Why reform transport prices? An overview of European transport infrastructure charging policy and research.

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1. Introduction

Europe's transport system currently faces a number of different, but related, problems. Infrastructure is sometimes in a poor state of repair and the roads, railways and skies are all congested at certain times and places, resulting in journey-time delays and unreliability, over-crowding and scheduling problems. Costs associated with road congestion in Europe amount to just over 1% of its overall GDP (UNITE, 2003). In addition to these problems facing the transport system and which have direct effects on transport-related activities, the transport system is a source of problems which have wider impacts for the whole of society. Environmental pollution and external accidents costs of road transport, taken together, were found to be 1.6% of Europe's GDP (UNITE, 2003). These problems have the effect of imposing costs on those engaged in travel, on governments who intervene in an effort to alleviate these problems and on the whole of society.

In recent years, the response of the Commission to these problems has been to place increasing weight on economic instruments as a way to tackle them by giving transport users appropriate incentives to modify their behaviour. Starting with the Green Paper 'Towards Fair and Efficient Pricing in Transport' (CEC 1995), and continuing with the White Paper 'Fair Payment for Infrastructure Use' (CEC,1998) and the new Common Transport Policy White Paper (CEC,2001), there is a strong emphasis on pricing policy to reflect the full social costs of transport use. At the same time, the Commission has funded a whole range of research projects into transport pricing, tackling the many different issues that arise in implementing this policy.

The paper seeks to give an overview of research in this field and its findings, as well as to expand on the context of the research and on its implications. Its organisation is as follows. In the next section we trace through the development of the Commission's policy towards transport pricing. We then summarise the results of the research into the principles of transport pricing, and the main alternatives. The following sections consider studies that have looked at existing pricing practice, and the implications of implementing the recommended policy, and consider the main problems involved in implementing them.

2. Development of EC Policy

Transport pricing policy development at the European level took a major step forward in 1995 with the publication of the green paper "Towards fair and efficient pricing in transport" (CEC, 1995). Whereas previous discussion of EC pricing policy had emphasised maintenance and operating costs, this paper recognised the importance of pricing to reflect external costs. The policy was taken further in the white paper on "Fair payment for infrastructure use" in 1998 (CEC, 1998). The latter put a clear case for marginal cost pricing, whilst recognising that the movement towards this target

would need to be phased over a number of years, and that second best measures to achieve desired levels of cost recovery would continue to be necessary. A number of mode-specific pricing policy developments have either stemmed from these papers or have emerged in parallel with them.

The core features of the White Paper focused on the need to relate charges more closely to the underlying marginal social costs associated with infrastructure use, extending these costs to include external costs, and with the need to depart from prices that are purely based on the direct costs of infrastructure use when cost coverage requirements need to be met. The need to ensure transparency, and to facilitate fair competition between modes, within modes, and across user types was emphasised. Furthermore, the contribution of transport services to the enhancement of industrial efficiency and European competitiveness was recognised.

In order to give transport users and providers time to adjust, the White Paper proposed a phased approach to the implementation of this framework. The first of three phases, identified as running from 1998 to 2000, aimed to ensure that a "broadly compatible structure is in place in the main modes of transport" (CEC, 1998). Air and rail were to be the particular focus of this first phase and charges incorporating external costs, on the basis of an agreed Community framework, were to be allowed but total charging levels were to be capped by average infrastructure costs. The second phase, identified as running from 2001 to 2004, aimed to oversee further harmonisation. The White Paper proposed that this phase would particularly focus on rail and heavy goods vehicles, where it was proposed to institute a kilometre based charging system differentiated on the basis of vehicle and geographical characteristics, and on ports, where it was proposed to introduce a charging framework. From here on in, it was proposed that charges should be capped at marginal social cost. The third and final phase, identified as running from 2004 onwards, should revisit the overall charging framework, with a view to updating it in light of experience.

The principle of subsidiarity, which recognises that the location-specific nature of many transport externalities means that policy action is often better pursued at the national or local, rather than the European, level, was affirmed by the Green Paper on fair and efficient pricing. This has meant that European policy development has focused much less on urban transport than on inter-urban transport. However, the Green Paper did highlight the possible need for European involvement in local issues where they affected the efficient workings of the internal market. The white paper (CEC, 1998) went on to commit to encouraging member states to develop urban road charging systems and to reviewing any Community legislation that may harm implementation. In furtherance of its plan to encourage member states to develop urban road charging, the Commission has supported and facilitated a number of cross-national networks of interested cities (e.g. EUROPRICE and PROGRESS). In addition, the 'Citizen's Network' initiative (CEC, 1996; CEC, 1998) sought to promote the concepts of affordability and quality in local and regional public transport and included pricing as one of a number of practical measures for the promotion of sustainable transport.

Regarding railways, Directive 91/440 (CEC, 1996) sought to separate accounting for railway infrastructure and operations in order to make the basis for railway infrastructure charging transparent, whilst opening access for specific types of international services. The recent directive on rail infrastructure charging (2001/14) requires marginal social cost to be used as the basis of charging, whilst permitting supplementary charges where necessary for cost-recovery purposes.

The review of Transport Policy (CEC, 2001b) reaffirms the commitment to more efficient pricing of transport in order to internalise externalities, and proposes a framework directive on pricing which will set out the principles to be followed in all modes of transport. This document also sees an important link between pricing and financing, and will permit funds raised from some sectors of the industry to be used for worthwhile projects in other sectors where the result is to reduce social costs. Thus for instance, charges raised for environmental costs of road transport may be used for new rail infrastructure, as in the explicit linking of new hgv charges in Switzerland to the funding of the new rail tunnels under the Alps. This will require replacement of the Eurovignette Directive by one permitting the charging of all social costs and the use of the revenue in this way.

The "Eurovignette" directive (CEC,1996) aimed to limit competitive problems within the road freight sector caused by the existence of very different methods and levels of charging for infrastructure use in different countries. For example, vehicles licensed in a country with low annual licence duty plus supplementary tolls may have an unfair competitive advantage when competing with a vehicle licensed in a country with high licence duty and no supplementary tolls. The Eurovignette was intended to set a limit for the maximum infrastructure access charges payable as a general supplementary licence for heavy goods vehicles, on the basis of average infrastructure costs, with non-discrimination between goods vehicle operators of different nationalities.

A proposal to amend Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructure was put forward in 2003. The overall average charge had to be equal to infrastructure and uncovered accident costs (i.e. external cost of accidents minus insurance premiums), where infrastructure costs must be allocated to vehicle types on the basis of stipulated equivalence factors and may include the annualised cost of investment going back 15 years only.

The directive proposed that the charging system should be more differentiated and tolls could vary according to a number of factors such as; the distance travelled, the location, infrastructure type and speed, the vehicle type (axle weight, engine type, energy source, emission standards), the time of day and specific routes. (CEC, 2003). The toll will be applied to HGVs weighing over 3.5 tonnes, replacing the previous 12 or more tonnes. The earlier Directive will change by being applied to the TEN network and to other roads to which traffic might divert, but permitting application of pricing to other roads as well (the previous directive only covered motorways).

Changes to the use of revenue from the tolls according to the proposed directive, include ensuring strict enforcement that revenue from the tolls is used for expenditure on roads, other transport networks, transport substitutes or the transport sector as a whole, but not general state expenditure such as spending on health or education.

Each state must create an independent transport infrastructure supervisory authority to guarantee that charges are being set and revenue is being used in the required way. In exceptional circumstances a surcharge of up to 25% will be permitted, to fund alternative rail infrastructure.

Despite the flurry of activity at the level of the Commission, progress on implementation of the policy has been slow. Even in the rail sector, where infrastructure charging is generally a new concept resulting from the separation of infrastructure from operations, a variety of approaches to charging has been taken in the different member states. UIC has argued strongly that this is a major barrier to the success of rail in international transport (Gustafsson and Knibbe, 2000). On the other modes there has been relatively little progress. The result is that research has focussed increasingly on implementation issues and understanding the barriers to progress and how they may be overcome. However, the number of countries now implementing or considering a kilometre based charging system for heavy goods vehicles may indicate that the pace of implementation is accelerating.

3. Principles of transport pricing

A number of 4th framework projects, including in particular PETS, TRENEN and AFFORD, sought to clarify the approach advocated by the Commission to transport pricing. Essentially this approach is that known to economists as short run marginal cost pricing, whereby prices are set to reflect the additional costs to society associated with an additional km travelled or an additional trip made, given that the capacity of the transport network is held constant.

When car users, rail operators or the operators of other vehicles decide to travel additional kilometres or to make additional trips they impose additional costs on themselves, on the infrastructure-provider, on other users and on the rest of society. Costs to other users and to the rest of society are referred to as ‘external’ costs. External costs or benefits arise when the social or economic activities of one agent have an impact on the welfare of another agent, without that impact having been taken into account by the first agent. If monetary values can be placed upon externalities then they can be incorporated into the pricing mechanism by means of direct charges or subsidies; in this way they will then be taken into account by all economic agents.

Prices which reflect the additional infrastructure and external costs will act as signals to travellers about the ‘social’ costs associated with their additional travel. They will then base their demand decisions – whether, how and how far to travel - upon these price signals. In fact, prices fulfil several functions in parallel. In addition to acting as cost signals, the price mechanism is the best way to ensure that a limited supply of a good is made accessible to those who value it most. By raising prices until the total demand equals the available quantity, the consumers with the highest willingness to pay for the good receive the good. Also, in competitive markets firms will only succeed if their prices are kept as low as possible; otherwise their competitors will take their markets. In this way the price mechanism provides all producers with incentives to develop cost-reducing production techniques.

What the principle of short run marginal cost pricing translates into, in terms of infrastructure charging, is a need to measure three components of cost for the addition of extra traffic to the existing infrastructure. The first is the cost imposed by additional use on the infrastructure provider. This comprises additional maintenance and renewals costs plus any additional operating costs. The second component is the marginal cost imposed on other infrastructure users, in terms of delays, congestion, accidents and opportunity costs (perhaps more commonly referred to as scarcity costs), on those modes where there is a physical limit and once all the slots are taken no-one else can get one. The third element is the cost imposed outside the transport system and that is mainly environmental cost, but some elements of other costs such as accidents, for instance where these are borne in part by the police or health service and not recovered from users, may enter there.

The same sort of approach may be taken to scheduled transport services. In the case of private transport, if the infrastructure prices are right, essentially, the problem of efficient use of the system is solved. But with scheduled public transport services and with freight transport services that is not so. Or at least it is not so unless there is a fully competitive environment so that it can be left up to the market to determine what is produced. In practice, we rarely have that and there are various cost characteristics, of scheduled transport in particular, which make that difficult and unlikely. For instance when traffic is added to public transport systems, either this raises load factors or leads to operation of larger vehicles or longer trains, in which case the marginal cost to the operators is very low, or services are increased, in which case there is a benefit to existing users from a better service as traffic rises. In other words, for the marginal social cost of operating scheduled transport services, there is again a mix of costs to the supplier, to the users and to society at large. But the cost to other users is typically negative because extra traffic leads to an improvement in the service. (Mohring, 1972). This means that there is very often an a priori case for subsidising scheduled transport services in order to implement pricing policies which do not cover full cost. In the absence of efficient provision of the scheduled transport services themselves there is no guarantee that simply getting the infrastructure charging right will even improve resource allocation let alone solve the problem. The Commission has been concerned mainly with infrastructure charging because of its concern with the terms of competition between different users of the infrastructure as it promotes open access and competitive markets for all modes of transport, but in doing so it has given less attention to a very important aspect of transport pricing, which is that for scheduled transport services it is the final price to the consumer that determines its competitive position with respect to other modes.

4. Criticisms of the EC Approach

The most thoroughly argued critique of the approach published to date is that of Rothengatter (2003). According to Rottengatter, the Commission has essentially adopted the marginal social cost pricing approach of neoclassical economic textbooks.

As Rothengatter rightly reminds us, there are numerous reasons why the simple textbook approach may not be optimal in practice. These may be summarised as follows:

a) measurement is complex
b) equity is ignored
c) dynamic effects, including investment decisions and technology choice, are ignored
d) financing issues are ignored
e) institutional issues are ignored
f) price distortions elsewhere in the economy are ignored
g) implementing marginal social cost pricing may involve substantial administrative costs which may not always be justified by the benefits it brings.

All of these criticisms are well established in the literature and can hardly be denied. Do they imply, as Rothengatter asserts, that there is no need for a uniform pricing system and that a real-world pricing system cannot be based on an abstract economic orthodoxy? We will consider these criticisms one by one.

(a) That measurement of short run marginal social cost is complex is undeniable. A recent review (Lindberg, 2002) concludes that even those elements of cost that have been long studied, such as infrastructure maintenance and renewals and congestion cost, are not without considerable uncertainty as to the true marginal social cost. Scarcity costs, which arise on those modes where use of the infrastructure is scheduled and the presence of operators filling all the slots make it impossible for anyone else to get access to the infrastructure at the time in question, are little researched. Whilst enormous progress has been made on the measurement and valuation of environmental costs and external accident costs these too are of course still subject to big uncertainties.

However, Lindberg concluded that research within a number of European projects is rapidly reducing this uncertainty, and that 'the use of proper theory and modern methods will lead to a convergence also of the more difficult marginal cost categories in the near future'. In other words there is no reason for measurement problems to hold up moves towards marginal social cost pricing. In any event it is hard to argue that, were marginal social cost the right concept to use in pricing, measuring something else instead of using the best estimate possible would be a sensible approach.

(b) The issue of equity is more controversial still. If the Green Paper was not totally clear on what constituted efficient pricing, it was much less clear on what was fair. Fairness seemed to be based on some version of the polluter pays principle, whereby the user paid the costs they imposed. But this principle might be applied at the margin, requiring that the individual consumer should pay at least the additional costs they impose, or it might be applied at a more aggregate level - e.g. requiring that all users of a particular mode of transport should collectively bear the total costs this mode of transport imposes. Rather remarkably, by the time the Commission issued a White Paper on Infrastructure Charges (CEC, 1998), which firmly espoused the marginal cost pricing principle, it was entitled Fair Payment for Infrastructure Use, the word 'efficient' having been dropped rather than the word 'fair'!

It may be argued that a more appropriate way of dealing with on equity approaches the problem a totally different way, as concerning the overall welfare of each individual or group of individuals in society, rather than the effects of a single policy or project (Mayeres and Proost, 2003). Thus if someone is poor, or disadvantaged in some other way - for instance through lack of affordable transport - then policy needs to seek to offset this disadvantage; if someone is clearly well favoured, then they represent a prime target for the levying of additional charges. Of course in an ideal world this would all be done through the taxation and income supplementation system and pricing of transport services could then ignore equity as an issue. But given that it is not politically or practically possible to deal with all these issues in this way, they do need to be taken into account in pricing decisions. It is necessary therefore to know who will gain and who will lose by these decisions. Thus, for instance, it may be seen as fairer to expand subsidies to bus services than to air services or high speed trains, even though on pure efficiency grounds the argument may go the other way. But the appropriate approach to dealing with equity concerns of this type is to use distributive weighting systems, which still use marginal social cost pricing as a starting point, but adjust prices in accordance with the distributive characteristics of the goods concerned (Feldstein, 1972). There is no reason to suppose that this rule will in general lead to full cost recovery on any particular mode or facility.

(c) The dynamic concerns relate particularly to the fact that short run marginal social cost pricing totally ignores the capital costs of expanding the system. There is an alternative in the textbooks, known as long run marginal cost pricing, which charges not the costs of adding extra traffic to the existing infrastructure, but the costs imposed by the extra traffic when the infrastructure is optimally adjusted to the new traffic level. This will therefore include some marginal capital costs, but compared with short run marginal cost the congestion cost, and possibly some of the other external costs, will be reduced. It is easy to show that if capacity is optimally adjusted, then it is expanded up to the point where the extra capital costs of expanding capacity just equal the reduced other costs so that at the margin short run marginal cost and long run marginal cost are equal. There is therefore only an issue between the two as a basis for charging when capacity is not always optimally adjusted to demand. Resolution of this issue depends on the relative speeds of adjustment of capacity to demand and of consumers to price. It is clear that infrastructure capacity adjusts slowly to demand. If consumers adjusted instantaneously to price, then short run marginal social cost pricing would clearly mean that at all points in time demand would be optimally adjusted to capacity. There remains an issue of the incentives for the appropriate adjustment of capacity over time, which we will return to under institutional issues. Given that there is in fact a lag in adjustment of demand to price, particularly for commuters and for freight traffic – where the adjustment may involve relocation – it is not necessarily the case that charging short run marginal social cost will always achieve optimal adjustment of demand to capacity, and there is clearly a case for at least smoothing the adjustment of price as capacity changes to give signals as to the longer term level of marginal social cost.

If we moved entirely to long run marginal cost as the basis for charging then the case for charging higher prices in urban areas would be based on the high cost of expanding capacity in such locations rather than on existing levels of congestion. But in practice most advocates of long run marginal cost pricing would accept that in

some locations, particularly in urban areas, the costs of expanding capacity are so high and the political problems so great that it is inappropriate to price on this basis - it is more important to get efficient use of existing capacity by pricing at short run marginal cost. It is only in locations, perhaps on the public transport and inter-urban road network, where infrastructure capacity expansion is actually likely to take place, that there is a case for long run marginal cost pricing. But there are many other problems, such as indivisibilities, which mean that in practice, the measurement of short run marginal social cost, but allowing for a different level of infrastructure capacity, may still be the best approach. In short, dynamic effects may mean modification of the simple short run marginal social cost pricing rule, but the concept of marginal cost is still fundamental to the derivation of an efficient alternative.

(d) The financing and institutional issues reflect the most common objection to marginal cost pricing - that it does not recover total cost. However, this conclusion may depend on the level of aggregation at which the comparison of costs and revenue is made. At the aggregate level, pricing to recover total cost typically implies big increases in rail and other public transport charges, together with reductions in road taxation, whereas marginal cost pricing often implies the reverse. Most transport infrastructure is subject to increasing returns to scale, which means if capacity is anything like optimal, then marginal cost pricing will not recover the total cost of the system. On the other hand, the cost of land and property acquisition limit expansion, particularly in urban areas, so efficient supply of capacity in urban areas will typically still involve significant congestion and consequently high charges for the use of infrastructure. So the likelihood is that marginal cost pricing will imply substantial surpluses of revenue over costs on urban roads, whereas on rural roads and much public transport, there will be deficits. Nevertheless, there remain two important questions. One is whether the whole package of effects satisfies government budget constraints. Does it provide enough finance, or are there other means of supplementing it if necessary? There is some evidence that typically surpluses in urban areas are so big that budget constraints are not a problem (Roy, 2002). But then there is a second issue, and that is whether a system whereby urban road users greatly cross-subsidise rural road users and public transport users is perceived as acceptable, both in terms of equity and in terms of influence on locational choice.

If for any of these reasons the budgetary outcome of marginal social cost pricing is seen as unacceptable, then of course we have to depart from marginal cost pricing, but that does not mean we throw the principles away. As Rothengatter comments, there are well-established rules for supplementing the revenue raised in the way which is least damaging to the efficiency of the system. The solution is to consider multi part tariffs and differentiating pricing according to willingness to pay, but with marginal social cost as a starting point, and then looking for the optimal departures from that base. But, unless multipart tariffs can be found which exclude no users and face all users with a marginal price equal to marginal social cost, there will be an efficiency loss due to these measures (except in circumstances where there is a budgetary problem and there is no more efficient way to raise the necessary revenue from general taxation). That efficiency loss will be minimised by applying the budget constraint at the most aggregate level possible, so budgetary problems will not lead to a case for requiring each mode to cover its total cost from revenue.

(e) The institutional issues concern ways of providing appropriate incentives for the efficient provision and development of transport infrastructure. There are two crucial institutional issues surrounding marginal social cost pricing. The first is the general one of cost coverage. Rothengatter asserts a general rule that charging users the full cost of the infrastructure rather than subsidising it will lead to technical and allocative efficiency in the level of infrastructure provision. In the presence of economies and diseconomies of scale, as discussed above, there will be a cost in terms of efficiency if full cost recovery suppresses or expands demand compared with the level that would arise with marginal social cost pricing. This cost could be more than offset if it were the case that the full cost recovery rule led to an increase in technical efficiency of the infrastructure provider. But it is unclear why this should be the case. Most transport infrastructure is a natural monopoly, which may use its monopoly power in pricing to break even without being technically efficient; on the other hand, given the presence of economies of scale, there may be economically efficient infrastructure investments that are unable to break even with any practicable tariff.

The second concerns the incentives to infrastructure providers given by short run marginal social cost pricing. Under short run marginal social cost pricing, prices will be high where capacity is inadequate, giving the infrastructure manager an incentive to withhold necessary investments. Of course, if it could be assumed that infrastructure capacity decisions were taken by governments, solely on the basis of social cost-benefit analysis, then this would not be a problem. But most economists recognise, as Rothengatter asserts, that governments are not so entirely benevolent in their motives. If it is considered that efficiency requires infrastructure managers to be constituted as commercial organisations exploiting private capital to fund their investment then the problem of reconciling incentives to infrastructure managers with efficient pricing becomes acute. Again, long run marginal social cost pricing has attractions in this case, but given that transport infrastructure managers always have considerable monopoly power, a regulator will still be needed to ensure that investment levels are efficient and that charges are related to the costs actually incurred. Hence, to the extent that infrastructure is a natural monopoly it is difficult to see any approach to optimal provision and pricing which does not have some degree of government intervention; whether that intervention should best take the form of regulation of private monopolies or direct provision and control remains a major source of controversy.

(f) Few advocates of marginal social cost pricing would deny that the case for marginal cost pricing assumes the existence of marginal social cost pricing elsewhere in the economy. For instance, if one good is charged a price below marginal social cost, there is a case for charging substitute goods below marginal social cost as well to reduce distortion of choices between them. The practical implication is that, where there are divergences between price and marginal social cost in related markets, these lead to cases for divergences in the market in question. The most common application of this argument is in terms of competition between modes. But there are other concerns. For instance, if the costs of urban sprawl are not adequately reflected in property prices and local taxation, then it may be desirable that transport prices are configured in part to offset this distortion and to discourage sprawl. The implication is that charges for entering town centres should be below marginal social cost. Similarly

if labour taxes discourage labour supply that may lead to a case for subsidising the cost of commuting.

Thus, in essence, most advocates of marginal social cost pricing would accept these criticisms. What they would say is that 'pure' marginal social cost pricing has to be modified to take all these issues into account. This is the subject of second best pricing, on which a wide literature exists (Verhoef, 2001). In essence, the simple marginal social cost pricing rule has to be modified to reflect divergences between price and marginal social cost elsewhere in the economy, weighted by the degree of interaction between those sectors and the service for which the price is being set. The resulting pricing rules may be very complex, but it is likely to be better to make the best possible estimate of the necessary data than to ignore the issue.

(g) Regarding the final criticism of marginal social cost pricing, it is certainly true that implementation of sophisticated pricing systems remains far from costless, whilst the ability of users to respond to the prices may be limited by their ability to understand and predict what they will have to pay. Thus there is an optimal degree of complexity of any price structure arrived at by comparing the benefits of greater differentiation in terms of their influence on the volume and location of traffic with the costs. There are also issues concerning the speed of implementation, which may differ between the modes both because the technical requirements differ and for political reasons. In turn, these factors lead to second best considerations; differing degrees and speed of implementation between the modes could itself be distorting and needs to be taken into account in policy determination. Thus implementation of marginal social cost pricing is far from straightforward, but there seems to be good evidence that simple systems of road pricing in heavily congested cities or on congested inter-urban links can bring worthwhile benefits (Nash, Niskanen and Verhoef, 2003), whilst more complex systems are becoming steadily easier to implement as technology advances.

To sum up, then, Rothengatter does well to remind us of the whole range of factors that mean that pure marginal social cost pricing is not a desirable or sensible aim to follow. The set of issues he raises is very important, and no doubt the solution to them will include multipart tariffs in appropriate circumstances. But this does not mean that a totally different theoretical approach to pricing policy needs to be adopted, or that full cost recovery as a principle is a good starting point. It is possible to measure marginal social cost and to move towards it as the basis of transport pricing although difficulties and uncertainties remain. Considerations such as budget constraints, equity, institutional issues, simplicity and price distortions elsewhere in the economy lead to a need to depart from pure marginal social cost pricing but do not change the position that the measurement of marginal social cost is the correct starting point in the development any efficient pricing policy. For this reason, recent projects for the Commission which have sought to address these issues have tended to use the phrase ‘marginal social cost based pricing’ rather than ‘marginal social cost pricing’ to summarise the philosophy they adopt (Verhoef, 2001).

5. The existing situation

A number of projects, including PETS and MC-ICAM, have reviewed the current transport pricing scene in Europe. The pricing of urban transport varies widely

throughout Europe. Urban roads remain unpriced, except for taxes on vehicle ownership and fuel. The main exception to this in Europe is the finance-driven toll rings such as the three Norwegian cities. Parking charges are sometimes used as a proxy to urban road pricing but the limitations of this practice are well known. Urban public transport is generally subsidised and the basis for pricing varies between commercial incentives, political objectives and tradition. The result is very high charges in some countries and very low in others.
Thus, whilst travellers currently face a variety of taxes and charges, these tend not to be very closely related to use or the incidence of externalities. Hence, current pricing signals are not efficient. The most striking inefficiency in most transport markets is the lack of differentiation in pricing to reflect the different social costs of travel. External costs are severe in congested urban and inter-urban situations where travel patterns are heavily peaked by time of day, day of week or season of the year. Yet drivers travelling in the rush hour pay more or less the same price as those who travel in the off-peak period. The price of a bus or train ticket is often the same in peak and off-peak periods. There is insufficient incentive to travel in the off-peak period. Similarly people driving highly polluting cars pay more or less the same rate per kilometre as those driving less polluting cars. Again, there is insufficient incentive to use less polluting cars. Given this pricing structure, it is no surprise that too much travel occurs in the peak period, too much pollution is generated, or that too many accidents occur.

For long distance transport there is no more evidence of marginal cost pricing. Generally long distance public passenger transport, freight transport by all modes, ports and airports are seen as facilities and services that should be operated on a commercial basis and not be subsidised except in specific cases where this is necessary to secure an adequate service.

Road transport is more complicated. Generally, vehicle owners pay an annual fixed sum to licence the vehicle for use, plus fuel tax when using the vehicle. Clearly this allows a degree of differentiation by type of vehicle, but that differentiation takes the form either of a fixed sum unrelated to use or of fuel tax the relation of which to vehicle type is determined by fuel consumption rather than by any variable that is of use to policy makers. Some countries have supplementary tolls on motorways, or require purchase of a vignette to use the motorway system, whilst a few cities have toll rings to enter the city. All of this adds up to a pricing structure ill-suited to reflecting the variation in marginal social cost by time and place.

There have been developments in HGV pricing over the last few years. Switzerland introduced a distanced based HGV charge in 2001. This charge applies to all HGVs weighing over 3.5 tonnes using the Swiss road network. The charge is distance-based and takes into account emission category and axle weight of the vehicle. So far the toll is considered to be a success, resulting in a fall in motorway traffic and leading to the renovation of HGV fleet to lower and cheaper emission class vehicles. (Balmer, 2003) Germany proposes to introduce a distance-based HGV toll for the use of German motorways in November 2003. The toll will apply to vehicles weighing over 12 tonnes. Britain also proposes for HGVs to implement a distance-based toll for the use of the entire UK road network in 2006. The toll will apply to vehicles weighing

over 3.5 tonnes. All three countries rely on electronic fee collection in order to ensure that the system runs smoothly and there are few delays in traffic.

The charges all aim to take into account the costs imposed to infrastructure by HGVs. It is commonly argued that the charges must also take into account the external costs imposed to society. The Swiss toll also considers external costs such as air pollution, noise and accidents, but however costs caused by congestion or the greenhouse effect were not considered. Revenue from the HGV tolls was proposed to be spent on the transport sector, particularly on infrastructure projects. Switzerland aimed to improve and modernise the rail network in order to facilitate a modal shift from road freight to the railways, in order to reduce the costs on the roads and contribute to relieving road congestion. The ten year plan (DETR, 2000) in Britain also aims to increase rail freight, by as much as 80% measured in freight tonne kilometres by 2010.

In order to ease the implementation of HGV charging, other policies were put forward. Switzerland increased the permitted gross vehicle weight of lorries simultaneously with the introduction of the HGV toll, which was hoped to raise the productivity of road transport. Britain proposes to introduce off-setting tax cuts in the form of a reduction in fuel duty, whilst Germany proposes to introduce a toll rebate scheme if proof of mineral oil tax paid was produced, lowering motor-vehicle tax for HGVs to the minimum level admissible under EU law and a HGV innovation programme where an investment subsidy is given for purchasing HGVs with lower emission classes. These policies were thought to enable much a fairer and smoother implementation of the HGV tolls.

Currently very little use of marginal social cost pricing is made in practice in Europe. There are only very few cases, predominantly relating to infrastructure charges in the Nordic countries, where explicit reference to marginal social cost is made in the determination of pricing structures and levels. Although the HGV charges in Switzerland and Germany are differentiated by emission levels, they are essentially based on average cost.

6. Implications of marginal cost pricing

The existing range of pricing policies in most Member States is so varied that it is difficult to generalise about the likely implications of pricing reforms designed to reflect marginal social cost. Pricing based on marginal costs may result in price reductions for some modes as well as price rises for some others because current levels of taxation and charging have to be taken into consideration. Evidence is available on the implications of marginal cost pricing from a small number of actual implementations or demonstration projects, and from a much larger number of modelling exercises. Both will be reviewed in this section, which draws heavily on CAPRI (2001) updated from the stated sources.

For the use of urban roads, the Norwegian experience is the most valuable. In Norway, special area entry permits are being used in Oslo, Bergen, and Trondheim. Although they are primarily used to raise revenues, there is evidence that there has been some impact on the overall traffic levels in the controlled area. In Oslo, the car traffic reduction is estimated as 5%; but the toll was introduced at a low level with the

main aim of raising revenue for the building of transport infrastructure. At Bergen the effect is slightly higher at 6-7%. A form of area pricing system has been in use in Singapore since 1975 with considerable success. From 1998, this was adapted into a more sophisticated electronic charging system, the early results of which show a 15% reduction in overall traffic levels (Menon, 2000). However, it should be noted that these examples of pricing reform could only be described as having been 'loosely' based on principles of marginal cost.

In February London became the first city in Britain (excluding a very small scheme in Durham) to introduce congestion charging (Transport for London, 2003). All vehicles have to pay a charge of £5 to drive in Central London between 7.00 a.m. and 6.30 p.m. Mondays to Fridays, with certain exceptions. Buses and taxis are exempt and residents within the area can obtain a 90% discount. Payment can be by web, mobile phone text message or over the counter at Paypoint outlets. Enforcement is by cameras linked to number plate recognition technology.

The aims of the scheme were to reduce traffic within the charging zone by 10-15%, improve bus services and raise net revenue of £130m for investment in improved transport. Initial indications are that the scheme has got off to a good start, with no major hitches, and that the objectives are largely being achieved. There was an average reduction of traffic entering the zone of 16% (since this is for all traffic it implies a much greater reduction in private cars of course), bus use was up 10% and traffic conditions much improved. The only real worry is that the greater than expected reduction in traffic may reduce the amount of revenue the scheme produces and thus reduce future transport investment below the level planned!

Modelling studies for urban and inter-urban road pricing indicate that proposed price changes can induce small but significant changes in behaviour (e.g. a 5 to 10% demand reduction) – small changes in behaviour can make a major contribution to the reduction of congestion and other externalities. In some studies a small reduction in demand has been shown to result in the marginal external cost of congestion falling to 20% of the pre-charge level.

In contrast, demonstrations of urban road pricing often suggest that unacceptably large price changes may be needed in order to influence behaviour. However, these magnitudes of response should be treated with caution - although these demonstrations have provided valuable evidence on behaviour, their short-term focus and use of compensation to volunteer participants who chose not to use their car (as opposed to charging those who did) affects the results obtained. In some volunteer exercises, compensation levels have only returned a proportion of the "money saved" by the volunteer and have also been uncertain and paid out at the end of the trial period; this has affected the volunteers' perception of compensation in relation to "real money".

Demonstrations such as the Leicester demonstration in EUROTOLL as well as modelling exercises confirm the main impact of more variable road charging is likely to be travel at different times or by different routes by the same mode – the user's first preference will often be to continue to use their vehicle, but in a different way

(different departure time, route etc.). Provision of park and ride appears to be important in the use of road pricing for promotion of public transport

Modelling case studies carried out as part of a series of European research projects have analysed the potential results of implementing a variety of pricing reforms. Results vary across countries. However, despite the context-specific nature of case study findings, some general messages emerge.

Urban transport by means of road-based modes is typically dramatically under-charged, particularly in congested conditions. The well known phenomenon of serious underpricing of the car mode is reflected in the results of the PETS and TRENEN urban case studies (Nash et al, 2000; Proost et al, 1999).

The passenger transport case studies suggest that reform of prices for urban rail services in line with an approach based on marginal cost would involve only a slight increase on current prices. Moving to more optimal prices for peak buses would, however, involve substantial increases as compared with current prices, since external costs are greater. Overall, implementation of prices based on marginal cost might generate small reductions in the total volume of urban travel.

The under-charging of road-based modes in urban areas implies that efficient pricing will have the greatest impact in reducing externalities in urban areas. Modelling and demonstration work as part of the TRANSPRICE project (1999) confirmed that road use pricing is an effective way of changing modal split from private car to public transport and park & ride. Modelling tests for five cities taking part in the TRANSPRICE project produced city centre traffic reduction of 5-20%, with associated environmental benefits. In the case of Athens where both demonstration and modelling were carried out, a reasonably close result between the two sources was found. Parking pricing provides an effective way for restraining car trips (assuming that enforcement can be maximised), but less so than road use pricing options for which enforcement levels are expected to be higher than past experience with parking pricing.

For inter-urban passenger travel in uncongested conditions, it is likely that road-based modes are over-priced – due to the combination of existing charging and taxation systems. For example, the PETS case studies (Nash et al, 2000) suggest that existing prices for inter- urban car broadly reflect and perhaps exceed marginal social cost including all externalities. It is common to find that inter urban rail and road-based public transport are overpriced, despite generally low taxation to account for externalities. Current fares are often in excess of the marginal cost of providing additional services due to full cost recovery targets in the presence of economies of scale. This forms the main case for a realignment of prices to favour rail transport. The same result may not apply to air transport, however, because of its much higher level of external cost. The main effect of these changes would be to induce minor shifts from air and road to rail transport. These shifts become stronger when policies are integrated and infrastructure development is combined with economic incentives for internalisation of environmental costs.

For inter-urban freight transport, evidence suggests significant under-charging in many cases for both road and rail-based modes – even in uncongested conditions. Inter-urban road freight is also likely to suffer from distortions due to the variety of pricing regimes in operation in different Member States. The benefits of internalisation for rail freight are again limited by the finding that rail is often underpriced as well.

Therefore, pricing reform to reflect marginal social cost in passenger transport would, in general, involve a decrease in prices for inter-urban road and rail transport and increases in the price of urban road-based transport, in particular the private car. For freight transport, the introduction of efficient prices would often lead to increases in prices for both road and rail. In addition, these pricing reforms would result in a substantially greater degree of differentiation and variation in transport prices.

Interestingly, improving service quality and investment in infrastructure appear to be the most important measures for increasing modal shares – as opposed to internalisation of externalities for all modes via the pricing mechanism. This is particularly the case for freight transport, according to the case studies in STEMM.

Internalisation of externalities does not necessarily imply lower travel demand, or a shift to more "sustainable" modes of transport, since prices may increase or decrease for the different modes. As referred to above, existing prices for inter-urban car broadly reflect and perhaps exceed marginal social cost including all externalities. Simply internalising externalities will, therefore, not necessarily benefit public transport modes even though they may have a much lower level of external cost than road, because of the existing levels of taxation on road transport.

The attached figures illustrate some of these results in particular with reference to the PETS (2000) project. In PETS the key externalities we looked at were:

- congestion; there is a long tradition of measuring and valuing congestion, so it is not so controversial
- accidents, where there is also a long tradition, but there is more uncertainty about issues like the degree to which extra traffic imposes risk on other users
- air pollution, where there are more uncertainties still but we had the results of a very major project called 'EXTERNE' which had as its aim to value air pollution (Friedrich, Bickel and Krewett, 1998)
- noise where there are actually some particular problems, but again a lot of research
- global warming, where of course the uncertainties are greatest of all; again, this was examined by ExternE but their valuation changes drastically from one report to another.

We were able to estimate all of these items though subject to uncertainties. Looking at some of the results for case studies, the uncertainties are reflected in the fact that we estimated low and high values. Table 1 shows the changes to passenger transport charges that would be needed to have marginal social cost pricing in the year 2010. The year is important because we were assuming continued improvement in emission

standards of the vehicles and we were assuming that quite substantial increases in capacity would be in place by 2010. What we found on that basis is that in interurban transport, the current level of taxation on cars would more than cover marginal social cost by 2010. It would be efficient actually to charge cars less on long distance transport. But in our one more urban case study, the Lisbon one, as you would expect, current taxes on cars are far below marginal social cost. For bus and rail passenger services commercial considerations tend to leave the prices above marginal social cost and in fact for our two air examples, that was also the case (a factor here is that the air case studies were in countries where there are significant departure taxes). Looking at the sort of changes in passenger demand that we forecast resulting from these price changes, (Table 2) we find that rail gains in most of the corridors but the only place really where car has a significant reduction is the urban case of Lisbon.

On the freight side the picture is more mixed (Table 3). For heavy goods vehicles efficient prices would involve raising taxes in two of the case studies, but in the transalpine one, where there are already substantial charges actually the taxes would be lowered, and for rail in some cases the subsidies already reduce charges below marginal social cost. So rail prices could go in either direction. The changes in demand in the freight sector (Table 4) as a result of moving to efficient pricing are not very large and certainly the Swiss results suggested that efficient pricing with the low valuation of externalities on the transalpine corridor would actually divert from rail to road which is not a popular conclusion.

To sum up, then, it is possible to measure marginal social cost although uncertainties remain. For most estimates it is not simply the case that efficient pricing would favour environmentally friendly modes, for instance by uniformly diverting traffic from road to rail. The picture is more complex. For road, the position for passenger cars tend to be that charges are far too low in congested areas but too high elsewhere. For heavy goods vehicles the position varies enormously between countries but with undercharging common. For rail, passenger is often priced above marginal social cost, but freight again varies.

7 Implementation issues

Given that the technology exists, some might argue that we should implement electronic road pricing everywhere with tariffs that vary by the minute in terms of the price paid by the user. For rail and public transport the scope for highly differentiated prices is even greater. However, implementation of sophisticated pricing systems remains far from costless, whilst the ability of users to respond to the prices may be limited by their ability to understand and predict what they will have to pay. Thus there is an optimal degree of complexity of any price structure arrived at by comparing the benefits of greater differentiation in terms of their influence on the volume and location of traffic with the costs. There are also issues concerning the speed of implementation, which may differ between the modes both because the technical requirements differ and for political reasons. In turn, these factors lead to second best considerations; differing degrees and speed of implementation between the modes could itself be distorting and needs to be taken into account in policy determination. Thus implementation of marginal social cost pricing is far from straightforward.

Projects dealing with acceptability of pricing reform, including AFFORD (Niskanen et al, 2001), PATS (Linke et al, 2000) and PRIMA (Harsman et al, 1999), have raised three principal issues relevant to implementation: the need to consider policy packages, the need to give consideration to how pricing (in particular urban road pricing) revenues are spent, and the need to adopt a phased approach to implementation.

For road, it appears that there should be two priorities. The first, and obvious, one is to implement some form of road pricing in congested areas. These are likely to be mainly, but not necessarily solely, urban areas. How sophisticated a system this should be depends on the trade-off referred to above. The second is to reform charges for commercial vehicles, and particularly heavy goods vehicles. The first step here would be a kilometre-based charge varying with axle weight and gross weight, to reflect the importance of wear and tear costs for such vehicles. Ideally this would vary with the type of road - these costs are much greater off the motorway and trunk road network where pavements are thinner. To this needs to be added external costs - accidents, environment and congestion. Clearly these vary with location and time of day, so the ideal would be universal electronic road pricing for heavy goods vehicles. But it may be that a significant step forward in terms of efficiency may be made by charging a fixed rate per kilometre, plus supplementary charges where urban road pricing is implemented.

Although road freight traffic is not very price sensitive, such a charging system would reduce distortions between vehicle types and countries of origin as well as between modes. If these changes were implemented, then efficient pricing would dictate a reduction in fuel tax in many countries. It would also be possible to reduce or eliminate vehicle excise duty on vehicles subject to the kilometre charge, so that vehicles would pay the same no matter where they were registered. The continuation of vehicle excise duty on cars would be a matter for consideration in terms largely of revenue requirements and equity; it is likely to be a relatively undistorting form of two part tariff with little effect either on car ownership or car use, but may be a useful way of encouraging less polluting vehicles if it is appropriately differentiated.

For rail, whilst in some senses implementation is easier, in other senses there are greater complications. Firstly there is a big difference in the nature of congestion between road and rail. On roads, congestion usually manifests itself as volumes of traffic such that speeds are reduced below free-flow speed and/or queuing occurs at junctions. Since rail infrastructure managers control access to the network on a planned basis, rail congestion manifests itself in a different form. Indeed, it is useful to distinguish between two effects of shortages of capacity - congestion and scarcity. Congestion represents the expected delays resulting from the transmission of delays from one train to another. These become worse at high levels of capacity utilisation, since there is a lack of spare capacity to recover from any delays, (Gibson, et al, 2002). Congestion costs are the costs associated with these expected delays. Scarcity represents the inability of an operator to obtain the path they want, in terms of departure time, stopping pattern or speed. Therefore, in the presence of a capacity constraint, the value of any train which could not be run as a result of lack of capacity would be added to the costs of track damage and of expected delays. The High Level

Group on Transport Infrastructure Pricing identified scarcity, rather than congestion, as the dominant consequence of existing capacity constraints on the existing rail network (CEC, 1999).

Both in the case of congestion and scarcity, it may be argued that there is only a genuine external cost imposed when the effect is on the time of another operator. However, the issue arises of whether the cost perceived by the operator fully reflects the cost imposed on the final users. Only in the event of perfect price discrimination is this likely to be true.

Secondly, there is a particular issue involved in the setting of rail infrastructure charges, and that is the desire to encourage open access. The recent railway directive (CEC, 2001) requires that charges be based on marginal social costs, but with non-discriminatory mark-ups. In terms of economic efficiency the best way to implement these mark-ups would be via two part tariffs, as with roads. The fixed element could then be recovered by the train operator from their customers in the most efficient way possible. But there is a big concern that such fixed charges could not be levied on existing operators and new entrants in a non discriminatory way. For instance, if both have to pay the same fixed charge, then the new entrant, who is almost certainly smaller than the incumbent, is penalised. If the fixed charges differ, how is the charge for the entrant to be set? Baumol (1983) produced an ideal solution, that it should be set in accordance with the loss of contribution to the fixed costs that the entrant imposes on the incumbent, but that is very difficult for a regulator to estimate. What is often favoured therefore is some sort of differentiated charges according to the market position of the commodity or type of traffic to be transported (Ramsey pricing, to the economist). In other words the charges per train kilometre are raised above marginal social cost.

Whilst a lot of attention has been paid to rail infrastructure charges, because of the open access proposals, relatively little attention has been paid to the charges faced by the final customers. For reasons explained above these often exceed marginal social cost, quite apart from any overcharging for infrastructure.

In part, these problems are reduced by a provision in the Directive that rail should not be charged for its environmental costs until road is. But that only partly solves the problem. As we have seen in some contexts road is already being charged for its full external costs, but in others it is grossly undercharged. The failure to charge rail for its, in any case low, external costs will only correct this price distortion to a very limited degree.

In other words there are potentially very serious issues of second-best and of time phasing to be borne in mind in planning the implementation of marginal social cost pricing. Our judgement would be that these are particularly serious in the case of freight, where almost all rail freight is carried in direct competition with road, whereas in passenger, the interdependence is less strong and the cross elasticities lower.

The MC-ICAM project dealt with these issues (Nash, Niskanen and Verhoef, 2003). It concluded that more efficient charging for the use of roads, especially in urban

areas and for goods vehicles, should be the top priority, and that there were benefits from introducing simple cordon or kilometre charges in advance of more sophisticated systems. Such simple first steps also help to build up acceptability. Most importantly, benefits and therefore appropriate charging levels depend crucially on the use of revenue. With respect to the policy of dedicating the revenue from charging to transport infrastructure, whilst this may be an important measure to make proposals acceptable, the efficiency costs could be large.

8. Conclusion

The adoption by the Commission of the simple rule of marginal cost pricing is a really quite remarkable and all too rare example of policy makers following the prescriptions of transport economics. It is a simple message, and perhaps it has to be simple for there to be any hope of progress being made.

In reality, complexities inevitably crowd in. We have to find ways of dealing with institutional issues and the presence of commercial infrastructure managers, with budgetary issues and the problems of equity, with the trade off between accuracy and complexity and with the problem that progress will not be equally fast for all modes and locations. The result is that whilst the rail Directive and the proposed HGV Directive (2003) both indicate progress in the right direction, both fall far short of pure marginal social cost pricing. The rail Directive takes marginal social cost as its base but allows for many exceptions. The proposed road Directive takes average infrastructure and external accident costs as its base but allows differentiation according to environmental and congestion costs.

There is no sign yet of the promised framework Directive covering all modes of transport. The result is that it is unclear at present whether we are still on the implementation foreseen in the 1995 White Paper but running a few years late (which given the complexity of issues on which agreement has to be reached would not be particularly surprising) or whether the momentum for reforming transport prices in Europe has been lost.

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Table 1
CHANGES IN PASSENGER PRICES
(ECU/100 passenger km)
(change compared to 2010 base situation)

Case Study	Cost Est.	Car (2010)	Bus	Train	Air
Cross Channel	low	-2.75	-	-3.00	-2.27
	high	-1.35	-	-2.82	-1.16
Finnish	low	-2.24	-2.96	-4.06	-
	high	-0.49	-2.56	-4.04	-
Oslo-Goth	low	-2.57	-1.18	-1.26	-5.71
	high	-0.80	0.51	-1.22	-4.54
Lisbon	low	+1.19	-1.72	-0.90	-
	high	+3.37	-1.65	-0.87	-

Source: PETS project results

Table 2
CHANGES IN PASSENGER DEMAND
(% change compared to 2010 base situation)

Case Study	Cost Estimates	Car	Bus	Train	Air	Total
Cross Channel	low	-0.2	-	+7.1	-1.7	-
	high	-0.7	-	+10.3	-2.2	-
Finnish	low	-1.4	+3.7	+12.1	-	-
	high	-3.2	+11.4	+20.7	-	-
Oslo-Goth	low	+21.5	-10.5	-8.4	+6.8	+14.6
	high	+6.2	-4.4	+0.2	+8.9	+4.7
Lisbon	low	-29.0	+22.2	+29.6	-	-
	high	-36.3	+25.0	+32.0	-	-

Source: As Table 1

Table 3
CHANGES IN FREIGHT PRICES
(ECU/100 tonne km)
(change compared to 2010 base situation)

Case Study	Cost Estimates	HGV	Train
Cross Channel	low high	+1.21 +2.04	+1.50 +1.61
Finnish	low high	+1.13 +1.58	-0.27 -0.26
Transalpine	low high	-4.80 -1.19	+0.28 +2.02

Source: As Table 1

Table 4
CHANGES IN FREIGHT DEMAND
(% change compared to 2010 base situation)

Case Study	Cost Estimates	HGV	Train
Cross Channel	low high	+1.2 -1.5	-3.0 +4.0
Finnish	low high	-5.9 -7.9	+7.4 +9.7
Transalpine	low high	+3.1 +0.1	-12.5 -1.7

Source: As Table 1