doubt on the efficiency of pulse systems; the driver before starting his journey does not know how much it will cost him since this will depend on the degree of congestion on the road, still unknown and hazardous; the refinement of the system therefore seems to be for the most part useless. Likewise, a toll system varying considerably according to the highway would be useless since it would be impossible for the users to know all the tolls and make the required choices.

Finally, action on demand depends mainly on its elasticity; primarily overall elasticity but also elasticity of substitution of one form or of one route for another and elasticity of substitution over time. It must be admitted that there is no detailed information on these elements which are difficult to measure. It can be assumed, however, that, at least at short term, these elasticities are low. Thus in urban areas the travel which interests us here is mainly that of commuters, which is affected by the location of the home and place of employment and by the hours of work, factors that are almost impossible to change at short term; overall transport demand is therefore fairly inelastic. As to the substitutability of one form of transport over another, it depends on the unused capacities in the different forms; in average-sized towns public transport is not, and is not likely to be, sufficiently developed for its contribution to have much effect, but in large towns its contribution is higher, but it is generally saturated at peak periods and the possibilities of substitution are therefore also very low.

As regards freight transport, overall demand results from the location of customer and supplier, and a change in infrastructure pricing which would entail only a very low variation in receipts would hardly change this relationship. There again overall demand is inelastic, at least at short term. The substitutions of one form for another are perhaps more numerous but they are only equal in value for certain goods, many others being captive because of the particular characteristics of the form: speed, reliability and good service or quite simply the existence of no other form of transport.

The elasticity, at long term, might seem higher but is then due to a change in location which depends not only on the infrastructure pricing policy but also on more general aspects of land development, the setting up of urban centres and economic expansion. But at long term the increase in traffic leading to road congestion will result in an increase in prices compared with present prices. This increase should be made known in sufficient detail so that the sites now being chosen are adapted to it.

Business travel is also more affected by the time taken on the journey than by its price.

Finally, another element to be taken into consideration in urban pricing is the importance of loss of time and the fact that at near saturation point this part of the price is extremely variable. Estimates made in a report by the Commission d'Etudes des coûts d'infrastructure [7] show that when at near saturation point the traffic varies by 15 per cent, the price could even double. With such responsiveness a system exactly meeting these requirements would probably be unusually unstable, if not at traffic level (which in any case is fairly inelastic as we have just seen) at least as regards price.

1.4.2 Are there other more efficient systems influencing demand?

Prices are not the only means of changing demand. There are others which might prove to be more effective. If the traditional theory favours these parameters, i.e. prices, it is because of their quantification possibilities "all things being equal". But prices alone do not seem to affect behaviour.

Instead of adjusting prices we could, for instance, simply introduce controls. For instance, parking restrictions in towns are a means of restricting the use of the motor car. Likewise, a regulation on road freight transport might make it possible to change the proportion of traffic in favour of rail. Finally, instead of introducing high charges for heavy axles on the road we might simply prohibit their use.

Likewise as regards the choice of route, a system of road signs might be very effective as shown by the relief roads recently introduced at peak periods; formerly, users did not use them because they did not known they existed. But the fact that they have been brought to their notice has led to a much more efficient distribution of traffic.

Information activities might also be considered as a substitute for incentive pricing. These might include conventional publicity as well as consideration for the users and adjustment of the minor details about which they are concerned.

These various methods involve the selection and distribution of users by other means than prices and for this reason might be preferable where, contrary to the theory, the distribution of income is not optimal.

1.4.3 Is the orientation of demand in accordance with the economic optimum a final objective?

The first objective of the theory of the optimal allocation of resources is optimum production; how can this production be obtained without waste and by making the best use of available resources?

Its second objective is optimum consumption. How can the available goods and those resulting from the production process best be distributed in terms of individual tastes and incomes? This is the main objective of the theory on which optimum production is based. It might sometimes be wondered whether these two optima are equally valid, and in particular, if optimum consumption is as important as it is considered to be.

It is difficult to criticise the concept of optimum production; whatever the government system or whatever its objectives, there has to be a certain volume of production. It should obviously be reached without waste and by making the best use of available resources. These two guiding principles inevitably lead to the corresponding results of the theory of the optimal allocation of resources, in particular the principle of pricing at marginal cost. The latter therefore also seems to apply to the transport of intermediary goods.

There is good reason for thinking that it will be another question for the transport of final products. The community might think it advisable to change the individual assessment of the usefulness of these final consumer goods. This is obviously the case for some goods, such as spirits and luxury products which are often highly taxed. The same might be said of the usefulness of certain transport facilities which are highly appreciated by some persons but are not acceptable to the community. For instance, a government wishing to concentrate its efforts on industrialisation might treat holiday transport as of secondary importance although it is appreciated by consumers. The frequency with which corrections of this kind are introduced into the final consumer structure are a warning to be careful about the relevance of the theory of optimum consumption.

This theory, moreover, is based on the assumption of optimum distribution which is generally not assessed correctly. For example, for social purposes the development of air transport, which because of its price is reserved for the higher income group, might be deliberately restricted in favour of mass transport which is more reasonable.

This brings us back to what was previously said about optimum production; if the main objectives of certain intermediary transport is to co-operate in the manufacture of consumer goods and it is desired to restrict the use of these goods, their prices might be raised above those resulting from the theory and vice-versa. Thus preferential rates for transporting coal would be a distorted means to solve the problem of the decline in coal-mines. It is true that other measures would be more effective and direct and also more in accordance with the theory.

2. PRICING AND INFRASTRUCTURE MANAGEMENT

Supply and demand go side by side and if infrastructure pricing can be used to influence transport demand, it can also be used for a better adaptation of supply and in particular for a satisfactory development of investment.

In the first section we will examine how pricing at marginal cost makes it possible to meet the two requirements of good investment management i.e. obtaining the necessary credits and causing them to be used in the best way.

In the second section the "budgetary equilibrium" system of pricing in order to obtain the necessary credits will be described.

The third section will deal briefly with the use of these credits and the role of infrastructure pricing.

2.1 Pricing at marginal cost and infrastructure investment.

Pricing at marginal cost is not unconnected with investment. In fact both are closely related through economic theory as we will now show.

2.1.1 The theory of the choice of investment as part of the optimal allocation of resources.

This theory is well known; based on the principle of surpluses it leads to the choice among several varying operations on the same liaison to the one which yields the highest profit at present value. This profit at present value /8/ and /9/ is the difference between future receipts, discounted back to the year of origin, produced by the investment and the overall expenditure on initial installation and subsequent maintenance, also discounted back to the year of origin, which this investment will involve. Developments of this theory make it possible to say that the optimal date of introducing an investment when there is an increase in the traffic concerned in course of time is the date when the ratio between the annual profit and the cost of the operation is equal to the discount rate.

Two points connect this with price at marginal cost. The first is that the choice between several investments according to the method just described clearly assumes a bias as regards price; the investment decision will depend on the price adopted. The second is due to the fact that the theory of surpluses is at the basis of investment choice and so directly justifies pricing at marginal cost. Choice of investment and price are therefore two complementary operations which have the same objective: to optimise the surplus as a whole. This liaison is shown particularly clearly in [3] and [6].

But is this theoretical equivalence borne out in practice? In other words, are the natural mechanisms sufficient to ensure the liaison put forward by the theory?

To answer this question it is necessary to find out to what extent pricing at marginal cost is likely to be able to finance the necessary investment.

2.1.2 Pricing at marginal cost and budgetary equilibrium.

Managers of transport infrastructure often run their services like private firms or have a certain independence. But will they be able to find the resources needed to develop their activity if they base their pricing on marginal costs?

A priori, this would be a matter of chance. In other productive activities this coincidence only occurs when there is constant productivity. As regards infrastructure, Morhing (quoted in [2] has shown that this occurs when the cost of infrastructure is in proportion to its capacity, which is in some way the same thing as constant productivity in industry. Likewise as regards renovation M.D. Laval [4] has calculated the price to be charged for an indefinite chain of renewals and has shown that it produced a return which was very close to the expenditure involved. But one element which is peculiar to transport infrastructure makes the position different from that in industry. In the case of transport, infrastructure prices, linked to the level of traffic, are initially low; they rise only at the end of the investment's lifetime when it becomes necessary to increase capacity. The financial profitability is therefore at long term and it does not seem that the method of amortization, which is usual in industry can be easily applied.

Separate examination of the various forms of transport leads to the following conclusions:

- in urban areas, particularly in big towns, the receipts from pricing at marginal cost should cover infrastructure expenditure;
- this does not seem to be the case either for road or railway transport outside urban areas.

In addition, a deficit is apparent in the case of inland waterways. These conclusions are nevertheless contingent; the prices only depend on the present situation since they are based on the short-term marginal cost. The credit requirements also depend on future trends in traffic. The respective positions of these two elements therefore might be different with other forecasts for traffic growth.

The theory of the optimal allocation of resources enables this possible disequilibrium between revenue and expenditure to be remedied. If there is a surplus it will be used to finance the government's public expenditure; if there is a deficit, this should be met by a neutral tax, i.e. one not related to the behaviour of managers towards consumption or production. But the difficulty of fixing a neutral tax must be appreciated; it is easy to apply a tax on revenue, particularly when it is progressive.

Indirect taxes are more satisfactory when the rate is similar for all goods and when they are like the Value Added Tax; but this does not entirely apply to consumer goods for which taxes vary.

As regards wages, the government's social transport facilities can to a certain extent be considered as a negative tax, according to the theory, but it would still be necessary to make sure that its absolute value is the same as that of the tax on consumer goods.

However that may be, pricing at marginal cost nevertheless implies some government intervention which will have to take back the surplus it produces or make up the deficit it allows to remain. But is this situation likely to be harmful to efficient investment?

2.1.3 Does pricing at marginal cost set up mechanisms which prevent the optimum choice of investment?

The government's more or less marked control over pricing and choice of investment is not without disadvantages. Generally speaking, governments lack resources; the various needs they have to meet are covered by taxes which are always unpopular. It is not an easy matter to balance the budget and often expenditure which does not seem to be urgent has to be sacrificed. Transport infrastructure frequently comes in this category because owing to traffic growth its profitability is at long term.

The budget is a popular instrument for regulating the economy. When the economy is overheated it is customary to block credits for public works, whereas in periods of crisis there is a temptation to increase them beyond what is actually needed from the standpoint of profitability in order to set the economy going again.

Moreover the government inevitably comes under political pressures.

These factors are likely to cause distortions compared with an optimal policy, particularly since if the objective of pricing at marginal cost is distorted it might be an important source of tax revenue, for the receipts it produces increase with infrastructure congestion. Correct choice of investment should rapidly remove congestion and therefore result in a reduction in receipts. However, it could be tempting to an improverished government to postpone investment and thereby make substantial savings, increasing income by more congestion and a consequent rise in receipts! In short, the government may be tempted to take action of this kind rather like the monopolist in the private sector who willingly restricts supply to maximise his profit. These are evidently only assumptions but actual experience tends to show that they are not ill-founded.

Pricing at marginal cost may therefore be distorted for reasons unconnected with a defect in the theory but because of the short-comings of those who apply it. How can a more satisfactory system of pricing be found which, in particular, will make it possible to balance receipts and expenditure?

2.2 Pricing ensuring budgetary equilibrium.

An account of various systems which might ensure budgetary equilibrium with practical examples will be given in the first paragraph.

In the second paragraph we will show how budgetary equilibrium can be reconciled with the satisfactory adjustment of demand.

Finally, the last paragraph will assess the pros and cons of pricing on the basis of budgetary equilibrium.

2.2.1 The various systems of budgetary equilibrium.

There are mainly two types of budgetary equilibrium; the first is without credit arrangements and the second involves possible loans and may be compared with the system of total costs.

(a) Budgetary equilibrium without credits.

In this case pricing should enable expenditure to be covered yearly without possibility of carry forward. This is evidently a very crude system for only the investment expenditures and not their profits are spread over time. This disadvantage is unimportant when there is a regular flow of expenditure but becomes serious when there are temporary peak periods of expenditure. In the latter case, this system is totally inconsistent with a satisfactory adjustment of demand since it leads to pricing at the highest rate when there is least congestion. However, it has the advantage of being simple.

(b) Budgetary equilibrium with credits.

This enables infrastructure charges particularly investment charges to be carried forward over time and is therefore more suitable when expenditure is likely to vary from year to year. However, it is somewhat arbitrary because of the credit terms included in the calculation of the prices; should the market terms which vary according to the personality and financial standing of the borrower - which might introduce distortions between forms - be taken or a single rate common to all the forms, which then would involve an arbitrary element? Another difficulty arises when the system is introduced, should prices relating to previous investment be taken into account? If they are not, liaisons which have been over-developed in the past and therefore have considerable surplus capacity are favoured. If they are, the whole history of the infrastructure has to be traced back and credits invented (at the terms prevailing at that time) for which present users would provide the means through prices. Finally, inflation, which all countries have experienced for many years, would distort this figure for the repayable loans; the repayment of loans made twenty years ago would produce paltry sums in present money compared with the expenditure in real value they were supposed to cover.

It is to remedy these various disadvantages that we have imagined the system of total costs.

(c) The total cost system.

This system consists of calculating annually or over a slightly longer period the amount needed to reconstruct infrastructure today and to allocate to the users the proportion of the annual repayments corresponding to the period and rate of credit. This removes the disadvantages of inflation and the difficulty of analysing the past history of the infrastructure. But there are other disadvantages, for instance, the value in the cost of reconstruction of the land on which the infrastructure is placed. What value should it be given? The value of the land before the infrastructure was set up or its present value? It would seem logical to take its present value so as to avoid going back into the past, but often the present value of land is due to the presence of transport infrastructure. This is particularly so in urban areas and near motorway interchange junctions for infrastructure where the value of the land is substantial in the total price. Moreover, techniques change and if the infrastructure had to be reconstructed it would be done quite differently. This method likewise can be somewhat arbitrary.

One difficulty is common to the three methods - the breakdown of total expenditure between the forms of transport. For instance, how will the expenditure on construction and road maintenance be broken down between cycles, private cars and different categories of goods transport vehicles. As regards railways how will this expenditure be broken down between passenger and goods trains. Some rules of allocation seem more logical than others but none is completely satisfactory. For example, the method proposed in the United States to finance the "Interstate and Defense Highway System" is on an incremental basis. A breakdown is made of private vehicle traffic and several categories of goods transport vehicles at increasing total weight:

- First, the cost of a road constructed only for light traffic is assessed. This cost is distributed between all vehicles, including heavy vehicles in proportion to the total number of vehicles.
- Secondly, the additional expenditure for light traffic and the first category of heavy vehicle is assessed. This additional cost is broken down among all the vehicles actually in circulation, except light vehicles, in proportion to the total number of vehicles.
- Finally, the additional cost is assessed in relation to the foregoing with the addition of the second category of heavy vehicle. This new addition is distributed among the traffic as a whole, excluding light vehicles and the first category of heavy vehicle; this distribution is made in proportion to the number of vehicles.

And so on until all categories of traffic have been dealt with. The next step is to calculate for each category of traffic the expenditure chargeable to it during the various stages. This is divided by the number of vehicles in the category concerned, which gives the price.

The apparently satisfactory nature of this method is attractive but closer examination reveals its arbitrary character due to the choice of order in which the traffic is taken. Why begin with light and not heavy vehicles? This would not be serious if the final result did not depend on the order, but unfortunately this is so and indeed its dependence is very considerable. Finally, another problem connected with the breakdown of relative costs appears in the budgetary equilibrium method which was not apparent in pricing at social marginal cost. This is the breakdown between two forms of transport, or between one form of transport and another economic activity, that is to say infrastructures which have two functions: for instance, level crossings or installations on inland waterways which are used both for internal navigation and for regulating the flow of water. In these cases an attempt can be made to determine the main user, without whom there would have been no need for any installation, and to assign to this user the cost of the installation, which his presence alone made necessary, and to the other user the additional cost. Or an assessment can be made of the cost of the two structures made necessary by the actual presence of each of the two users, assigning the actual structure constructed to each of them in proportion to the cost of the two fictitious installations. These methods are applicable in the case of a bridge over a river which is raised so that vessels will have the required clearance. But it is difficult to see how they can solve the case of level crossings which are due to the simultaneous presence of rail and road. It might be argued that since the trains benefit from them they should pay for them, rather than road vehicles, but the matter is doubtful.

The uncertainties mentioned above can be avoided by methods which reconcile the orientation of demand and budget equilibrium. These will be discussed in the following paragraph.

2.2.2 Optimal orientation of demand with the constraint of budgetary equilibrium.

Here we have the following problem. By one method or another (budgetary equilibrium with or without loans or the system of total costs) we have defined a certain level of receipts based on the prices. In view of this constraint, how can the prices be fixed so as to influence demand in the best possible way i.e. to best fulfil the objective analysed in Section 1?

In [2] this problem is studied on the assumption that the different traffics using the infrastructure have laws of demand which only depend on their own prices where, in short, substitution between one traffic and another is impossible. It is then easily shown that the best orientation is obtained when prices are such that at the point of equilibrium the elasticities of demand for different traffics are equal to each other.

This simple conclusion might be difficult to put into effect for the laws of demand are not fully known; moreover those shown in statistical studies often have a constant elasticity and in this case the condition evidently cannot be realised.

This is why we often have to be satisfied with adopting prices which are proportionate to marginal costs, the factor of proportionality being such that total receipts reach the desired level; or again, that each price differs from the marginal cost by a constant quantity. These corrections to the marginal cost are only valid so long as they remain low; if the marginal costs provide a revenue which is very different from that desired, they are no longer very meaningful.

Nevertheless, whatever the difficulty in practice, these methods provide a guideline in solving the problem of the breakdown of prices between connected productions.

2.2.3 Overall assessment of budgetary equilibrium systems.

One of the advantages often referred to as regards budgetary equilibrium systems compared with marginal cost is that they fit in with current practice in private industry, but this does not seem to be conclusive. First, it is not clear why it is necessary for transport infrastructure to follow the same accounting rules as the rest of the economy and, secondly, the upholders of pricing at marginal cost can reply that the latter also fits in with current practice in the private sector. But since this sector is mostly composed of differential activities, generally speaking the fixing of prices at marginal cost corresponds to the balancing of receipts and expenditure; as to monopolistic activities, any attempt to reach or even exceed budget equilibrium results in a loss to the community.

On the other hand, another advantage which it is more difficult to deny is that through budget equilibrium infrastructure expenditure is made the responsibility of those who gain from it. From this standpoint, the transfers of income, which would otherwise be necessary and might not be desirable for the community, are avoided. In short, no one is put at a disadvantage as with the Pareto optimum.

On the other hand, where pricing at marginal cost does not ensure equilibrium of receipts and expenditure, transfers of income have to be made and this, theoretically, has two diadvantages:

- since the assumption of optimal distribution of income is not generally fulfilled these transfers will be meaningful for the well-being of the community;
- the tax through which they will be effected being generally not neutral will introduce a distortion in behaviours which will be detrimental to the fulfilment of the optimum.

Finally, to assess the advantage of budgetary equilibrium another important point has to be considered the level at which budgetary equilibrium must be effected. It can be envisaged at the level of:

- transport as a whole;
- each form taken separately;
- each liaison taken separately;
- each liaison within each form.

It is not easy to decide on this point. From the standpoint of the breakdown of total traffic between the forms, the first level - the most accepted - is the one which seems to be the most satisfactory if overall transport demand is inelastic. In this case a system in which the price is equal to marginal cost multiplied by a constant coefficient for all forms(1) is likely to give the most satisfactory breakdown of traffic. But it may introduce geographic disparities by favouring systematically vertain regions and putting others at a disadvantage.

On the other hand as regards the breakdown of traffic the last level seems to be too detailed and would result in big disparities between the forms and liaisons.

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(1) In this case a price equal to the marginal cost plus a fixed charge would introduce a proportion of uncertainty. For example if the fixed charge is Frs.1 for the road vehicle, to what part of the railway should the charge of Frs.1 be applied, the train or the wagon...?

A satisfactory compromise in this respect might be to effect budget equilibrium for all forms together within a geographic area neither too big (so that conditions are homogeneous) nor too small (to level out extremes).

But another consideration should be noted, it concerns the objective itself of budgetary equilibrium which is not an end in itself but a means of ensuring good management; its importance can therefore only be assessed by reference to the management system with which it is integrated. It is by this means that we can best assess the level of aggregation to chose and the system of budgetary equilibrium to adopt.

2.4 Prices as part of a system of infrastructure management.

The conventional rules for good management consist in placing the decision centres as near as possible to the persons they concern, with an independent system of receipts and expenditure, subject to certain controls so that there will be no waste. The usual constraint for this purpose is that of budget equilibrium, i.e. equality, at least, between receipts and expenditure.

We see in this connection that budget equilibrium loses its objective if it appears as a condition to be fulfilled a posteriori and not as a constraint to encourage the service to improve its management, effect economies and avoid waste.

It also loses its advantage if the management is not directly concerned with the result of the expenditure it incurs and is not penalised in some way or another for bad investment.

Let us illustrate this statement with examples:

A government department responsible for road investment obtains its resources from the general budget. The charges paid by the motorist are transferred to the general budget without being assigned directly to road works. If the decision centres should first decide on the amount of desirable expenditure, afterwards adjusting the receipts from infrastructure charges with automatic cover by the general budget for a possible deficit, budget equilibrium will never be an encouragement to the efficient use of credits. At the most it will be a protection against the unreasonable demands of government services and will provide users with some assurance that their money will be used to make roads.

If, on the other hand, it is a question of a service which is run locally and is financially independent with an elected management, there is genuine responsibility and encouragement to use the credits accoding to the wishes of the users. It should be noted, moreover, that this does not require strict equality between receipts and expenditure; due proportion between the two would be sufficient, provided the proportion were fixed and intangible.

As regards new infrastructures there are many advantages; first, contact with those who are most directly concerned makes it easier to define and satisfy needs and secondly the users benefit directly from the work they are financing and will be more willing to help to pay for it.

This principle of autonomy seems to be the basis of the recent reform of the French railways and the establishment of independent sea and river ports.

These considerations evidently take us beyond the framework of infrastructure prices into the field of "management" and social behaviour and therefore the analysis can go no further in this direction. It seems nevertheless that the choice of a pricing system for infrastructure cannot be separated from the institutional framework within which it will be applied.

But although it seems desirable to instil into infrastructure management the driving force which is the basis of the dynamism of private enterprise it is evidently not possible to go too far along these lines. Transport infrastructures are a favoured means of government intervention; especially in connection with land development and social policy, and this cannot have an impact on prices.

3. INFRASTRUCTURE PRICING, LAND DEVELOPMENT AND SOCIAL POLICY

Numerous decision centres with too great an autonomy would leave too much room for micro-decisions which, as so often the case in economics, would obstruct the macro-decisions of the community. The risk is all the greater because transport infrastructures generally have increasing returns.

The macro-decisions most directly affected by infrastructure pricing seem to be those relating to land development and town planning. Social policy is also affected very directly.

3.1 Pricing and land development.

Land development generally has two different aims; to control the development of areas which are growing progressively and to stimulate development in depressed areas. In the first case it is a matter of channelling and in the second of catalysing.

Infrastructure pricing does not seem to have a big role to play in controlling development, although perhaps the pricing systems which handicap projected infrastructure (budgetary equilibrium without credits) are sometimes an obstacle to the development of modern means of communication. Moreover, in certain situations small changes in prices seem to lead to big changes in traffic. For instance, as regards international sea trade, the choice of port of discharge might be appreciably affected by the rates applied; in view of the many activities in port traffic, prices might then play a substantial role in the development of neighbouring ports.

On the other hand, as regards the catalysing role of development in depressed areas, it will often be necessary to set up infrastructure with a higher capacity than needed if the amount of travel only is taken into account. If, therefore, pricing for these infrastructures is based on budgetary equilibrium the high prices will destroy the desired advantages. A subsidy from a central agency for the construction with a low price level similar to that resulting from marginal cost would seem to be required.

3.2 Pricing and town planning.

In urban areas, prices whether related to budgetary equilibrium or marginal cost, will certainly be very high because of investment needs and the degree of present congestion. Their influence may therefore be proportionately greater than for other traffic and might be used at two levels.

3.2.1 At urban development level.

The influence of prices on transport demand and therefore on the localisation of activities may change the present and future concentration of occupations and lead to the transformation of many towns with congested centres into more widespread conurbations with a more uniform density. Moreover, they may involve a change in the value of land. The price of land is closely related to traffic costs [10]; an increase in traffic costs in urban centres would result in a reduction in the price of land and, consequently, the value of the surrounding land which could be bought more cheaply would increase.

By using the effect of prices on town planning, the latter can be orientated in certain directions by removing the charges on the traffic involved.

3.2.2 Prices may affect three aspects of everyday life:

- The size and technology of road vehicles.

Prices in all transport systems are logically related to traffic congestion and to the social disadvantages (noise, pollution) they cause. This may encourage the construction of small electrically-powered vehicles for town users. But households would then have to possess two vehicles, one for town and the other for the highway.

- Location and type of public transport.

Suitable pricing in urban areas would be likely to result in the transfer of a large proportion of passengers to public transport. Its quantitative development might then be accompanied by a qualitative change to make it more attractive; for instance, by shortening the distance between stops, by the size of the vehicles, the introduction of U.R.B.A. systems and escalators.

- Finally, general parking charges would produce more resources for financing parking grounds and more of these might encourage the use of private cars.

These various effects of pricing would evidently appear slowly and are only a possibility but they give an indication of the possible impact of infrastructure on town life.

3.3 Pricing and social policy.

Transport prices are a favoured means of social transfers apparently due to the fact that the transport companies, because of their more or less monopolistic nature and the public service considerations which prevailed when they started have often been under strict government control. For example, there are reduced holiday rates, reductions for family situations, weekly tickets for commuter transport in towns. Such expedients do not generally fit in with pricing at marginal cost for they often favour peak periods (holidays and home-to-work transport).

The theory of the optimal allocation of resources shows that these transfers should be brought about by means of a change in income. It seems, however, that transfers in kind such as price reductions are more appreciated by the public than the increase in income which would make up for them. Generally speaking, they only have a very small pecuniary advantage for the user when related to his overall income. But for the transport manager they may in the end be a heavy burden. However, they pander to the taste for preferential treatment, and give the feeling of being favoured.

For freight transport, such transfers might help to sustain a declining activity; but in this case there is no longer a psychological justification and it must be admitted that this would be completely at variance with optimum production.

Another case for transfer would be where a form of transport is in decline but where, for social considerations and through fear of unemployment, it is hoped that the decline will not be too rapid so that the necessary changes can be made. Government subsidies might then lead to a more favourable situation than if the rules for pricing were similar to those applied to other forms.

Finally, a special case of transfer is due to the numerous public service obligations, namely;

- a road service for even the most isolated dwellings;
- a railway service for very small conurbations;
- the acceptance of all packages sent for transport by rail.

It seems that in the past these obligations were one of the fundamental aspects of transport infrastructures. Now that the latter's economic role has become increasingly important they are only a legacy from the past; similar activities would only be financially profitable at prohibitive rates. But there are many obstacles to their abolition. Although this is desirable in the future a rational policy of subsidised prices will have to be defined to cover the transition period, including the definition of these obligations and determination of their cost.

4. CONCLUSION

It is apparent that the problem of infrastructure pricing is particularly difficult. Prices are only a means which can serve many, unfortunately often contradictory, objectives.

Economic theory states that, for an optimal allocation of resources, prices should be equal at marginal cost; this concept is difficult to define correctly; to calculate it accurately requires a detailed analysis of the problem, both theoretically in terms of categories of users and competitive infrastructures, and from the practical standpoint of the necessary statistical data to understand it.

Its application involves varied and more or less well-adjusted methods which all require some equalisation of prices, an equalisation which, moreover, does not seem to involve substantial economic losses.

Nevertheless, the principle itself of prices influencing demand is debatable because of the relatively small role prices often seem to play in the users' choice and also because of the low elasticity of demand - at least at short term - due to the existence of other perhaps more efficient means of influencing demand.

Finally, the orientation of demand in accordance with the requirements of the optimal allocation of resources may be challenged, if it is a question of final demand, although for intermediary demand, the theory might be more acceptable.

Another objective for pricing may be to encourage good management. From this standpoint there is perfect agreement theoretically between pricing at marginal cost and choice of investment. But in practice some facts may distort this ideal system such as the government's lack of means which may delay investment and so increase marginal cost, the fact that there is often a deficit and the difficulty of covering it by a neutral tax. This disadvantage is met by systems of pricing based on budgetary equilibrium with or without credits or on total costs. They involve, however, uncertainty when existing infrastructure has to be taken into account and when it is a matter of distributing expenditure common to several categories of user. An optimal orientation of demand with the constraint of budgetary equilibrium allows this problem to be solved and in some way meets the objective of the optimal allocation of resources. Finally, a last question to be solved as regards budgetary equilibrium is the extent to which it should be applied; should it be applied to overall transport, each form separately or at a more refined level? But in any case budget equilibrium is not an end in itself; it is simply a factor of good management. This brings us into the field of organisation and management; some independence and responsibility in management seem desirable and may influence the pricing system which is adopted.

But it is not possible to go too far in decentralisation of this kind without frequently meeting the other more general objectives of pricing policy which are used by the government as an instrument for preferential treatment. These objectives are the localisation of activities, whether in connection with land development, town planning, or life in urban centres or from the standpoint of social policy such as transfers and public service obligations. This last category of objective will always imply a certain amount of government control over infrastructure and its pricing.

The guideline for fixing infrastructure pricing, on the basis of these general considerations might be as follows: first a breakdown of overall transport into homogeneous categories (competitive forms, geographic unities) then the marginal cost for each category - which is indispensable; finally an analysis of the structure of the decisions taken and the regulations defining the action to be taken by the management and, consequently, adjusting prices to the marginal cost while allowing for the fact that since the latter is an optimum the low variations will not involve economic loss. It might then be possible to find a method of achieving a certain budget equilibrium.

In any case, provision will have to be made for exceptions to satisfy the needs of general economic policy as regards land development and transfers.

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SUMMARY OF THE DISCUSSION

AT THE FIRST SESSION OF THE SEVENTH ROUND TABLE

(Discussion on the papers submitted by Mr. Quinet)

I. INFLUENCING THE CHOICE OF USERS

The main comments relevant to this first point in the introductory paper were as follows:

A. Optimal use of infrastructure

1. Definition of optimal use

No clearly defined economic criteria are available for determining the optimal number of vehicles on a given infrastructure. The only known factor is physical capacity (the maximum number of vehicles for a reasonably smooth flow of traffic on a given infrastructure), but this approach is of only limited use in an economic context. What is far more important for the economist is to determine the level of the services that a road should render and, in particular, take into account the different types of vehicles that the traffic involves, the aim being to define optimal economic use. A possible starting point for this process is to compare (at a given price level) the benefits for one additional vehicle with the disbenefits for other vehicles already on the infrastructure concerned.

2. The different ways of influencing user's choice

Roughly speaking, the most common means are as follows:

(a) Price.

(b) Quantitative restrictions.

(c) Information and advertising.

The discussion on this topic was chiefly focussed on the first two points. Most participants considered that, from a social and economic angle, quantitative restrictions were less effective than pricing for influencing users. Quantitative restrictions should be regarded mainly as an alternative to be applied in special cases or emergencies.

Some quantitative restrictions are inevitable on purely technical grounds (e.g. use of bridges), but in a more general sense traffic output can be regulated in an indirect way by neglecting maintenance, deferring a capacity increase or systematically developing parallel routes on which tolls are charged. Within cities, it even seems essential to make use of the negative procedures as part of an effective policy for the distribution of traffic and rational use of space. This does not in any way pre-judge the application of the pricing policy.

3. Infrastructure pricing policy

All participants agreed that marginal social cost was the right criterion for ensuring the optimal use of infrastructure and that road pricing should therefore be based on this concept. Some participants pointed out, however, that non-optimal consequences might follow depending on the time scale: thus, a short-term marginal price might induce users to take decisions that are incompatible with longer-term requirements.

For instance, if a new road is designed with a capacity to match the traffic forecast 20 or 30 years hence, the marginal cost at the start will obviously be very low and the cheap price that users will then have to pay may induce them to change their home or workplace. Later on, as traffic increases, the price to be paid for use of the road will rise as the growing density of traffic must inevitably imply an increase in marginal social cost. It is thus questionable whether individuals should be prompted to make decisions on the strength of prices that will be altered at a later stage and, hence, whether it would not be better to apply at once prices based on estimated medium-term or even long-term marginal social cost; for instance, a price fixed for a five-year period (calculated on the average value of marginal costs during that period). By true economic standards the price would thus be too high at the beginning of the period and too low at the end. As such, it may be regarded as a compromise from a pricing policy angle, but would not provide better guidance for users' long-term decisions.

Against this, some participants were not in favour of upsetting the short-term balance in order to achieve equilibrium in the long run, the forecasting techniques for calculating long-term marginal cost being, in their view, inadequate. This means, in short, that there would be no other course than to use present knowledge and not pay too much concern to long-term aspects still to be resolved. This view is reinforced by the fact that the price to be paid for the use of an infrastructure is only one factor among many others taken into account for determining individual decisions and it seems somewhat far-fetched to expect that transport pricing in itself could bring about many changes in the pattern of individual trips.

Moreover, the growth of demand together with inflation - two trends which cannot be ignored - reduce the significance of this aspect in actual practice.

A difficulty of a somewhat more psychological nature was pointed out in this connection, namely, that the application of a pricing system based on present marginal social cost implies that users would have to pay the highest charges precisely when suffering the heaviest traffic hardships. This is clearly a difficult psychological pill to swallow and might raise political difficulties.

4. The influence of prices on users' behaviour

Though the overall elasticity of demand in the short-term is probably low, the impact of relatively high prices on cross-elasticities should not be under-estimated.

The response to price changes being usually fairly slow, long-term elasticities are likely to be much greater than short-term ones. Unfortunately, only piecemeal information is available on long-term elasticity. In any event, when price changes are introduced to influence users' behaviour they cannot in practice be expected to have substantial effects very quickly.

A number of participants considered nonetheless that pricing policy has a considerable influence on users' choice, even though the price paid for the use of infrastructure sometimes accounted for a relatively small part of total transport cost. It would, however, be useless to apply a pricing policy to categories of users for which there is no elasticity of demand.

B. <u>Evaluation of marginal social cost</u>

1. <u>The components of marginal social cost</u>

The Chairman of the Round Table submitted a list of the elements covered by the concept of marginal social cost, classified as follows:

(a) Costs associated with usage.

- Police.
- Routine maintenance.
- Repairs, re-conditioning and strengthening.

(b) Congestion costs.

- Vehicle running costs.
- Vehicle repair and replacement cost.
- Time losses.
- Additional costs resulting from non-productive use of public passenger transport and freight transport capacities and staff.

(c) External costs.

- Adverse effects caused by a given mode of transport on other modes.
- Disbenefits affecting third parties (noise, pollution, loss of value for land and buildings, etc.).
- Safety.

2. <u>Evaluation of factors listed under I above</u>

The discussion enabled some of the factors to be developed in detail:

<u>Time losses</u>

Here, the main difficulty is to determine exactly how the loss of time inflicted on other users varies with each category of vehicle. Costs can be imputed for each category in three ways:

(i) The technical solution, which consists in applying coefficients to a given type of vehicle (e.g. by taking the passenger car as a standard unit and then weighting the other categories according to occupation of road space). This approach gives averaged costs which cannot accurately reflect particular cases arising from different speeds and from the actual characteristics of the infrastructure (widths, curvature, gradient, etc.).

(ii) A purely political solution involving priority for a given category of vehicle which may be based on "production" or "consumption" criteria, (e.g. banning of heavy vehicle traffic at week-ends).

(iii) An economic solution which consists in relating responsibility for loss of time to various categories of users according to the intensity of demand. This last solution, however, is even less feasible than the first.

Besides calculating time losses, a value must be put on them in order to obtain the required marginal cost. Much research has been done on the valuation of time, more particularly with regard to urban transport, but more information on this point is needed in the case of inter-city transport. (These aspects were discussed at length in the course of the Sixth Round Table - see B.C.M.T. Report on the Sixth Round Table.)

Repairs, re-conditioning and strengthening of roads

The Round Table agreed that the findings of the A.A.S.H.O. tests could give useful guidance for calculating marginal costs especially for road reinforcement costs, but each case must be judged on its merits: due regard should be paid to all local conditions to ensure that general rules are not wrongly applied. Statistical studies on road maintenance and reinforcement costs could usefully be undertaken in order to improve the basic data available in this field.

Safety

As the car owner at present pays his insurance premium as a "lump sum" which he is later inclined to "forget", economic considerations of the cost of accidents will not affect his choices. The Round Table considered that insurance costs should vary more than they do at present and be related to the variations in the marginal "safety risk" factor attributable to each user. Many improvements are still required in this field also.

On the question of the introduction of more differentials in systems of insurance, the participants held different views as to methods and feasibility. Some were in favour of replacing the present "lump sum" premium by an additional tax on petrol combined with additional arrangements involving penal rates for accident-prone drivers. In this way, premiums would vary with mileage and would weigh more heavily on those who caused too many accidents. Other participants were doubtful whether such arrangements would really work. In their view, the only tangible result after all this upheaval would be that people drove less, but not more carefully.

It should also be borne in mind in this connection that those who get involved in accidents are not always those who are fundamentally bad drivers but may well be skillful drivers who with their manner of driving are more prone to create accident situations.

It should also be borne in mind that insurance costs are operating costs and not infrastructure costs. They are, however, related to the "safety risk" cost that an additional vehicle should pay according to the system under review on a given infrastructure; in theory, when the marginal cost is determined, a deduction should be made for the insurance premium already paid.

3. Equalisation (cost-subsidisation)

In principle, the prices paid for the use of infrastructure should vary according to time, space and vehicle category, but a whole series of cross-subsidiations are needed if a system is to be workable in actual practice.

The participants exchanged views as to how far such cross-subsidisation should go. They generally agreed that this should be regarded as a problem of optimisation. On the one side, some degree of cross-subsidisation has the advantage of simplifying the administrative machinery for collecting revenue; against this, non-optimal use of the infrastructure resulting from cross-subsidisation implies an economic loss.

When all is said, it seems that the problem of cross-subsidisation is largely bound up with the question of administrative efficiency. Fortunately, there seems to be a fairly wide margin within which prices can vary without the user's choice being thereby affected in a non-optimal manner, but if cross-subsidisation oversteps these margins, prices must inevitably have less weight in swaying the user's choice and it then becomes necessary to introduce quantitative restrictions instead.

The problem of cross-subsidisation mainly applies to roads and, more particularly, to congestion costs. Where the railways are concerned, it should, in principle be possible to draw up a sufficiently differentiated pricing system, even though there is very little differentiation in their case at present. This is due to institutional factors and to difficulties in making a clear distinction between infrastructure and operating costs.

C. Charging methods

The discussion on this topic centered on the practical possibility of imposing charges on road traffic in urban areas. This topic is of prime importance since it is precisely for this type of traffic that the main difficulties arise.

1. Pricing based on parking charges as compared with automatic meter systems for private cars

Even allowing for certain geographical differences, it was generally agreed that a pricing system based on parking charges was not a good solution in the long run. The two main grounds for this judgement are as follows:

(a) Parking charges have no deterrent effect on through traffic. Indeed, they may well encourage it and unduly penalise local traffic. This problem particularly applies to small and medium-sized towns.

(b) Every town possesses a good many privately-owned parking facilities. The fact that this applies to a surprising degree, even in certain city centres, destroys the effectiveness of a system based on parking charges.

The Round Table accordingly judged that automatic meters, or even a licensing system, was a better overall arrangement. Theoretically, the ideal with a metering system would be to charge users according to actual traffic at a given time on each section of the infrastructure, but if the intention is to sway the user's choice he must know how much he will have to pay. For practical purposes, therefore, price differentials based on traffic density must be abandoned as the resulting uncertainty would be counter-productive. (A detailed study on the possibilities and effects of road-pricing in urban areas appears in the papers submitted by Professor Beesley for the Second Symposium and the Second Round Table of the E.C.M.T.)

2. <u>Charging for the use of infrastructure by public transport</u>

A differential pricing system for the use of infrastructures is a distinct possibility where public transport is concerned, but private transport offers far less scope for it. As these two sectors must be given equal treatment, a compromise solution would consist in deliberately restricting the differential for the public sector. This is essentially a practical problem.

Many participants were in favour of price differentiation based on journey-time. This would have the advantage of inducing operators to find optimal economic solutions.

3. <u>Garages and on-street parking</u>

In many towns, the use of the public highway as a "garage" for overnight or long-term parking is a special aspect of the use of infrastructures. This is a factor of growing importance which has a bearing on the proper functioning of various activities within the area concerned.

The Round Table therefore gave attention to this aspect, and it was generally agreed that car owners who neither owned nor rented a garage should bear the economic cost of on-street parking. Various solutions were envisaged. One consisted in allowing car-owners to deduct garage costs from their taxable income, but this would have only a slight and piecemeal effect. A more radical arrangement would be to include in the yearly tax for car-ownership a "parking tax" from which car-owners who have their own private parking space would be exempt.

This last solution could be linked with a fund for the construction of garages, for it would be pointless to exert pressure in this way if no garages are available. In this connection, attention must be drawn to the differences between the "garage" used for housing one's own car and the "car park" normally intended to take other people's cars. In congested areas, the widespread adoption of garages can be prescribed whilst also preventing the proliferation of car parks. Although it is most difficult to prevent people from owning a car it is possible to make them use it in a reasonable manner.

Some participants judged that quantitative restrictions would be a more convenient way of dealing with the parking problem, but they all agreed that the basis of an infrastructure policy should be a rational garage and parking policy. It was not within the scope of this Round Table to discuss the ways of achieving a policy of this kind (this topic was discussed at the Second Seminar of E.C.M.T.).

II. PRICING AND INFRASTRUCTURE MANAGEMENT

The discussion under this head covered the following points:

A. Budgetary equilibrium

1. Advantages of budgetary equilibrium

It is often said that one of the major advantages of budgetary equilibrium is that this constraint may help towards good management of the infrastructure. However, this is true only if there is a certain degree of independence in decision-making. In practice, many decisions affecting the infrastructure cannot be made independently but must be seen in a wider context. Hence, it seems useful and even necessary, in the best interests of the community, that the decision-making process should be guided by an overall plan, together with an institutional framework, aimed at producing the social optimum.

Another advantage of budgetary equilibrium constraints relates to relatively short-term investment, with special reference to equipment. In some sectors, investment in equipment at the time when replacements and general re-adjustments were needed has been prevented by lack of funds. This particularly applies to the railways and, to some extent, to urban transport. With a system of budgetary equilibrium, piecemeal investments would have been avoided and the fact of maintaining investment at a certain level would have helped towards the smoother operation of, and a better balanced demand for, the transport services concerned.

It is important to bear in mind, however, that if budgetary equilibrium constraints are applied unilaterally to a given mode of transport, the results are entirely different from those described above. Public transport operators, cornered between "non-commercial" obligations on one side and the obligation to balance their accounts (or at least bring the deficit down to a politically acceptable level) on the other, are naturally inclined to begin by skimping on renewals; this is one of the plainly tangible effects of a mis-applied concept of "public service".

2. <u>At what level should budgetary equilibrium be introduced?</u>

The introductory report suggested that budgetary equilibrium should cover all forms of transport combined within an "appropriate" region. The Round Table generally agreed that this might easily lead to unduly narrow constraints and so distort the optimal use of resources. In any event, the criteria for an "appropriate" region seem somewhat difficult to specify. A possible basis would be to make the size of the region match the needs of management efficiency.

Most participants were against the imposition of the budgetary equilibrium constraint on each mode of transport. They judged it better to propose systems of budgetary equilibrium possibly involving government financial contributions. This point is discussed below.

B. <u>A system of budgetary equilibrium for the railway sector</u>

The following system was recently introduced for the French railways (S.N.C.F.). The market is divided into two parts which receive somewhat different treatment.

1. <u>The passenger market</u>

Here, equilibrium has to be achieved on the basis of average prices, if only because this is the practice adopted by road and air transport operators. However, equilibrium in this sense also allows for government compensation in respect of fare reductions imposed on social grounds, e.g. for large families, etc. Thus, the Government reimburses the railways for a series of costs classified under the general heading of "normalisation of accounts", that is, a series of costs which would not arise if the railways were managed on a strictly commercial footing. It may be mentioned in this connection that "competitive economy" problems as applied to the railways will be discussed at a special E.C.M.T. Round Table in 1971.

2. <u>The freight market</u>

The marginal costs system is applicable here because marginal cost is what is paid by competing modes engaged in freight transport. The axle taxes, etc., levied on road transport are a case in point. Thus, the aim is to institute true inter-modal competition. Where freight transport is concerned, the S.N.C.F. also receives an all-inclusive grant to cover the difference between the marginal and real cost of infrastructure.

The distinctly different treatment meted out to the freight and passenger sectors is also justifiable from a purely theoretical angle. Freight transport is an intermediate goods sector and, as such, subject to the theory of marginal cost. By contrast, a consumer tax is warrantable for passenger transport.

Most participants were in favour of the system proposed by the S.N.C.F. rather than that which calls for equilibrium on a regional basis as proposed in the introductory report. The S.N.C.F. system does however raise a number of problems, including the following:

(a) <u>The all-inclusive grant to be paid by the State</u>

A railway administration which did not try to get the biggest possible grant would be neglecting its own interests. This of course implies the need for strict rules coupled with an effective monitoring system.

Substantial progress has indeed been made in this direction at national level, particularly within the Common Market. The fact remains that the criteria must be periodically reviewed to check whether the special arrangements made for public services are still relevant, as a basically sound justification may be eroded over time.

(b) Balancing of accounts for passenger services

Here, the main issue is the price which should be taken as a basis, due regard being paid to the losses imposed by government policies. Even so, the question arises as to who ultimately benefits from the continuance of services that are running at a loss which has to be made good by the community.

(c) Allocation of infrastructure costs as between passenger and freight traffics

This is a particularly thorny problem which in practice may call for some degree of arbitrary judgement. A possible procedure is outlined below:

(i) Allocate to the freight sector all costs that would be dispensed with if freight traffic were eliminated. It is, of course, possible to start from the exactly opposite assumption (i.e. the elimination of passenger traffic), and this would give altogether different results. In any event, only a relatively small part of the costs of a railway system can be extracted in this way.

(ii) Next, financial charges are allocated to passenger and freight services according to the turnover they each account for. The basic assumption here is that the marginal cost ratio is roughly the same as the turnover ratio. From a theoretical angle it can be shown that, ideally, the allocation of overall cost should be in inverse proportion to the elasticity of demand for each type of traffic, it being assumed that the demand curves are independent. Turnover is a convenient criterion for a fairly accurate allocation of costs, but the question arises whether this procedure provides a sound basis for marketing policy.

C. Creation of a "Railway Infrastructure Company"

Another suggestion put forward for solving the problems of railway infrastructure pricing and management was that rail transport activities should be shared between two vertically integrated companies. One would be responsible for infrastructure and would sell "infrastructure services" to the other (i.e. the operating company). The infrastructure company's deficit would be met by direct government grant. The problem which arises here is whether the activities of the infrastructure company would exactly match the needs of the railway operating company. The suggestion under review implies that the railways are put on a par with road and inland waterway transport, whereas it could be argued that rail transport is different in kind and could be more suitably compared with pipeline transport which involves an unbreakable technological link between infrastructure and operational management.

D. Railway marketing

Here, the underlying idea is that rail infrastructure pricing policy should be seen in the context of the "marketing approach" which is apparent in many countries and which aims to create an organisation better suited to management decision-making on a competitive market, thus implying the need for fuller information on costs, demand, etc. According to this line of thinking, the railways are expected to operate as a commercial undertaking and, hence, to maximise their profits or at least minimise their losses. This means, of course, that they must also make optimal use of the infrastructure from a commercial standpoint. On the other hand, the community is interested in the infrastructure being used in a manner which gives most weight to social criteria. It is accordingly difficult to recommend an infrastructure pricing system which meets both requirements. The resulting situation may be described as "sub-optimisation of the use of rail infrastructures".

Assuming that there is an optimal social use of road and inland waterway infrastructures, there may then be some distortion of competition. In any event, the use of different criteria for the infrastructure pricing policy to be adopted for each mode of transport implies a "second best" solution for the transport system as a whole.

III. INFRASTRUCTURE PRICING, LAND-USE PLANNING AND SOCIAL POLICY

The main points in the discussion under this heading were as follows:

A. Pricing policy is clearly a multi-purpose instrument capable of serving various objectives such as optimal use of the infrastructure, regional development, social policy and so on. As these objectives clash at some points, prices must be seen in the general context of economic aims. This emphasizes the need for coherent long-term plans embracing all the sectors concerned. Such planning should, in particular, indicate how the use of various means (e.g. infrastructure pricing policy) for achieving an objective in a given field may affect the goals to be attained in other fields. It is vitally important that such planning should not be unduly rigid: it should include alternatives or provide for their inclusion as required by developments at a later stage. However, flexible planning does not mean flexibility with no planning at all, unfortunately a common practice: on the pretext of adjustment to changing circumstances, every guideline and the future shape of things is left to random impulses and conflicting decisions.

B. With regard to the inter-relationships between infrastructure pricing policy and urban development, the question arises whether pricing can ease traffic congestion in city centres and lead to better spaced conurbations. The Round Table did not deny that this was so, but was doubtful whether pricing policy could win car users back to public transport. The demand for private transport is a powerful and irreversible trend, with deeply rooted psychological, social and other motivations. It is a perfectly sound idea to try to canalise this trend, but the limits of what is politically acceptable are soon attained. It could therefore be wondered whether mere price constraints can be effective enough to achieve town planning objectives without quickly leading to price levels which would be regarded as quite unacceptable.

The relationship between income level and use of private transport can be dangerous if, as a consequence of infrastructure pricing, the community is ultimately faced with a scattered housing pattern. Such a prospect cannot be dismissed as a matter of course since, with rising standards of living, there might be an inclination to use a car even though the cost is very high. The end result would be a huge demand for road investment in far flung and loosely knit conurbations. This shows that the whole issue lies in finding the right functional balance.

C. The impact of infrastructure pricing policy on regional development is closely bound up with the classical issue of the influence of infrastructure on resource flows in the regions concerned.

The two conclusions arrived at by the Fourth Round Table were re-asserted on this occasion: First, as there is practically no factual analysis available on this subject, empirical analysis is the only possible approach, and this knowledge gap has helped to spread hazy and conflicting ideas. The second conclusion of the Fourth Round Table was that, broadly speaking, the effects produced by the infrastructure are in themselves slight, and come into play only when combined with other factors conducive to development. Where this combination does exist or is wisely engineered, infrastructural investments can have substantial marginal effects and hence be used to give an impulse to regional development. In this event, it is usually better (from a long-term economic angle) to make immediate provision for an infrastructural capacity well in excess of initial requirements. This problem of scale underlines the importance of the overall pricing policy to adopt since due regard has to be paid to investment finance.

Clearly, if a system of strict budgetary equilibrium is adopted, the prices to be paid by users will be so high at the start that the effective benefits of regional development will fail to materialise. On the other hand, if prices are based on marginal costs, they can only yield a return on capital invested in the very long term.

Some participants were very doubtful whether all costs could be covered by marginal prices, even at very long-term. In their view, prices should exceed marginal cost, this being offset by, or combined with, regional development subsidies. Government financial help would then be deemed to be directed to regional development. Should such help still not suffice, prices would have to be brought down into line with marginal costs. The remaining portion of uncovered costs would then be borne, in the form of a regional subsidy, by the State.

In any event, before allocating considerable amounts of public money to infrastructures relating to regional development, it should always be seen whether the same purpose cannot be achieved at less cost or more effectively by subsidies to other sectors.

D. Transport pricing is frequently used nowadays as a means for the re-distribution of income. The participants agreed that the transport sector should be kept outside the income re-distribution process in order that the transport market mechanism, which already had many imperfections and was difficult to control, should not be further upset. It was better to re-distribute incomes by more direct means.

It must be pointed out that this finding challenges a substantial part of the so-called "normalisation of accounts" policy of the railways. Here again, the whole problem lies in striking the right balance and making gradual improvements.

PRICING THE USE OF INFRASTRUCTURE

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SUMMARY

Page

I. INTRODUCTORY REMARKS ON THE STATE OF THE THEORY OF PRICE POLICY

The theory of price policy has, to the author's mind, reached a turning point. In certain aspects, it still operates within the traditional framework of paretian welfare economics, in others it draws its results from recent benefit-cost analysis. This has lead to inconsistencies which ought to be eliminated.

At the outset, the theory of price policy was only concerned with the optimal utilisation of a given infrastructure. This was necessarily so because paretian welfare economics from which it originated, in concentrating on developing marginal conditions of optimal resource allocation only, had itself assumed as constant production techniques, the size of capacities, and the number of firms. At the same time, by confining the theory of price policy to the question of how to use given capacities optimally, its objective could be stated quite unambiguously. Welfare economics aimed at maximising utility. Since the theory of price derived its postulates from welfare economics, it was clear that price policy based upon the same theoretical framework would also postulate an increase in utility or welfare.

It soon became evident that the scope of price policy, by being limited to questions of optimal capacity use, was too narrow, and that, with its limited assumptions which only held in theory, it could lead to false conclusions in practice. In particular, the question arose whether the exclusion of the costs for constructing production capacities would not lead to a misallocation of resources.

Attempts, therefore, had to be made to include the problem of dimensioning capacity into the traditional theory; the marginal conditions had to be supplemented by total conditions. It would exceed the scope of this paper to discuss the numerous attempts at integrating these total conditions into the traditional set-up of paretian welfare economics and at bringing them into line with the postulate for an increase in utility.

To my mind these attempts have failed. I do not know of an operational formulation of total conditions that can justifiably claim to increase welfare. Furthermore, MISHAN's recent summary of welfare economics suggests that no such formulation is likely to appear.

What the total conditions do in actual fact entail is generally not the maximisation of utility or welfare but the maximisation of social surplus(1).

It must be stressed that the maximisation of utility and that of social surplus is not the same, although this is often implicitly assumed. Social surplus is made up by the difference between the maximum of what buyers are willing to pay and the minimum sellers will ask for successive units of output. Unlike utility, it is thus a pecuniary concept.

Social surplus and utility would only be directly linked if one could assume the marginal utility of money to be constant and identical in interpersonal comparison. Since these assumptions are, however, unlikely to be fulfilled in practice, it must be stated quite clearly that these are two distinct objectives, the pursuance of which may lead to different conclusions.

The theory of price policy has thus, to my mind, been somewhat schizophrenic. On the utilisation side it continues to derive its conclusions from paretian welfare economics, thus operating within the framework of ordinal utility, indifference curves etc. On the investment side it bases its conclusions on the social surplus criterion, thus working with pecuniary magnitudes, costs and benefits determinable in absolute categories. Drawing its conclusions from different theoretical set-ups has resulted in generally treating the utilisation problem as independent from the investment problem. Utilisation and investment problems are not, however, independent of each other. On the contrary, the investment decisions imply utilisation rules and vice versa.

Maximising welfare on the utilisation side may impede social surplus and maximising social surplus on the investment side may impede the welfare aspect. This must necessarily lead to inconsistencies in the formulation of policy recommendations. One cannot hope to maximise two different objectives with one instrument at the same time.

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(1) The concept of social surplus was originally developed by DUPUIT and MARSHALL. After having been superseded for a long time by paretian welfare economics, recently attention has again been focused on it as a result of benefit-cost analysis.

Consistent rules can only be developed if the same objective is applied to both problems. To my mind there is no alternative between the utility proposition and the surplus proposition. As stated above, the attempts to develop operational criteria for investment that are in line with the utility proposition have failed. Hence one cannot in fact extend the utility point of view regarding the utilisation of resources to questions of investment as well. One can, however, extend the social surplus idea and apply it not only to the problem of investment, but also to that of utilisation. The present contribution is to be seen as an attempt in this direction. The following price postulates are deduced with the aim of maximising social surplus both on the utilisation and on the investment side.

The author is fully aware that setting social surplus as an objective of economic policy is not unproblematic. Since the difficulties involved have been discussed at length elsewhere, a short commentary may suffice on this subject.

Firstly, there is the question of the political implication of surplus maximisation. Traditional welfare economics, in that it treats the indifference curves of all individuals on an equal level, entails something like an egalitarian value judgement. Social surplus, however, since it takes account only of those desires that can and will be expressed in terms of market demand, implies a pecuniary value judgement. In societies which adhere to the system of price and market economy there is, however, a good chance that such a value judgement be politically acceptable.

Secondly, the social surplus criterion raises great problems because it is an instrument of partial analysis only. It focuses attention on one particular service, assuming the market conditions of all other services to be constant. This means that it may not be applied to different services simultaneously but only consecutively.

Otherwise, market conditions would be taken as variable and constant within the same analysis. The consecutive application of the surplus criterion, therefore, entails the assumption that all planning decisions concerning infrastructure and its pricing are taken by a centralised authority, or at least that they are co-ordinated between various sectors in their temporal sequence. Whether this assumption holds is a question of fact.

II. THE INTERDEPENDENCE BETWEEN OPTIMAL UTILISATION OF CAPACITIES AND OPTIMAL INVESTMENT

1. Perfect divisibility of all factors

The inconsistencies mentioned above that have arisen from treating the utilisation and the investment problem as virtually independent have been veiled, to a certain extent, by some of the rather heroic assumptions that are generally made in the theory of price policy. One of these assumptions entails the perfect divisibility of all productive factors, including infrastructure. In the case of perfect factor divisibility, the problem of utilisation influencing the investment decision and vice versa, is easily solved. For then every output will have its specific infrastructure, which is optimal for this output and this output alone. With the objective of maximising the social surplus in mind, infrastructure will have to be extended as long as long-run marginal costs run below the demand curve. The utilisation of capacity is then determined uno actu by the output for which this infrastructure is specifically constructed. Since, in this case of perfect factor divisibility, the very construction of infrastructure does already imply a certain degree of utilisation, the conflict between price policy with regard to the utilisation problem and with regard to the investment problem can, by way of assumption, not arise.

Furthermore, in the case of perfect divisibility of infrastructure, there is no question of any divergence between the short-run and the long-run solution. The problem whether one is to price at short-run or at long-run marginal cost does not arise since they both render the same result.

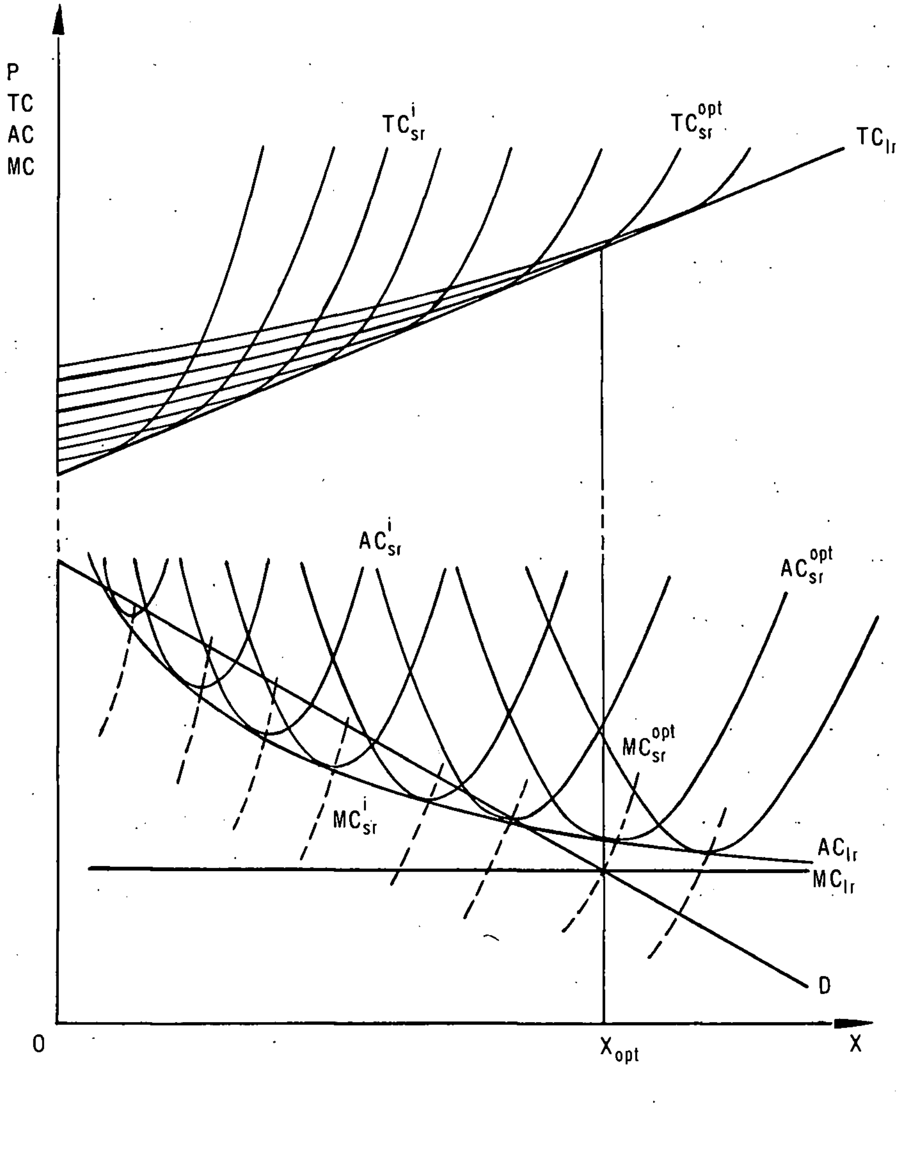
This is illustrated by Figure 1. The variation of total costs for a specific size of infrastructure i dependent on its degree of utilisation is reflected by the shape of the short-run total cost curves TC^i_{sr}. Since infrastructure is assumed to be perfectly divisible, an infinite number of such short-run cost curves is obtained. The envelope of all these curves renders the long-run total cost curve TC_{lr}. In the case of perfect divisibility, this envelope is tangent to the various short-run total cost curves at one point only; i.e. only for one particular output.

From the total cost curves, the average and the marginal cost curves are developed in the usual way. Since the short-run average cost curves AC^{i}_{sr} shift downward to the right, the long-run average cost curve AC_{lr} is falling thus illustrating increasing returns to scale. The cases of constant or decreasing returns to scale can be constructed analogously. The long-run marginal cost curve is represented by the curve MC_{lr}. It should be noted that it is not identical, as is sometimes stated, with the envelope of the short-run marginal cost curves. In contrast to the latter, the former (MC_{lr}), being developed from the slope of the long-run total cost curve, includes the additional cost of increasing capacity.

The optimal point of production is indicated in Figure 1, by output x_{opt} with production taking place at the infrastructure with the short-run average cost curve AC^{opt}_{sr} and the short-run marginal cost curve MC^{opt}_{sr}.

The point of intersection between the demand curve and the long-run marginal cost curve MC_{lr} is, assuming as we are at present, perfect divisibility of all factors, identical with the point of intersection between the demand curve and the short-run marginal cost curve of the optimal infrastructure MC^{opt}_{sr}. For at output x_{opt} the total long-run cost curve TC_{lr} is tangent to the total short-run cost curve TC^{opt}_{sr} of the optimal infrastructure. At the point of tangency, both curves have, of course, the same gradient and hence long-run marginal cost must be equal to short-run marginal cost of the optimal infrastructure. One can, therefor, state the optimal output either as determined by market price equal to long-run marginal cost or as equal to the short-run cost of the optimal infrastructure. A divergence between the short-run and long-run solution does not then occur.

FIGURE 1



P
TC
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MC
TC_{sr}^{i}
TC_{sr}^{opt}
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2. The problem of indivisibilities

If infrastructure is not perfectly divisible, then a long-run marginal cost curve in the ordinary sense cannot be determined; geometrically speaking, in the case of indivisibilities, the gradient of the envelope to all the short-run total cost curves will only reflect short-run marginal costs but not long-run marginal costs. For marginal cost curves, by way of definition, refer to single units of production, turned out successively. If, as in the case of perfect divisibility, there is a specific infrastructure for each and every additional unit of output, then there is no problem of also attributing specific costs of infrastructure to every single unit. In the case of indivisibilities, however, any one infrastructure will not only comprise one additional unit of output but a whole range of additional units. An increase or decrease in production will, therefore, not necessarily lead to a change in the size of infrastructure. (This will only take place at certain intervals.) Hence the marginal costs compiled for units within these intervals will only include short-run but not long-run costs.

If one is to include the cost of infrastructure into our considerations, then the definition of long-run marginal costs must be changed from just producing extra units of output to producing extra units at an extended level of infrastructure. This definition will then include both the short-run costs and the increased costs of infrastructure. Since an addition to infrastructure will, however, by way of assumption, enable us to produce not only one extra unit but a number of extra units, one will have to divide the additional costs of infrastructure by the number of additional outputs. Long-run marginal costs, therefore, necessarily entail an averaged value. It is the sum of the short-run costs plus the average costs of the increased infrastructure that will render the (averaged) long-run marginal costs(1).

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(1) In the following analysis long-run marginal costs will be referred to in this sense, always taking into account that they contain an element of average cost.

Of course, the long-run marginal costs so defined will only be determinable if a definite utilisation of the existing and of the enlarged infrastructure is assumed. Only then does one obtain two definite points of comparison.

With the objective in mind of maximising social surplus, it should be clear that the optimal degree of utilisation for each infrastructure must form the basis of any such comparison. The optimal degree of utilisation for alternative sizes of infrastructure is, of course, determined by the intersection point of the short-run marginal cost curve and the demand curve.

The problem is illustrated in Figure 2. The curves AC^i_{sr} represent the short-run average costs of alternative sizes of infrastructure. The fact that they shift downward to the right is again an expression of increasing returns to scale. The optimal degree of utilisation of each size of infrastructure is determined by the intersection of the short-run marginal cost curves MC^i_{sr} and the demand curve D. Hence the long-run marginal costs must be computed for the range of products between these optimal points of utilisation.

Since the long-run marginal costs are computed as averaged over the entire range of additional output, they must necessarily render horizontal lines. The combination of these horizontal lines for successive ranges of output shall be termed the long-run marginal cost curve MC_{lr}. Since the short-run average cost curves AC^i_{sr} shift downward to the right, the long-run marginal cost curve must shift downward to the right as well and run below the average cost curves.

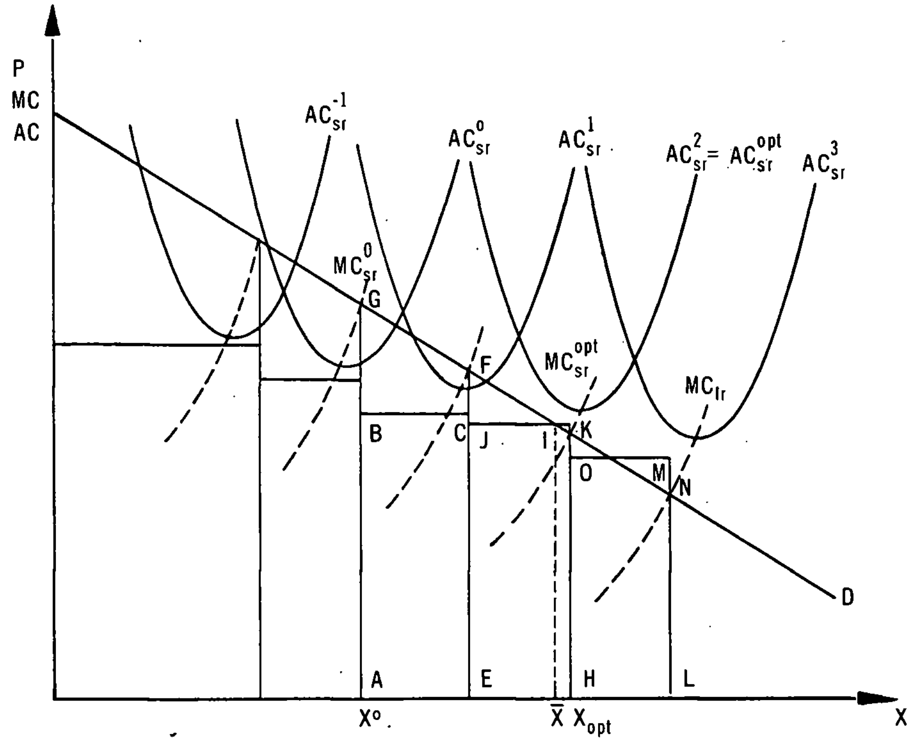
It must be noted that the cost of extending or reducing capacity to a certain size is dependent to a very high extent on the size of capacity already in existence at the outset. In Figure 2, for instance, it is assumed that AC^o_{sr} is the average cost curve of the existing infrastructure, MC^o_{sr}, its marginal cost curve. All the other average and marginal cost curves are only valid as alternative variations of infrastructure from this starting point(1).

Any other starting point, be it a smaller or a larger capacity would also render a completely different pattern of cost curves concerning any variations of infrastructure.

In Figure 2, the alternative possibilities as seen from the existing capacity AC^{o}_{sr} are illustrated by the short-run cost curves AC^{1}_{sr}, AC^{2}_{sr} ... . These curves, and this is important for a correct interpretation of Figure 2, do not represent the average cost curves of successive increases in infrastructure

(1) These extensions of capacity may be undertaken simply by adding infrastructure to the existing capacities or by substituting the existing capacity completely by altogether new infrastructures. The long-run marginal costs will, as a rule, differ in both cases. In the former case it is a question of computing the progression cost, in the latter it is a question of integrating the regression costs into the costs of the new infrastructure. The same holds analogously for any reductions of infrastructure. Since these distinctions are, however, immaterial in the present context, they need not be further pursued here.

FIGURE 2



P
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AC
AC_{sr}^{-1}
AC_{sr}^{o}
AC_{sr}^{1}
$AC_{sr}^{2} = AC_{sr}^{opt}$
AC_{sr}^{3}
MC_{sr}^{0}
G
F
MC_{sr}^{opt}
MC_{lr}
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but rather they denote the cost curve of alternative increases in infrastructure (as seen from the departing point AC^{o}_{sr}). If, starting from AC^{o}_{sr}, the alternative AC^{1}_{sr} is, in fact, realised, then the alternative AC^{2}_{sr} is automatically eliminated. The same holds vice versa and in relation to all other extensions AC^{3}_{sr}, AC^{4}_{sr} .... . Once any of the alternatives shown in Figure 2 has been effectuated, an entirely new pattern of cost curves for further extensions would have to be drawn up. The same holds analogously for the short-run marginal cost curves.

The curve MC_{lr} shows the long-run marginal costs as seen from the present production point x^{o} averaged for successive ranges of output. The long-run marginal cost structures too would have to be completely redrawn once any one of the extensions possible had, in fact, been realised.

An extension of capacities is, as stated above, worthwhile as long as the long-run marginal costs are below demand price. More precisely, in this case, since we are dealing with ranges of additional output, it is worthwhile increasing capacity as long as the product of (averaged) long-run marginal costs multiplied by the additional quantity is smaller than the relevant integral under the demand curve.

In Figure 2 the optimal capacity is, therefore, that denoted by the average cost curve AC^{opt}_{sr} and the short-run marginal cost curve MC^{opt}_{sr}. For, starting from AC^{o}_{sr} it is obviously worth extending (hypothetically) to AC^{1}_{sr} since the long-run marginal cost ABCE is below the additional benefit AEFG. The same holds for a further extension to AC^{2}_{sr} (= AC^{opt}_{sr}) where marginal costs EHIJ are still below the sum of additional benefit EHKF. Since the area HLMO exceeds the area HLNI, a further increase of capacity to AC^{3}_{sr} would lead to a fall in surplus and is, therefore, not worthwhile. The optimal utilisation of the optimal infrastructure is as stated before, determined by the point of intersection between the demand curve and the short-run marginal cost curve MC^{opt}_{sr}.

It is important to note that now, in the case of indivisibilities, the point of intersection between the demand curve and the short-run marginal cost curve is no longer identical with the point of intersection between the demand curve and the long-run marginal cost curve. Any such identity would be a matter of coincidence only. As a rule, the short-run marginal cost curve will intersect the demand curve later, i.e. at a higher output than does the long-run marginal cost curve.

Hence, in this case, pricing at long-run marginal cost and at short-run marginal cost (of the optimal infrastructure) will lead to different results. It is, however, immediately intelligible from Figure 2 which alternative renders the higher surplus. Pricing infrastructure at the long-run marginal cost leads to output x; but this output involves under-utilisation of capacity from a surplus point of view. Only when infrastructure is priced at the short-run marginal cost (of the optimal infrastructure) does social surplus become a maximum. Output will then extend to x_{opt} and all the possible surplus will be realised. Thus, in the case of indivisibilities, when short-run and long-run marginal cost curves render different results at the intersection point with the demand curve, it is short-run marginal cost that must determine the optimal pricing policy.

Furthermore, and this is important for our further considerations, it should be noted that any deviation from the optimal degree of utilisation may involve a reconsideration on the investment side. For any such deviation will generally also affect the course of the long-run marginal cost curve. If, for instance, prices were, in fact, to be fixed above short-run marginal cost, then, because of the smaller output, the cost of the last increase in infrastructure would necessarily have to be averaged over a smaller range of additional products. Therefore, at a lower level of utilisation, the long-run marginal cost curve would be higher than the one actually presented in Figure 2 (which was computed on the basis of utilisation at output x_{opt}). The long-run marginal cost at this inferior level of utilisation may in fact be so much higher, that it is not covered by the additional benefits EHIF. In this case the last increase of infrastructure would not be at all worth constructing.(1)

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(1) This argumentation does not hold only when demand is perfectly inelastic. In that case any additions in price to marginal cost would leave utilisation of the infrastructure and long-run marginal costs unaffected and thus have no influence on the investment side. In view of long term processes of substitution between production and transportation, this case, however, is unlikely to be of any real relevance.

Hence the sub-optimal utilisation of the optimal investment alternative may also render this alternative itself sub-optimal. Price policy would then be aiming at optimising price for an infrastructure that is itself no longer optimal. In actual fact neither the utilisation problem nor the investment problem would then be solved to any satisfaction regarding the social surplus. Optimal utilisation, optimal investment and, of course, optimal pricing are immediately inter-related. Therefore, any price policy must, simultaneously, take both the utilisation and the investment side into account.

III. THE INSTITUTIONAL ALTERNATIVES OF PRICE POLICY

When developing rules of optimal price policy, it is imperative that the assumptions concerning the institutional restrictions of any such policy should be stated at the outset. For depending on these restrictions one arrives at rather different results concerning how the optimal price should be set and concerning the degree of approximation towards the theoretical optimum. The importance of specifying the restrictions on the institutional side seems sometimes to have been overlooked and has led, quite unnecessarily, to misunderstandings and misinterpretations. In actual fact, quite frequently the difference in the solutions postulated did not stem from within the theoretical framework but rather from the difference in initial assumptions. The decision in favour of applying any one of these solutions in practice does then not depend on the logical correctness of their deduction but purely on the congruence of the assumptions made with reality.

On the institutional side one must, in the first place, decide what the parameters of economic policy actually are. Price policy has, of course, price as one parameter. Sometimes this is considered its only parameter which may be interpreted as a price prescription or as a price guarantee. Here, it is used exclusively in the former sense. Frequently another parameter is implicitly introduced when devising price policy, namely investment. Different results ensue if one assumes that either only price or price and investment can be freely regulated.

Secondly one must distinguish the alternatives on the financial side. In most empirical cases we are faced with profit restraints in the sense that the enterprise is to maximise its profits subject to the dictated price, or, at least that it must cover its total costs. In other, mostly theoretical, cases the possibility of subsidies is allowed for.

One can thus distinguish at least four institutional set-ups. 1. Fixation of price leaving investments to the entrepreneur. The entrepreneur is expected or allowed to maximise profits. 2. Fixation of price only, leaving investment to the entrepreneur. The entrepreneur is expected to cover total cost. 3. Fixation of price and of investment by the authorities. The restriction is that total cost be covered. 4. Fixation of price and of investment by the authorities. Deficits arising from the introduction of policies that aim at maximising social surplus are covered by general subsidies. These four institutional set-ups will be dealt with consecutively on the following pages.

Within these different institutional set-ups one has to further differentiate between various kinds of cost structures. As will be demonstrated, the specific kind of cost structure under review, is of great importance for the determination of the optimal price strategy. We shall confine the analysis to the case of increasing short-run marginal costs in combination with increasing returns to scale, decreasing short-run marginal costs in combination with increasing returns to scale and increaing short-run marginal costs in combination with decreasing returns to scale.

1. Price prescriptions and private profit maximisation

(a) Increasing short-run marginal costs and increasing returns to scale

Our starting point is the cost structures and the demand pattern as laid out in Figure 3 which are similar to those in Figure 2. Production is assumed to be undertaken by one entrepreneur only(1). This one entrepreneur is assumed to maximise

(1) It would exceed the scope of this paper to also deal with the case of several entrepreneurs since this would involve dealing with problems of oligopoly. The author has tried elsewhere to develop solutions for price directives for oligopolistic situations.

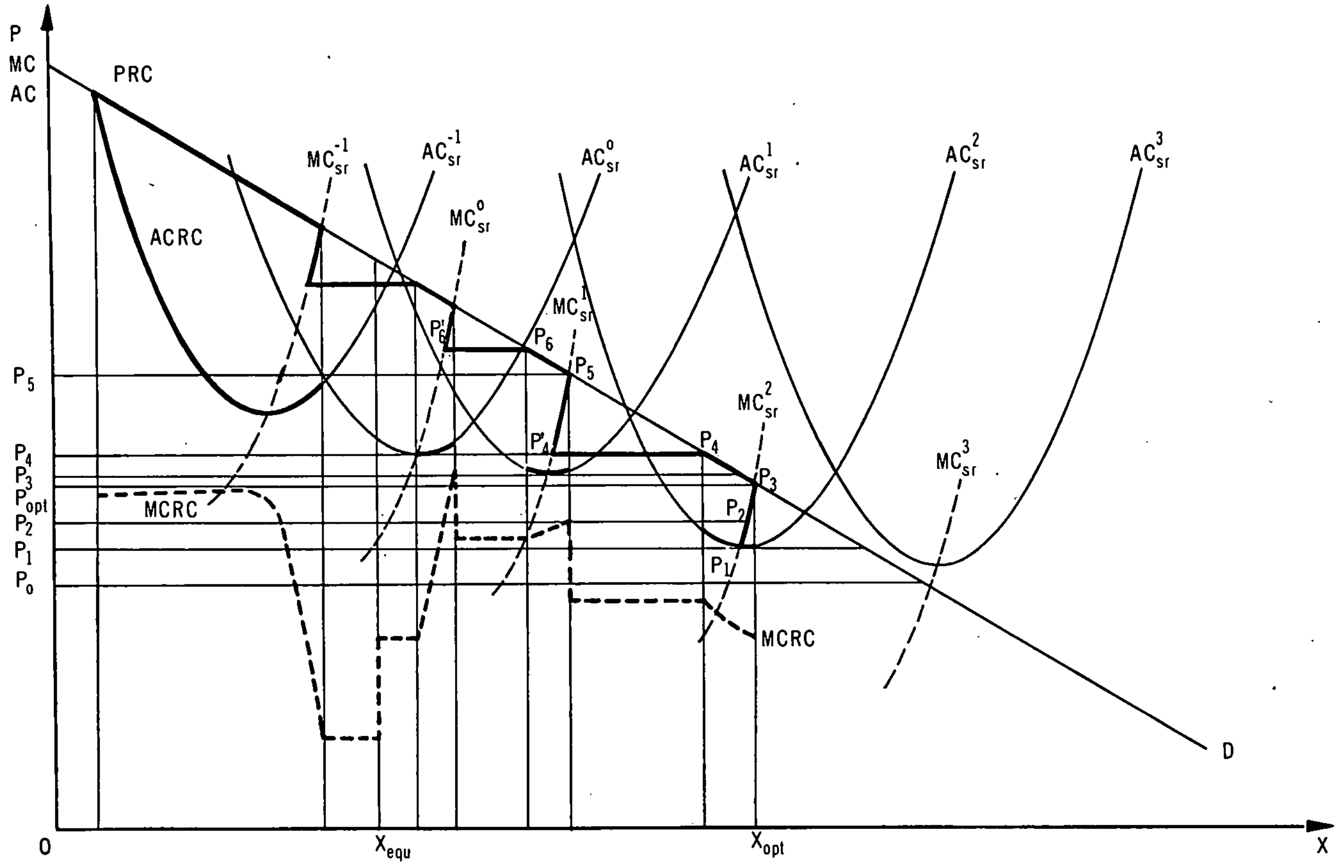
profits subject to the restraints of prices being prescribed by some price authority. The price policy of this authority is taken to be guided by the objective of maximising social surplus. The problem is to find that price which will factually lead the profit-orientated entrepreneur to maximise the price authority's objective, namely social surplus.

The simplest method of finding this price is to hypothetically determine the entrepreneur's equilibria successively at all possible price levels and to compare the social surpluses thereby attained. The optimal price will then be established by way of the price reaction curve (PRC), the average cost reaction curve (ACRC), and the marginal cost reaction curve (MCRC).

The price reaction curve is obtained by connecting the various entrepreneurial equilibria for all possible price levels. It has been termed price reaction curve because it shows how entrepreneurial output reacts to alternative prices. The average cost reaction curve shows the variation of average costs incurred by the entrepreneur at alternatively fixed prices. For each equilibrium output these average costs can be exactly determined. The connection of the average costs for all equilibria represents the average cost reaction curve. The marginal cost reaction curve can then be computed from the average cost reaction curve. It represents the variations in total costs, calculated from the entrepreneur's original point of production - averaged for all additional units of output.

These reaction curves will now be discussed in detail. Successive hypothetical variations of prices are represented by in Figure 3 by a series of horizontal price lines. If one starts at hypothetical price p_o, then production will not take place at all, because the entrepreneur cannot, at any output, cover these costs? The entrepreneur will, therefore, at this price, give up production in the long run or not take it up in the first place. It is not until price has reached the level p_1 that production becomes possible on a private basis. Production will then necessarily take place at point p_1, the only output at which total costs are covered by total revenue. If price is increased to p_2, then the entrepreneur's equilibrium will move along the short-run marginal cost curve to p_2. Further successive increases in price would render further equilibria along the short-run marginal cost curve - until

FIGURE 3



P
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PRC
ACRC
MC_{sr}^{-1}
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AC_{sr}^{3}
MC_{sr}^{1}
MC_{sr}^{2}
MC_{sr}^{3}
P'_6
P_6
P_5
P'_4
P_4
P_3
P_2
P_1
P_5
P_4
P_3
P_{opt}
P_2
P_1
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MCRC
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O
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X_{opt}
X

this curve intersects the demand curve. From the point of intersection onward the price reaction curve will follow the demand curve. At price p_3, for instance, the entrepreneur's point of maximum profit will be fixed at P_3. For at the intersection point of the price line and demand curve the entrepreneur's marginal revenue curve will drop vertically. Hence the point of intersection between the short-run marginal cost curve and the marginal revenue curve which determines the entrepreneur's maximum profit must necessarily lie at the same level of output at which the price line intersects the demand curve.

If price is still further increased then one obtains further equilibria along the demand curve for a certain time. However, since increases in price will change the utilisation of capacities, this will also influence the long-run marginal costs. For, as utilisation decreases, the long-run investment costs of the marginal infrastructure will have to be levied on fewer and fewer products. As long as the long-run marginal costs are lower than the price fixed, the entrepreneur will continue producing on the same infrastructure. But with the prices set continuously higher, there will come a point when the long-run marginal costs of the infrastructure used will no longer be covered by the price. Clearly the entrepreneur would then refrain from choosing this size of infrastructure. Instead he would choose a smaller infrastructure that is better fitted to meet reduced demand. The price reaction curve will then shift to the short-run marginal cost curve of this smaller infrastructure. In Figure 3 this shift takes place at price p_4(1).

As price is increased still further, the price reaction curve will again, at first, follow the short-run marginal cost curve of this smaller infrastructure. From the point of intersection P_5 between the short-run marginal cost curve and the demand curve it will then again coincide with the demand curve

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(1) In order not to complicate the illustration even further the appropriate entrepreneurial long-run marginal cost curve in Figure 3 has been omitted. Furthermore, it should be noted that the points on the connecting line between P_4 and the intersection point P'_4 of the price line with the short-run marginal cost curve of the smaller infrastructure do not represent points of entrepreneurial equilibrium in the above stated sense. They were included in the price reaction curve only for the sake of clarity.

itself. At P_6 the long-run marginal costs of this infrastructure will no longer be covered and production will again be shifted to a smaller infrastructure and so on.

The fact that the entrepreneur is in equilibrium does not necessarily imply that the market as a whole is in equilibrium as well. The market as a whole will only be in equilibrium where the price reaction curve coincides with the demand curve; only then does supply meet demand. At any point to the right of the demand curve there would be excess supply, at any point to the left of the demand curve there would be excess demand.

Under the assumptions made, all points to the right of the demand curve can be ruled out; the entrepreneur will definitely not choose any of these points since price policy, as understood here, is interpreted strictly as price prescription only. If price policy were to be interpreted as a price guarantee, the results postulated here would have to be reconsidered.

It may, however, be profitable for the entrepreneur to produce at a point to the left of the demand curve. As can be seen from Figure 3 that is the case for all price prescriptions when the price reaction curve runs along a short-run marginal cost curve.

If the price were to be set at such a level that would lead the entrepreneur to choose one of those points to the left of the demand curve, then the resulting excess demand would, depending upon the effectiveness with which the price authority can control prices, either lead to queues on the demand side or to the formation of black or grey markets. Whichever is the case, neither of these results will be acceptable to the official price policy. If one excludes the possibility of supplementary quantitative interventions by the price authority, then all those prices which lead the entrepreneur to establish his equilibrium off the demand curve will, therefore, have to be ruled out. Price policy in the strict sense, i.e. without any supplementary measures, can only take into consideration those prices, for which the price reaction curve coincides with the demand curve. For every point on the remaining parts of the price reaction curve the average cost that the entrepreneur incurs at that particular output, can be established. In Figure 3 they can be deduced from the short-run average cost curves. The connection of all points on these average cost curves for all alternative price stipulations that lead to a market equilibrium, we have termed the average cost reaction curve. Because of the fragmented form of the price reaction curve, the average cost reaction curve too exists only in a fragmented form. In Figure 3 it is illustrated by the heavily drawn parts of the short-run average cost curves.

From the average cost reaction curve one can construct the corresponding marginal cost reaction curve. In Figure 3 it is again assumed that the entrepreneur had originally been operating the infrastructure with average costs AC^{o}_{sr} and that he had produced the output x_{equ}. The variation in total costs (in comparison to total costs at the starting point) averaged over the variation in output renders the (averaged) long-run marginal costs of that output(1).

Marginal costs so defined, it should be noted again, include both the additional short-run costs and the additional investment cost. They are to be computed for all prices (and outputs) along the fragmented price reaction curve.

Connecting the long-run marginal costs for all prices possible leads to the marginal cost reaction curve. Its gradient is always smaller than that of the appropriate short-run marginal cost curve but greater than that of the average cost reaction curve. In those parts where the average cost reaction curve is continual, the marginal cost reaction curve runs continually as well. Where there are gaps in the average cost reaction curve, the marginal cost must be averaged over the entire range of products in the interval. The marginal cost reaction curve is

(1) Strictly speaking, long-run marginal costs should, therefore, be computed from the variation of total cost and, accordingly, a total cost reaction curve should be constructed. This would, however, necessitate an extension of the graphical presentation. For didactic reasons only we have chosen the indirect way of constructing long-run marginal costs via the average cost reaction curve, since this permits us to remain within the same set of curves.

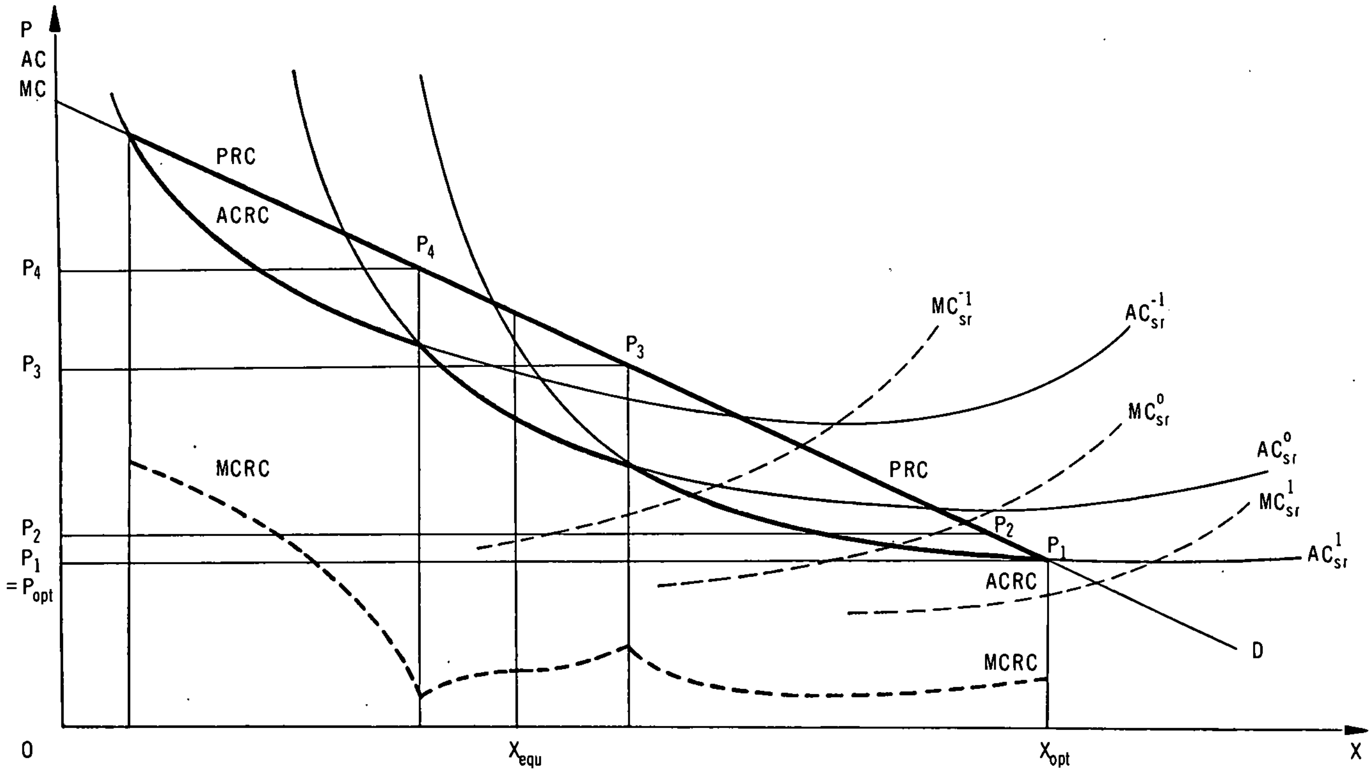
represented in Figure 3 by the heavily dotted line MCRC(1). Once the marginal cost reaction curve is constructed, the optimal price is easily determined. Price is optimal when the difference between the area under the demand curve and the area made up by the (averaged) marginal costs times additional output (counted from x_{equ}) has reached a maximum. In Figure 3 this optimal price would be fixed at p_{opt}. It is equal to the short-run marginal costs of the largest infrastructure that will allow private costs to be covered by private benefits.

(b) Decreasing short-run marginal costs and increasing returns to scale

A production pattern with decreasing short-run marginal costs and increasing returns to scale is presented in Figure 4. The demand curve is assumed unchanged. The price reaction curve, the average cost reaction curve and the marginal cost reaction curve are constructed along the same lines as in the previous chapter in order to find the optimal price policy for this constellation of costs and benefits. The price reaction curve begins at price p_1, the minimum price that has to prevail for private production to take place at all; at price p_1 production occurs at P_1. If price is increased to P_2, the entrepreneur will choose P_2 on the demand curve. For again, the private marginal revenue curve drops vertically at the intersection point between the relevant price line and the demand curve, so that the intersection of short-run marginal cost curve and the marginal revenue curve must necessarily occur at the same output at which the price line and the demand curve intersect. The same holds for further successive increases in price.

(1) The vertical parts of the marginal cost reaction curve have again only been drawn for clarity of presentation.

FIGURE 4


P
AC
MC
PRC
ACRC
P_4
P_3
P_2
P_1
$= P_{opt}$
MC_{sr}^{-1}
AC_{sr}^{-1}
MC_{sr}^{0}
AC_{sr}^{0}
MC_{sr}^{1}
AC_{sr}^{1}
MCRC
D
0
X_{equ}
X_{opt}
X

For some time production will take place in the same infrastructure. But decreasing utilisation of infrastructure will necessarily(1) lead to an increase in long-run marginal costs. Sooner or later there will again come a point where the long-run marginal costs (of the last increment in infrastructure) will lie above the prescribed price. In Figure 4 this is assumed to be the case at price p_3, therefore, production will shift to the next smaller infrastructure. In spite of this shift from one infrastructure to another - unlike in the case of increasing short-run marginal costs - the price reaction curve will continue to run along the demand curve.

As the price is successively further increased, the price reaction curve will continue to run along the demand curve. This also holds for any further shifts to still smaller sizes of infrastructure.

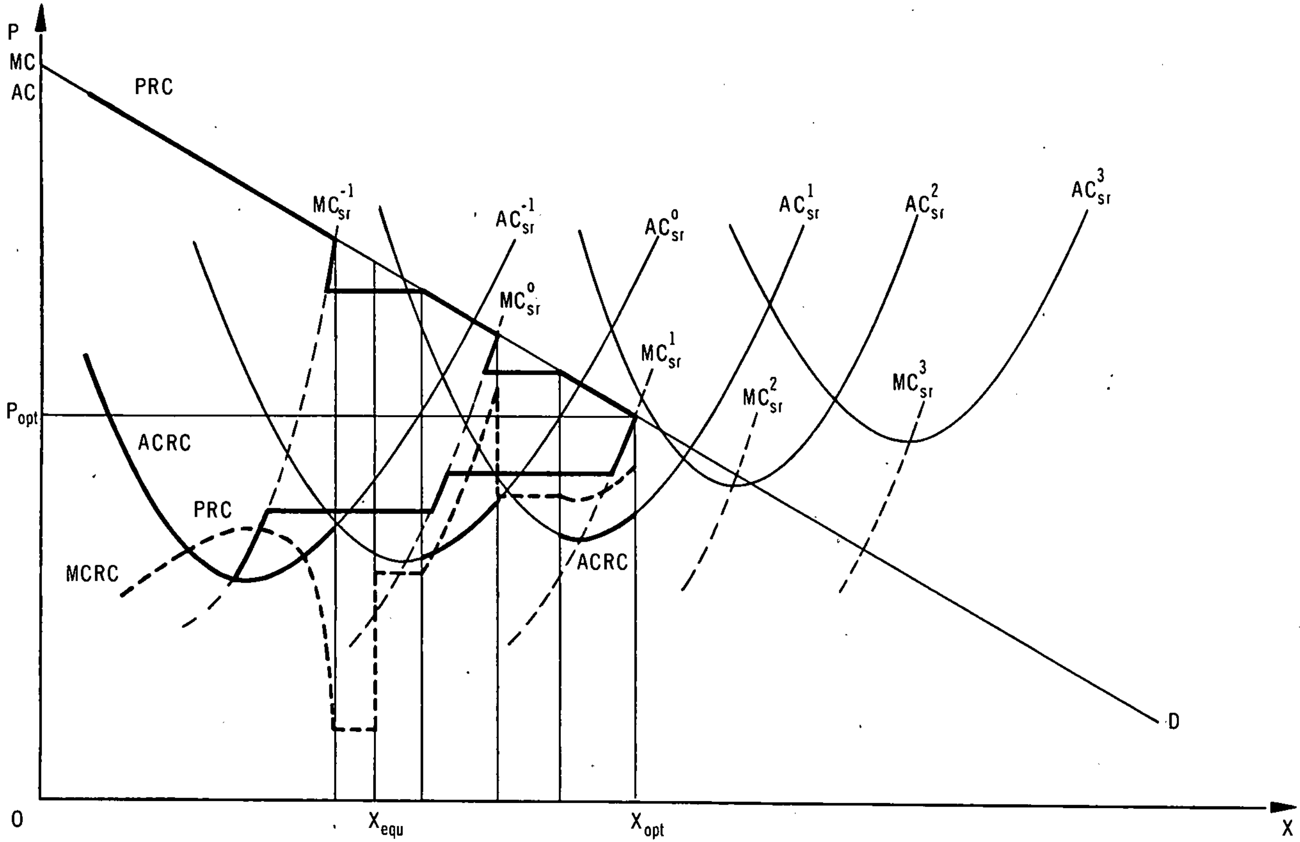
Thus, for the constellation of costs and benefits laid out in Figure 4, the price reaction curve coincides with the demand curve throughout. Of course, this only holds for those parts of the demand curve where long-run average costs are lower than the prescribed price, i.e. only within the two points of intersection between the long-run average cost curve and the demand curve. If in fact the long-run average cost curve were to have several points of intersection with the demand curve, then this would lead to gaps in the price reaction curve. Any fixation of price within these gaps would again have to be ruled out.

Similar to the case of increasing short-run marginal costs, the average reaction curve may now be deducted from the price reaction curve. In Figure 4 the average cost reaction curve is marked by the thick line ECRC; it is identical with that part of the long-run average cost curve that runs below the demand curve. The marginal cost reaction curve again shows the variation in total costs averaged over the additional output.

As before, it is assumed that at the outset the entrepreneur operated on the infrastructure marked by the short-run average cost curve AC^{o}_{sr} and that output extended to x_{equ}. The marginal cost curve computed with respect to this initial situation is marked by the heavily dotted line MCRC.

(1) Unlike in the case of increasing short-run marginal costs, in the case under review, the decrease in output will immediately lead to a rise in long-term marginal costs since short-run marginal costs are increasing as well.

FIGURE 5


P
MC
AC
PRC
MC_{sr}^{-1}
AC_{sr}^{-1}
AC_{sr}^{o}
AC_{sr}^{1}
AC_{sr}^{2}
AC_{sr}^{3}
MC_{sr}^{o}
MC_{sr}^{1}
MC_{sr}^{2}
MC_{sr}^{3}
P_{opt}
ACRC
PRC
MCRC
ACRC
D
0
X_{equ}
X_{opt}
X

Price is optimal when the difference between the area under the demand curve for an increase in output and the area made up by long-run marginal costs times that output has reached its maximum. In Figure 4 it is denoted p_{opt}. The optimal price will, in this case, be determined by the average costs of the largest infrastructure on which private production is possible. It will equal the average costs of this infrastructure at the point of intersection between the average cost curve and the demand curve.

(c) <u>Increasing short-run marginal costs and decreasing returns to scale</u>

The case of increasing short-run marginal costs and decreasing returns to scale is presented in Figure 5. Demand is assumed unchanged. The optimal price is again to be determined by means of the price reaction curve, the average cost reaction curve and the marginal cost reaction curve.

The price reaction curve is figured by the curve PRC(1). Since all entrepreneurial equilibria that do not also coincide with a market equilibrium have to be ruled out, it will again take a fragmented form. For this fragmented price reaction curve, the fragmented average cost reaction curve is constructed and marked ACRC. From this average cost reaction curve the marginal costs in relation to the starting point x_{equ} are deducted and combined in the marginal costs reaction curve MCRC.

As the optimal price is determined by the area under the demand curve and the area made up by the long-run marginal costs times the increase in output in relation to x_{equ} is to be set at p_{opt}. It is equal to the short-run marginal costs of infrastructure AC^1_{sr}. It is to be noted that the infrastructure AC^1_{sr} is not the largest one that could be run on a private profit basis. In the case of increasing returns to scale it may be well worthwhile to restrict output and investment to less than where total private revenues will just cover total costs.

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(1) An explanation of the construction of this curve seems superfluous as it is constructed along the same lines as the price reaction curves in the foregoing cases.

In addition to the three cases discussed here, a number of others could be presented. The foregoing analysis would, however, seem sufficient to demonstrate the principles of optimal price determination. These principles can, without any difficulty, be applied to any other situation. But the foregoing analysis should also have made it clear that there is no general "once and for all" rule for fixing the optimal price, as has frequently been contended, be it at the level of short-run marginal costs, long-run marginal costs or average costs of whatever size of infrastructure. Rather, the solution will depend each and every time on the specific situation, in particular, the specific cost structures and demand pattern.

2. Price regulation and the zero profit restraint

A price policy confined to the statement that prices should be fixed in such a way that output is extended until total private revenue only just covers total costs is, as such, indeterminate. For, in principle it would be possible to push the output of any infrastructure to such a level that, by reason of rising marginal costs, private profits become zero. But, depending on the size of the infrastructure to which it was applied, this policy would render rather different results concerning social surplus. If price policy is to bring about an optimum, it must, therefore, be further specified as to the size of the infrastructure to which it is to be applied. Again, the question of the optimal infrastructure will be dependent on the solution on the utilisation side and vice versa. If price policy is conceived as price prescription in combination with an order to the entrepreneur to extend output until private profits are zero then one must, furthermore, make sure that prices are set in such a way that both parts of this rule are consistent with one another. This condition is only fulfilled where the short-run average cost curves intersect the demand curve. At any price above such an intersection point, profits would necessarily accrue, at any price below, total costs would not be covered (provided, of course, that production took place on the same infrastructure). The alternatives of price policy are, therefore, greatly reduced in this case; there are only as many price alternatives as there are investment alternatives(1).

The price reaction curve is, therefore, reduced to a few points along the demand curve. For any of these points average (or total) costs must be calculated. From these one can then compute the curve of the long-run marginal costs in relation to the costs in the initial starting position. Optimal price is then again to be determined by comparing the area under the demand curve and the area made up by the long-run marginal costs times the increase in output.

In the case of increasing short-run marginal costs and increasing returns to scale (Figure 3), the optimal investment calculated in this basis would be the one marked AC^2_{sr}. The optimal price would have to be set at the intersection point of the curve AC^2_{sr} and the demand curve. Social surplus realised is smaller, given the institutional restrictions under review, than in the case of profit maximisation.

Furthermore, it should be noted that the optimal investment (from the social surplus point of view) being identical in the case of profit maximisation and in the case of zero profit is one of coincidence only. Since the utilisation of infrastructure is different in both cases, the marginal cost reaction curves will also be different. This may also lead to different results on the investment side.

In the case of decreasing short-run marginal cost and increasing returns to scale (Figure 4), the optimal price will be set at p_1. The above qualifications concerning the solution as presented in Figure 3 must also be applied to Figure 4.

Finally, in the case of increasing short-run marginal costs and decreasing returns to scale, the optimal price is determined at the intersection of the curve AC^2_{sr} with the demand curve. Profit maximisation and zero profit restraint will therefore, in this case, lead to different results concerning the optimal investment. Because of the lower degree of utilisation, a shift from AC^1_{sr} to AC^2_{sr} would, in the former case, imply an

(1) This assumes that short-run average cost curves are U-shaped and therefore intersect the demand curve only twice. If more than two points of intersection exist, then the price alternatives exceed the investment alternatives.

increase in average costs. Comparing the additional benefits with the increase in costs would, therefore, lead to the result that the shift from one infrastructure to the other should not be undertaken from the point of view of maximising the surplus. In the case of zero profit restraint, because of the higher degree of utilisation, the shift from AC^1_{sr} to AC^2_{sr} will, in contrast, lead to a fall in average costs. In order to maximise social surplus the extension of the infrastructure should, therefore, be undertaken.

3. Price regulation, investment rules and the zero profit restraint

In this section it is assumed that both prices and investment are parameters of action to the price authority. In addition, the restriction is introduced that whatever price is fixed, market revenue must at least cover total costs.

If price policy does, in this sense, not only comprise price regulations but also investment rules, then clearly no price reaction curve need be developed because the price authority can itself determine output as well. Rather, calculating the optimal price is then closely related to the analysis on which the construction of Figure 2 was based. For each investment alternative the optimal output is determined. Optimal output in the sense of maximising social surplus is fixed, as previously stated, by the point of intersection between the short-run marginal cost curves and the demand curve. For these outputs average (or total) costs are to be determined. Comparing these costs of optimal utilisation points with the cost situation in the initial starting position leads, as before, to the construction of the long-run marginal cost curve. Infrastructure should be extended as long as the difference between the long-run marginal costs and the additional benefits, as determined by the demand curve, is increased.

The additional restriction that costs must be covered by market revenues simply means that any such increase of infrastructure should only be continued as long as the long-run average cost curve lies above the demand curve. In Figure 2 this means that the infrastructure with the short-run average cost curve AC^1_{sr} should be realised. The price is then to be fixed equal to the short-run marginal costs of this infrastructure at the intersection point with the demand curve. As can be immediately concluded from a comparison of the institutional setups 2 and 3, simply fixing the price can bring the same results as fixing both price and investment. Since the former is likely to involve lower administrative costs, one has good reason to conclude that, in the case of institutional choice, it is to be preferred. Similar arguments may be developed for the cost structures presented in Figures 4 and 5.

4. Price regulation, investment rules and the problem of subsidies

If deficits are institutionally admissible then the solution to the price problem is relatively simple. Price is to be fixed where the optimal infrastructure is optimally utilised. In Figure 2 the investment to be realised by way of directives from the authoritative body would be that one with the average cost curve AC_{sr}^{opt}. Price is to be fixed at that level where the short-run marginal cost curve MC_{sr}^{opt} intersects the demand curve. The resulting deficit would be covered by way of subsidies. In Figures 4 and 5 these optimal prices can be determined in the same way. It is to be noted, however, that in all these cases optimal investment and utilisation are interdependent. Since utilisation may change under the marginal cost rule as compared to the foregoing cases, so may optimal investment. Since these problems have, however, been extensively treated above, the solutions need not be further demonstrated here.

Three arguments have been brought forward against subsidisation of deficits that result from marginal cost pricing in the form stated here. Indeed, to my mind, these arguments are so well-founded that the postulation of such a policy involving subsidies becomes highly questionable:

The first argument refers to operation difficulties in applying this deficit rule. It is contended that no clear distinction can be made between losses resulting from the application of marginal cost pricing and those resulting from inefficient management. The validity of this argument depends largely on the quality of the accounting system, the specific cost structures (proportion of direct to indirect costs) and the possibilities of management - supervision.

The second argument refers to the opportunity benefits of subsidies. Although using subsidies in any one production may increase the surplus in this particular production, it necessarily involves a diversion of funds from other economic activities and may, therefore, decrease surplus elsewhere. Hence, before allowing subsidies, it should be established that the production toward which they are directed really does provide the best alternative use. This, of course, leads to the problem of including external pecuniary effects into the analysis. Any such attempt raises substantial difficulties because, as mentioned before, the concept of social surplus is an instrument of partial analysis only and may, therefore, not be applied to various productions simultaneously. The author has dealt with these questions at length elsewhere. It does seem possible to develop solutions that are theoretically satisfying. But their empirical application would involve great problems concerning the necessary statistical data. It appears somewhat doubtful whether these problems can be overcome in the near future.

Finally, the third argument questions the very basis of a policy of subsidies. Costs and subsidies have always been treated in theory as separate concepts: cost structures have been considered technically determined, the magnitude of the subsidies has then been determined from them together with the necessary information from the demand side. There is, however, no good reason why the subsidies should not be included in the cost consideration itself. As BUCHANAN has recently contended, subsidies can themselves be treated as variables, depending on output. If one follows this line of thinking, then the institutional set-up 4 is, in fact, reduced to set-up 1, 2 or 3. Which one of these set-ups it then coincides with depends on the specific institutional restrictions made.

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SUMMARY OF THE DISCUSSION

AT THE SECOND SESSION OF THE SEVENTH ROUND TABLE

(Discussion on the paper submitted by Professor SCHUSTER)

I. INTRODUCTION

Some participants had the impression that the first session of the Seventh Round Table had mainly tackled peripheral issues and not the basic problem that the pricing of infrastructures raises.

Though there was an obvious risk of reopening a purely theoretical discussion, the Round Table recommended a second session, to be based on an ad hoc paper produced by Professor Schuster. Though the discussion at this session did not throw all the light that could be desired on this highly complex and controversial topic, it does seem to have provided more clarity and more distinctions. It would in any case be hopeless to expect definitive findings in a field which has been the subject of patient research and much discussion for several decades and which undoubtedly leaves scope for future scientific research by the E.C.M.T. This Round Table provides a very good basis for this purpose.

II. STATEMENT OF THE PROBLEM

The basic problem raised by the Round Table is that of a dynamic pricing policy or, more precisely, the optimal use of capacities which are variable. This variability is directly linked to the requirements of an expanding economy involving quantitative and qualitative changes in transport. The same applies to changes in the mode of living and the subsequent effects on trip patterns.

As a general rule, the angle of approach is restricted to optimal sized capacities (and this often means taking only existing capacity into account). Yet the optimisation of investment is a problem in its own right, and it is necessary to analyse the maximisation of social surplus. Optimal utilisation is unobtainable without a dynamic pricing policy. A static pricing policy gives uncertain results for investment and utilisation alike.

The focal point is the concept of utility, or put in a general way welfare expressed in terms of social surplus. Social surplus raises particular problems as regards the delimination of the market indifference curves (i.e. the representation of separate markets on demand curves).

In this connection, the relationship between investment decisions and effective utilisation is particularly relevant. Pricing theory should therefore include elements enabling the effects on investment decisions to be quantified.

III. PRICE DETERMINATION AND INVESTMENT

The two possible approaches are cost/benefit analysis and consumer's surplus. In practice, the theory of social surplus is applicable, but it should also be possible to take into account consumer's surplus, producer's surplus and indirect effects on the economy. This, of course, raises the problem of the criteria to be adopted for surpluses.

Indivisibilities (particularly with reference to time) can distort the problem of pricing and investment since the latter involves non-marginal decisions.

Having regard to possible cross-relationships between markets, social surplus can rightly be adopted as a criterion only if it is able to cover the effect that action on a given market will have on other markets. This aspect is not usually taken into account, yet the consumer would be able to determine what he is prepared to pay for better transport only if prices on alternative markets remained constant, and this is not so in actual practice.

Theoretically, it would be possible to make the criterion cover changes in demand, which means that a rate of discount would be assigned to social surplus, but this would imply a knowledge of future changes.

The following points were next raised in the course of the discussions:

(a) What is the difference between social surplus and the marginal cost criterion?

(b) What is the result when external effects are introduced in the social surplus criterion?

(c) Does the maximisation of social surplus not imply the reduction of investments?

The discussion was based mainly on the proposition that the short-term marginal cost criterion did not ensure optimal utilisation for the long run.

IV. PROBLEMS RELATING TO DEFICITS

The social surplus criterion on the one side and the existence of deficits on the other creates something of a dilemma. The deficit was a frequent topic in the course of the debate.

Theoretically, the problem lies in measuring the size of the deficit and finding ways of financing it. Other difficulties, no less big, arise in actual practice in some cases, government authorities show little inclination to cover losses quickly and first try to save on replacements. This at least results in a backlog of renewals and replacements and sometimes even leads to severe maladjustment of an entire operating system. This is the process which doubtless lies at the root of the economic troubles of the railways and their side effects on transport policy as a whole.

To come back to theoretical aspects, we should find out exactly what is meant by decreasing marginal costs. Long-term marginal costs include average investment costs which alter the "marginal" character of so-called marginal costs.

Some participants pointed out that the fixing of an overall price for the railways normally implies an evaluation of infrastructure costs to be included in this overall figure.

Views were exchanged on whether, in actual fact, the deficit was included in the cost or remained outside it; some participants judged that the problem did not arise in this way in practice.

V. STATIC AND DYNAMIC CHANGES IN DEMAND

In the course of the discussion, several participants expressed the view that the comparison of different static changes was more productive than analysis by means of a dynamic demand curve.

The question then arises as to how far prices will be allowed to fluctuate, since the situation in real life differs from the theoretical model; theoretically, prices should keep closely in step with fluctuations in the actual fulfilment of demand; what is more, users cannot foresee the future.

Though it is true that many difficulties remain where existing infrastructures are concerned, it does seem that, in the case of future investments, optimal investment criteria should be linked up with optimal pricing policy measures.

On this point, some participants remarked that it was a sounder economic proposition to provide a high-capacity infrastructure (i.e. one that is planned for long-term needs) from the start to save successive adjustments later on. Account must also be taken of the inconvenience (time losses, increased accident risks) caused by development work on an existing infrastructure.

Where users are concerned, there is also a problem of proper price differentials, a problem which is often insoluble in practice because of its complexity; this is particularly so for routes and sections of routes and for different levels of utilisation.

Attention was then given to the question whether unduly uniform pricing would conflict with theoretical economics. Apart from this, experience shows that it is hazardous to put prices too high at the start. Price differentiation according to a time scale and geographical sectors should be applied when reasonably feasible.

VI. PRICE POLICY

In most cases of infrastructural investment, some over-capacity is likely to arise at the initial stage and thus involve a process of rising interest rates. This has implications for optimal pricing policy.

Roughly speaking, the choice then lies between two methods:

(a) low prices to start with and gradual increases later on; this method can have a distorting effect on users' decisions;

(b) constant prices throughout the working life of the asset.

The policy adopted will depend on the following factors:

(i) budgetary equilibrium;

(ii) the loan raised on the market;

(iii) the degree to which external factors are taken into account;

(iv) price differentiation.

All this is of course subject to practical feasibility criteria.

One point raised with regard to budgetary equilibrium was over what period it should be envisaged (e.g. on some short-term basis or over the entire working life). Some participants considered that the only equilibrium that should be sought was that involving all means of transport at regional level. In this connection, it is also important to define clearly how tax proceeds are to be appropriated.

Social surplus could be a useful criteria in certain specific cases, but its significance is at present theoretical because of lack of knowledge in this field. In any event, a problem arises with regard to the perfect fluctuation of prices on the one side and losses of social surplus on the other.

There is also some uncertainty as to how prices will change and how congestion will develop (if prices remain constant). The possibilities for price differentiation can thus be improved only if a good deal more information becomes available.

VII. CONCLUSIONS

The Round Table was able to bring out certain aspects more clearly, including the following:

1. Price differentiation according to quality of infrastructure.

Perfect differentiation is not feasible for road pricing because of the administrative difficulties in collecting revenue and the uncertainties with which users would be faced. However, substantial improvements to the existing state of affairs could be made with a view to steering the use of infrastructures on a better economic course. This particularly applies to conurbations and to particular components of the infrastructure in open country (e.g. tunnels, bridges, and motorways). As regards charging for the use of an alternative infrastructure of better quality (e.g. a motorway on the same route as an ordinary road), this seems psychologically acceptable since what the user is asked to pay for is something better, and this is indeed already the case for added comfort (e.g. first-class carriages) on public transport services and for high-speed trains.

2. Budgetary equilibrium.

The purpose of such equilibrium is above all practical; secondly, it can serve investment policy provided that it is suitably tuned to match each market. However, the functional guidelines on which the market is set still remain the primary consideration; in the long run, services that are provided at a loss lead to distortions such as postponement of modernisation, ill-balanced competition and transfers outside the transport sector (e.g. the subsidisation of housing, regional industries, etc.).

Though such a situation may sometimes be justifiable at short and medium term, the subsidy tends to ensure its survival (and even perhaps added strength in the long term) within frames of reference where it no longer fits. In principle, unremunerative services should be a provisional solution. In any event, as the reasons for subsidisation often lie outside the transport sector, it should logically be budgeted for under headings (housing, regional economic development, etc.).

Furthermore, budgetary equilibrium should be visualised within the context of entire networks, the social surplus criterion being applicable only for each market taken individually. A corollary requirement of budgetary equilibrium would be that new investments are justifiable only in cases where such equilibrium is safely ensured.

In some quarters it is judged that budgetary equilibrium is meaningful only if it covers all modes of transport combined and encompasses an entire region. This first calls for a plain definition of what is meant by "region" (an international criterion is needed in this respect); secondly, services to be provided at a loss should be assigned to the means of transport whose deficit is lowest (and not as a matter of course to a given mode, as this entirely distorts the economics of the "public service" concerned.

Again with reference to budgetary equilibrium, attention may be drawn to a difference in the procedures of the public and private sector, the latter calculating budgetary equilibrium on the basis of future costs.

3. Cases where actual traffic falls short of the forecast.

The major conclusion to be drawn from this, even though it may sound obvious, is the importance of getting a better knowledge of demand and of more research in this direction.

In the event, three solutions can be envisaged:

(a) Raise prices to cover costs; the probable result will be even fewer users than before.

(b) Leave prices as they stand.

(c) Pricing on the basis of real cost (short-term marginal costs); this was the solution favoured by the participants in the Round Table.

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