TOWARDS FAIR AND EFFICIENT PRICING IN TRANSPORT - ISSUES AND PROSPECTS

C.A. NASH
J.P. TONER
H. BEAUMONT
Institute for Transport Studies, University of Leeds, England

J.O. JANSSON
Economics Institute, University of Linköping, Sweden

G. LINDBERG
CTS, Darlana University, Sweden

Abstract

At the end of 1995, the European Commission produced its latest proposals regarding transport pricing in the Green Paper 'Towards Fair and Efficient Pricing in Transport'. The present paper starts with a brief commentary and critique of the Green Paper. It then outlines the approach being taken to pricing principles in the PETS (Pricing European Transport Systems) project setting out principles for both infrastructure and scheduled transport services, and briefly considering their practical implications.

INTRODUCTION

At the end of 1995, the European Commission produced its latest proposals regarding transport pricing in the European Union. (CEC, 1995). These include measures to internalise external costs and to recover fully the infrastructure costs of all modes of transport from users. It is argued that a major implication of moves in this direction is the need for a much higher degree of price differentiation by location, time and type of vehicle. It is accepted by the Commission that complete achievement of this must await the widespread application of more sophisticated methods of road pricing, but in the meantime various measures are proposed, including more differentiation of taxes on vehicles and fuels and the introduction of a kilometre tax varying with vehicle characteristics on heavy goods vehicles.

Publication of the paper has led to widespread debate. Amongst the issues raised are:

- how would appropriate cost levels be measured and implemented as prices, especially given the trend towards deregulation and privatisation of transport operations, and in some cases even infrastructure? Can this be done solely through tolls and taxes, or does it involve continued regulation of private operators?
- should charges be based on the short run marginal cost of use of the infrastructure? If so would this raise sufficient income to finance the transport sector, or would supplementary charges be required, for instance based on 'Ramsey' pricing?
- should a part of congestion and accident costs be regarded as an external cost, and if so how can that part be identified?
- can the environmental costs of transport be measured and valued to an acceptable degree of accuracy?
- would the introduction of a more appropriate pricing policy be worthwhile, or would it involve high costs and have little effect on the level and mode of transport use in any case?

The PETS (Pricing European Transport Systems) project for the Commission, which forms part of the 4th framework research programme, has as its aim to examine these issues and come up with recommendations, and to apply the results to a set of case studies on the Trans European Networks. This paper is based on the first phase of this study, which deals with issues of principle. The second phase - a series of case studies to illustrate the effects of moving towards a more efficient pricing policy - will not be completed until late in 1998.

This paper will begin with a critique of the Commission's paper. We will then summarise our own response to the issues raised above, considering first the pricing of transport infrastructure and then externalities before discussing some of the particular problems involved in dealing with scheduled transport services. We conclude with some comments on the practical problems of implementing more appropriate pricing policies.

THE GREEN PAPER

The basic argument of the Green Paper is that for many journeys there is a significant mismatch between the prices paid by individual transport users and the costs they impose. This situation is said to be both unfair and inefficient, giving inappropriate incentives to transport users in terms of the volume, mode, time and location of their use of the transport system. The particular costs of concern are infrastructure costs, congestion, environmental and accident costs. Evidence is quoted that (excluding uncovered infrastructure costs) these add up to some 250 b ecu per annum, with more than 90% being accounted for by road transport. It is argued that reforms are needed to ensure that charges are linked to actual costs at the level of the individual user, and specific reference is made to marginal cost pricing. However, it is also argued that there should be full coverage of infrastructure costs, including capital costs.

Although the paper does not explicitly define the marginal cost as a short run marginal cost that is implicit from the inclusion of congestion costs. Nevertheless, it is obvious from the discussion following the Green Paper that the controversy of short run (SRMC) versus long run marginal costs (LRMC) is very much still alive. The former refers to the costs of additional journeys when the capital stock remains constant. The latter are the costs when the capital stock is appropriately adjusted. The former will therefore include additional congestion, environmental and safety implication of handling more traffic with the existing infrastructure, but will exclude all capital costs of infrastructure and any externalities concerned with the provision of capacity. The latter will include the costs of provision of additional capacity, but exclude increased congestion, environmental and accident costs to the extent that these are offset by the additional capacity. Whilst many authors have insisted that short run marginal cost was the appropriate basis for charging for the use of roads (see e.g. Walters, 1968) governments have typically supported long run marginal cost as the basis for road taxation.

One may wonder why there is so much argument on the subject of short-run versus long-run marginal costs? How could this issue get such a prominent place in the debate, in view of the fact that short run marginal cost (SRMC) and long run marginal cost (LRMC) are equal along the optimal expansion path? One reason why the debate has gone on for so long is simply that the LRMC-calculations presented as an alternative basis for road user charges were wrong, and therefore appeared to result in a much higher marginal cost. We will discuss this further in the following section.

In addition to the (short run) marginal cost pricing principle, the Green Paper argues that there should be full coverage of infrastructure cost, including capital cost. In the absence of externalities this is only consistent with marginal cost pricing in the situation of constant returns to scale. As will be pointed out below, this situation is atypical for non-urban transport infrastructure, so there is a fundamental efficiency and equity conflict, which the Green Paper does not fully address.

Finally, on the practical side, the Commission argues that advances in telematics will make electronic road pricing in its most general sense a real possibility in the near future. But, according to the Commission, the problems are building up now and the Green Paper therefore makes a series of suggestions that could be introduced at short notice:

- Adjusting existing Community legislation on road charges of Heavy Goods Vehicles in order to make progress towards fair and efficient pricing;
- electronic kilometre charges based on infrastructure damage and possibly other parameters (HGV);
- road tolls in urban areas;
- differentiated fuel taxes reflecting differences in fuel quality;
- differentiated vehicle taxes linked to a vehicle's environmental/noise characteristics;
- insurance systems that cover all accident costs and link risk and mileage to premiums paid by individual users.

Our theoretical studies in the PETS project favour all of these suggestions, .We would regard a sensible approach as being to seek to implement short run marginal cost pricing throughout the transport sector, subject to the modifications needed to meet reasonable budget constraints in the most efficient fashion. It should be added however that any pricing instrument that is planned to be introduced has to be carefully analysed to ensure that the benefits outweigh the administrative costs. In the next section we consider the implications of such a pricing policy for the pricing of transport infrastructure.

PRICING TRANSPORT INFRASTRUCTURE

Short run marginal cost pricing

It is an important characteristic of transport infrastructure that it is frequently not owned by the producer of transport services, but its services are acquired on a pay as you go basis. This is true of roads, ports, airports and increasingly of railways. The user then combines these services with his/her own inputs, in the form of vehicles, fuel and labour. The result is that the overall transport cost is the sum of costs to the infrastructure provider, costs to the infrastructure user and costs imposed on others outside the transport system concerned.

The requirement for efficient pricing is thus to ensure that the costs borne by the user of the infrastructure reflect the sum of the marginal costs in each of these three categories. The marginal costs to the infrastructure provider, in the short run are mainly the costs of wear and tear (as well as any additional operating costs such as additional costs of traffic control or signalling). The marginal costs to users include the costs borne by the individual user taking the decision but also costs imposed on other users by increased congestion or accident risk. (In some cases, where infrastructure use is timetabled, the so called congestion cost is mainly not actual delays but rather the inability of other users to get access to the infrastructure at the time they would wish. This is perhaps better referred to as the opportunity cost of the slots). Costs imposed on third parties are predominantly external accident and environmental costs. The 'price relevant' marginal cost is thus the sum of these marginal costs less the costs in any case borne by the individual user.

Cost recovery under optimal pricing

Would optimal pricing cover the total costs?

Most evidence suggests that in terms of the capital cost of infrastructure itself there are increasing returns with respect to traffic density in a wide initial interval for transport infrastructure, including pipe-lines (Cookenboo, 1971), airports (Doganis and Thompson, 1975; Swedish Ministry of Transport, 1990), railways (Caves, et al, 1985), and interurban roads (Swedish National Road Administration, 1978 and 1996). This tendency is reinforced when the infrastructure user costs are taken into account: a higher level of service, i.e. lower average user cost goes hand in hand with increasing plant size.

In particular in urban areas, however, these two co-operative tendencies are partly offset by property demolition and environmental effects of provision of expanded infrastructure, which in fact may make extra capacity prohibitively expensive and politically impossible in some locations. The net effect of efficient pricing for cost coverage would vary from country to country (compare Sweden with the Netherlands for instance).

A common feature of transport infrastructure services is that a very wide range of financial results of optimal pricing is represented in every mode in each particular country, and particularly so in the road sector – from small-scale facilities where the short-run marginal price-relevant cost is just a fraction of the fixed capacity cost to large-scale facilities in populous areas where the short-run marginal price-relevant cost far exceeds the capacity cost. This pattern makes intrasector cross-subsidisation a possible means of reconciling optimal pricing and total infrastructure cost recovery in the road sector, airport, and seaport industries, but hardly in the railway sector, at least as long as there is only one operator per line in which case a track congestion toll would be an anomaly. However, it has evoked LRMC-proponents to argue that pricing based on long-run cost would give a more reasonable financial result.

If long run marginal cost could be calculated simply by adding capital costs to short run marginal cost, the result would obviously be a higher level of charges. What is overlooked is that by increasing road capacity more traffic can be accommodated without inflicting congestion costs on the original traffic. A trade-off is involved: when capacity-expanding investments are justified, an equivalent traffic (time, accident and vehicle operating) cost *is saved*, which would occur if the investments were not made. The additional traffic does consequently not cause any congestion costs for the original traffic under these circumstances. Therefore a congestion cost component should not be included in the long-run marginal cost calculation.

The mistake of counting both the additional capacity costs and the additional congestion costs that the capacity addition eliminates is to be blamed on the lingering, total cost allocation procedure. Another even more common mistake was to forget that investments in the non-urban road network, where serious congestion is less common than in urban areas, are often made primarily to *raise the quality* of road services (in other respects than eliminating traffic congestion). Let us consider this fact in the light of the empirical approach to long-run marginal cost estimation known as "development cost" calculations. By time series analysis of the total costs of the whole interurban road network and the steadily growing total road traffic, it is thought that the indivisibility problem of long-run marginal cost calculations could be avoided: What appears as a marked indivisibility on an individual road link being improved, is smoothed out in the context of the whole road network. The error of the "development cost" school of thought is, however, that one decisive term of the price-relevant long-run marginal cost expression is overlooked. Only under the unrealistic assumption that the road investments are purely capacity-expanding, without any joint quality-raising effect like shortening of distance, or improved alignment, would it be reasonable to take the ratio of the annual capital costs of new investments to the additional traffic on the roads as a proxy for LRMC. Since, on the contrary, non-urban road investments are partly justified by cost savings for the existing traffic (including the autonomous traffic growth), a large error is made by ignoring the *negative* user cost term in the LRMC expression. The correct proxy for the price-relevant long-run marginal cost of the inter-urban road services has the following form.

$$LRMC_{proxy} = (C_t - B_t) / \Delta Q_t$$

C_t = Cost of new investment in year t

B_t = Discounted present value of benefits for existing traffic in the form of user cost savings thanks to the new investments not attributable to congestion relief.

ΔQ_t = Addition to the traffic on the roads in year t.

In some cases, particularly in less densely populated countries, B_t may wholly outweigh C_t, leading to zero marginal capacity cost.

The lessons from the long discussions of optimal charges for non-urban road services are generally relevant for all transport infrastructure including railways. The interurban railway investment boom that we have seen in recent times is to a large extent justified by train user benefits in the form of straighter lines, and above all higher speed. Applying the above formula for the $LRMC_{proxy}$ would most likely result in rather low marginal costs. We see fewer urban (overground) rail investments in spite of the fact that there are strong pressures of demand of commuters in many large cities. The big obstacles are land scarcity and encroachment costs. Again this problem is similar for urban roads and railways.

The equality of SRMC and LRMC referred to above presupposes that investments are optimal (defined by the goal of social surplus maximisation). The problem in practical cost-benefit analysis is that all relevant costs are not easily monetised. The unaccounted-for costs may still have a strong influence on the relationship between SRMC and LRMC in particular the encroachment costs of new infrastructure. These costs are very difficult to monetise and include in cost-benefit analysis of transport infrastructure investments, but can nevertheless play an important role in the decision-making process. Many planned roads, railways and airports will never be built, or the start of construction is greatly postponed because of lengthy efforts to persuade politicians and residents in the area of threatening encroachment to accept the project in its original design. Financing difficulties are another common reason for delaying infrastructure investments. This is strengthened if, as often happens, the original projects are substantially modified to lessen the encroachment costs, which leads to additional construction costs. This means that SRMC and LRMC can be substantially different.

In these circumstances, it is necessary to choose between giving price signals that provide for the most efficient use of the current infrastructure and those that signal what the long run cost might be. The argument for the latter is that some transport users take existing prices as the basis for long run locational decisions, which lock them into particular patterns of transport use. This might arguably provide a case for smoothing out any violent fluctuations in SRMC but only provides a case for charging LRMC when in the long run this will equal SRMC. We have just argued above, that for transport this is unlikely to be the case. It should also be borne in mind that SRMC is *higher* than LRMC under the circumstances held up above. The discarding of the long-run marginal cost as a basis for calculating the price-relevant cost will consequently not bias the result downwards, as is often claimed by LRMC-proponents, except where excess capacity exists, and this is not thought to be the typical problem.

Optimal departure from the first-best pricing rule

That the short-run marginal price-relevant cost is equal to or greater than the long-run one may still mean that it falls short of the producer average cost.

In a broad range of second best circumstances, theory suggests that it is better to meet any budget constraints by taxing final rather than intermediate goods, and taxes on final goods should be differentiated according to whether they are substitutes or complements to untaxed household production during leisure time (Layard and Walters, 1978). This would suggest that, even in the presence of a budget constraint infrastructure use should only be charged at a rate above marginal cost where it may reasonably be regarded as a final product, and particularly where it is complementary to untaxed household production. In the transport sector this applies predominantly to private motoring. For freight and other modes of transport it is preferable to ensure that marginal cost pricing of infrastructure is implemented whatever the financial consequences, and to offset these by taxes on final consumer goods as necessary. The exception might be a two part tariff implemented in circumstances where the fixed element has no impact on behaviour. For instance, train operators might be charged a fixed price for access to the system, reflecting their ability to raise finance in excess of marginal cost through price discrimination in the final product market, plus a variable charge per train kilometre based solely on marginal cost considerations.

EXTERNALITIES

It will be clear from the above that we believe that the appropriate approach to charging for externalities is to charge the marginal cost, and that this will be the sum of the congestion and accident costs imposed on fellow users, as well as the marginal environmental cost and any accident costs borne by non users. Further problems arise however, in measuring and valuing these items.

Congestion costs for road users may be fairly readily measured by a variety of approaches to estimating the extra time costs imposed on other road users by an additional vehicle, including speed-flow relationships and models of queuing at bottlenecks (see for example Small, 1992, p.107 et seq). Relevant costs comprise the increased time and operating costs. In addition, there is some evidence that in highly congested conditions time is valued more highly than in uncongested conditions, but the exact definition of the range of circumstances in which the higher valuation is appropriate is unclear (Wardman, 1997). For other modes, congestion costs (or the opportunity cost of slots) are much more problematic. For rail, for instance, delays from an additional train depend very much on the relationship between the speed of that train and the speeds of the existing mix of trains and how they are flighted (i.e. the order in which they run) (Rothengatter, et al 1996). The opportunity cost of a slot is even more complex, as it may be used to provide for an additional train between a whole variety of different points and of a range of services of different types. Ideally this value might be revealed by an auction, but many commentators doubt whether this is a practical possibility (Nash, 1997).

In the case of accidents, a substantial part of what is normally seen as accident externalities is really the consequence of inappropriate pricing for medical expenses and other costs incurred by third parties. If these were all covered by transport insurance they could be properly internalised without the need for them to be reflected in transport taxes (although appropriately reflecting these in prices would require that insurance premia be charged on a per kilometer basis and ideally be differentiated according to where and when the kilometre was driven; these premia would then need to be considered alongside the other elements of road pricing). (See Vickrey, 1968).

The other external element of accident costs is the additional risk imposed by one extra road user on others. Two kinds of traffic accidents are relevant here, intrasystem and intersystem traffic accidents, (Jansson, 1994). Accidents occurring where different transport systems are overlapping or crossing each other give rise to the highest externality charges. The reason is basically that it is known beforehand that if a train and a car collide, or a car hits a cyclist, the lighter vehicle takes most of the damage, whereas it is not known *ex ante*, which of all the cars will be most seriously damaged in the expected multi-car accidents. In the non-urban road network intrasystem traffic accidents dominant, and the risk for injury for a car traveller seems by and large independent of the traffic volume. When the elasticity of risk per vehicle kilometre with respect to the volume of traffic is zero, the external accident cost consists only of the costs that are imposed on society at large, which should ideally be internalised through the insurance system, as discussed above. (Satterthwaite, 1981; Nilsson, 1996).

In urban areas intrasystem and intersystem accident costs are of a comparable order of magnitude. In addition, given the relatively high frequency of intersections, the risk-elasticity for intrasystem traffic accidents is positive; it seems to be between 0.2 and 0.3. The risk-elasticity as regards unprotected road users exposed to the risk of being hit by motor vehicles seems to be around 0.5. (Brüde and Larsson, 1993). As the number of motor vehicles increases, the accident risk will increase for unprotected road users by the square root of the motor traffic volume. In urban traffic with a large proportion of unprotected road users this implies a rather high road pricing component, which, however, decreases with motor traffic volumes, because the risk of motorists hitting vulnerable road users is decreasing with increasing motor traffic volume.

Turning to environmental costs, there is also an important distinction to be made between the total environmental cost of a mode and its marginal environmental cost. Many studies have estimated the former rather than the latter (e.g. Mauch and Rothengatter, 1995). It is common to assume that marginal cost equals average cost for externalities such as air pollution, although this is certainly not the case where local concentrations of pollutants are important In this case the marginal cost curve is typically steeply rising and well above the average cost, this assumption would clearly not hold for noise, where at high levels of concentration a larger increase in traffic is needed to produce a noticeable change in nuisance than at lower volumes. In other words, the marginal cost curve for noise nuisance is downward sloping.

For externality functions where it is difficult to measure the relationship between damage costs and emission volume, imposing an absolute limit for the total emissions concerned could be a reasonable alternative approach to the perfect but demanding approach of equating the marginal damage cost and the marginal avoidance cost. Carbon dioxide emission is a case in point. One way of ensuring that the limit is not exceeded is to issue a corresponding amount of tradeable emission permits. This will give no revenue to the state; the income transfers connected to the trade in emission permits will be confined to the industry (sector) concerned. Another way is to impose a CO_2 tax sufficient to restrict fossil fuel demand to the given limit. If the problem of greenhouse gas emissions is tackled in this latter way, it seems likely that collectively the revenue from optimal pricing of fossil fuel burning transport modes might well more than offset any infrastructure pricing deficit arising from the other causes discussed above.

PRICING SCHEDULED TRANSPORT SERVICES.

We now turn from the pricing of transport infrastructure to the pricing of scheduled transport services using that infrastructure. In the pricing of scheduled transport services, the same three categories of costs are involved as discussed above, namely costs to producers, costs to users, and costs imposed outside the transport system concerned. Users still have costs in that they must devote their own time to making the journey and incur accident risks in doing so. Price relevant costs are the marginal costs to transport service producers (including the optimally determined charge for the use of the infrastructure as discussed above), costs imposed on other users and costs imposed outside the transport system concerned (mostly the latter will have already been considered in the optimal charge for the use of the infrastructure).

If we took a strictly short run marginal cost approach to transport services, we might consider that the timetable and vehicle stock would be fixed. In this case the immediate cost to producers of extra traffic is frequently negligible, but that to other users potentially substantial, taking the form of additional crowding of the vehicle, and at peak times of the inability of some users to board the vehicle intended. However, this would be a very short sighted viewpoint. Producers can often amend timetables at short notice, and acquire new or different vehicles on hire equally quickly. We consider it more appropriate in the case of scheduled transport services to adopt a 'medium term' view of marginal cost, in which the vehicle stock can be varied although the infrastructure cannot.

If the timetable and number and size of vehicles can be varied, then there are potentially two ways of adjusting to additional traffic. The first is to use larger vehicles (or longer trains) and the second is to increase frequency of service. The first will add to producer costs, but vehicle size is subject to very great economies of scale (Jansson, 1980). The second will add rather more to producer costs (indeed, they may well rise proportionately), but this will be offset by benefits to existing users from the increased frequency (the Mohring effect). These benefits are likely to be relatively greater for short journeys than long, since the time spent waiting for the vehicle (or the value of schedule delay if a service is used at a non optimal time from the point of view of the user) is likely to be a greater part of the total cost of the service. In either case, then, the price relevant marginal cost is, likely to be substantially below average cost to the producer for short to medium distance journeys.

If the service level were optimal, and there were no significant indivisibilities, then it would not matter which assumption we used in calculating the price relevant marginal cost - we would get the same answer. Given indivisibilities, we may use whichever assumption seems the most reasonable in the case at hand (for instance, in some cases, it may not be possible to use larger vehicles or longer trains without substantial infrastructure investment; in others, where lack of demand means that high cost small vehicles are currently used, substituting larger vehicles is the obvious thing to do in response to an increase in demand). But it is always important to consider pricing decisions alongside service level decisions; calculating marginal cost using a markedly non-optimal service level might give a very distorted answer.

Our conclusion concerning scheduled public transport services then is that efficient pricing might come close to covering total operator cost for long distance services (but remembering that this is on the basis of an optimal charge for infrastructure, which probably does not cover total cost in many cases) but will fall far short of it for short to medium distance services. Given also the superior ability to price discriminate over longer distances, where complicated fares structures can be worthwhile, we see no major problem in requiring operators of long distance scheduled transport services to cover their costs, and indeed where the market is reasonably competitive or contestable it may be appropriate to leave pricing policy entirely up to the market. (It has been argued, however, that in typical oligopolistic transport markets price discrimination is taken to excessive lengths with high-elasticity users being charged less than the price-relevant costs - Jansson and Lindberg, 1997 p.93-4.) But it does not appear to be efficient to leave pricing up to the market for short distance scheduled transport services, where there is generally a case for subsidy. In all cases there is also a strong argument for differentiated pricing between peak and off peak; the marginal cost of carrying an extra passenger in a vehicle which has more empty seats than are needed to ensure an optimal level of crowding is likely to be very low relative to the cost of increasing vehicle size or frequency.

CONCLUSIONS - FROM THEORY TO PRACTICAL IMPLEMENTATION

For road transport, it is fairly clear what price structure would be theoretically ideal. There would be specific charges per kilometre for the use of roads in areas and at times where congestion and/or other external costs are particularly high. This obviously includes urban areas but may also increasingly include inter urban main roads as congestion worsens. Most wear and tear is due to lorries (Small, Winston and Evans, 1989) and a specific charge per kilometre would be introduced for these, related to the axleload and gross weight of the vehicle. Obviously none of these measures is worth introducing unless the benefits from more appropriate pricing outweigh the cost of implementation, but with the decline in costs of electronics it is becoming increasingly likely that such measures are worthwhile.

The one factor which might break this well-known pattern is accident externality charges, which are potentially very important road pricing components, but for which crucial empirical evidence is still lacking. In urban traffic, where the level of accident externality charges is at its highest due to the mixture of protected and unprotected road users, the issue is complicated by the fact that the price-relevant accident cost is *falling* with increases in the motor traffic volume. This means that in quiet roads and streets, where many cyclists are found, and pedestrians often cross the road because there are few cars to worry about, the accident externality charges on cars should be almost prohibitively high, whereas on busy, occasionally congested roads dominated by car traffic the accident externality charges should be only a small addition to the optimal congestion tolls. The price relevant marginal noise cost has the same character. Of course, a sensible response to this may be traffic calming measures or traffic bans on low volume roads in residential areas rather than pricing measures.

In these circumstances it is probably sensible to think as the commission does of short term measures to correct the worst distortions by introducing urban road pricing in the most congested cities, and by means of a kilometre tax on heavy goods vehicles varying with their characteristics. There remain substantial political problems of implementation. Current thoughts are that the most likely chance of offsetting the opposition to road pricing comes from being able to use the revenue to the benefit of the people paying the increased charge, either by providing new road infrastructure (inter-urban) or better public transport (urban). According to the above approach however, the implication of introducing a sector wide optimal pricing system would be that there would no longer be a case for fuel taxation at anything like the current level. A major use of congestion charges therefore would be to reduce fuel taxes, and thus lower transport costs for many road uses outside urban areas, unless very much more ambitious targets are set for the reduction of greenhouse gas emissions in the transport sector than is currently the case. The major function of fuel taxes, as catalytic converters spread throughout the petrol engined fleet and emissions standards for diesel engines also tighten, in the optimal pricing scenario outlined, will be to reflect the greenhouse gas costs of fuel use. This is itself a contentious issue. It will be very difficult however to sell a new pricing structure that involves major transfers between different locations, or indeed which reduces energy taxes.

For public transport, there is a clear conflict between the desire to implement socially efficient pricing policies and the trend towards deregulation and privatisation. We concluded above that pricing of long distance services could be left up to the market provided that they were reasonably competitive or contestable and that infrastructure was appropriately priced, which would often imply prices well below the infrastructure supplier's average cost. Infrastructure charges in any case are normally set by the state or regulated since transport infrastructure is typically a case of natural monopoly. For short to medium distance scheduled public transport services, there will normally be a case for subsidising both services and infrastructure. In this case, the most appropriate approach to privatisation is likely to be via a franchising system, with continued public coordination and control of pricing. Clearly none of this is consistent with a policy of each mode covering its total cost although it may be consistent with a balanced budget or a surplus for the transport sector as a whole. Whether the transport system as a whole could cover its costs will depend on the degree of congestion and the scope for price discrimination in the system, but in any event there is sure to be justification for cross subsidisation both between modes and between locations.

These conclusions represent the findings of the first phase of the PETS project with respect to pricing principles. In the second phase, we intend to investigate the impact of these principles in a number of case studies, with different assumptions concerning budget constraints. The case studies comprise the Nordic triangle, the cross Channel corridor, Trans-Alpine freight traffic and the Tagus river crossing in Lisbon. They thus reflect a variety of circumstances ranging from acute bottlenecks where major new investment is planned, to areas where investment is aimed more at developing peripheral regions of the Community. They should therefore provide an interesting and informative test of what these principles might mean in practice.

ACKNOWLEDGEMENTS

The research reported in this paper forms part of the PETS (Pricing European Transport Systems) Research Project (1996-1998) which is funded by the European Commission under the Transport RTD Programme of the 4th Framework. The Partners contributing to the project are: ITS, University of Leeds, (Project Co-ordinator); Departmento de Economia Apliade (EIET), Universidad de Las Palmas de Gran Canaria (Es); Ekononiska Institutionen (EKI), Universitet i Linkoping (Sw); INRETS (Fr); Ekono Energy Ltd (Fin); TRT/CIRTRAS (It)); Institute of Transport Economics, TOI (No); Universitat Karlsruhe IWW (De); ECOPLAN (Swiz); TRANS-POR (Por); Technische Universitat Wien, IFIP (Ar).

REFERENCES

Brüde, U. and Larsson, J. (1983). **Models for predicting accidents at junctions where pedestrians and cyclists are involved. How well do they fit?** Accident Analysis and Prevention, **Vol.25**, pp 499-509.

Caves, D.N., Christensen, L.R., Tretheway, M.W. and Windle, R.J. (1985). Network effects and the measurement of returns to scale and density for US railroads. In: Daughetry, A., Ed, **Analytical**

Studies in Transport Economics. Cambridge University Press.

CEC (1995). **Towards Fair and Efficient Pricing in Transport.** Brussels.

Cookenboo, L (1971). Cost of operation of crude oil trunk lines in **Price Theory**, ed, H Townsend, Penguin, Harmondsworth.

Doganis, R and Thompson, G.F. (1975). The economics of regional airports, **International Journal of Transport Economics.**

Jànsson, J.O. (1980). A Simple Bus Line Model for Optimisation of Service Frequency and Bus Size. **Journal of Transport Economics and Policy, Vol. 11.**

Jansson, J.O. (1994). Accident Externality Charges. **Journal of Transport Economics and Policy, Vol. 28.**

Jansson, J.O. and Lindberg, G. (1997). **PETS Deliverable D2 Appendix** Transport Pricing Principles in Detail.

Layard, R. and Walters, A. (1978). **Micro Economic Theory**. McGraw Hill, New York and London.

Mauch, S.P and Rothengatter, W. (1995). **External Effects of Transport**. Union Internationale des Chemins de Fer, Paris.

Nash, C.A. (1997). The Separation of Operations from Infrastructure in the Provision of Railway Services – The British Experience in European Conference of Ministers of Transport. Round Table 103. **The Separation of Operations from Infrastructure in the Provision of Railway Services.** Paris.

Nilson, G. (1996). **Trafiksäkerhetssituationens variation i tiden**, VTI Rapport 15.

Rothengatter, W. et al (1996). **Bottlenecks in the European Transport Infrastructure.** European Centre for Infrastructure Studies, Rotterdam.

Satterthwaite, S.P. (1981). **A survey of research into relationship between traffic accidents and traffic volumes**. TRRL Supplement Report 692, London.

Small, K.A., Winston, C. and Evans, C.A. (1987). **Road Work**. The Brookings Institution, Washington DC.

Small, K.A. (1992). **Urban Transportation Economics.** Harwood Academic Publishers, Chur, Switzerland.

Swedish National Road Administration (Statens Vägverk) (1978). **En studie av vägstandard.** P003, Stockholm.

Swedish National Road Administration (Vägverket) (1996). **EVA, Effektberäkning vid Väg Analyser**, Borlänge.

Vickrey, W. (1968). Automobile accidents, tort law, externalities and insurance: an economist's critique. **Law and Contemporary Problems.**

Walters, A.A. (1968). **The Economics of Road User Charges.** World Bank Staff Occasional Papers No.5. John Hopkins Press, Baltimore.

Wardman, M. (1997). A Review of Evidence on the Value of Time in Great Britain. **Journal of Transport Economics and Policy, forthcoming.**