Why reform transport prices? A review of European 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. Conservative estimates of the costs to the European Union associated with congestion amount to some 2% of its overall GDP (CEC, 1995). 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. The most notable of these problems are environmental pollution and accidents, the costs of which are, taken together, estimated to be in excess of 2% of the EU's GDP (CEC, 1995). 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,1998b) and the new Common Transport Policy White Paper (CEC, 2001b), 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.

This paper is written to form the opening paper of the first meeting of the IMPRINT-EUROPE thematic network. The aims of this network are

1) To facilitate the exchange of experience and transfer of knowledge among scientists and practitioners in the field of pricing;
2) To draw together the results of previous and ongoing research in the field of pricing and to make them accessible to policy-makers, practitioners, industry and other professionals in a series of seminars and deliverables designed to assist them in developing and responding to pricing policy reform;
3) To identify, through critical comparative work, the prerequisites for the development of an integrated approach to implementing the White Paper's proposed pricing reforms.

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. The intention is to set the scene for the more detailed consideration of later papers. 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 criticisms of those principles. The following sections summarise studies which have looked at existing pricing practice, 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, 1998b). 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 Commission's Green and White papers on pricing policy emerged from an environment of considerable turbulence in the transport field. A range of needs at member state and European level were apparent, including the need to manage transport capacity more efficiently, to finance transport infrastructure, and the need to improve the efficiency of the transport sector by means of institutional reform involving deregulation and privatisation. At the same time, continued European integration meant that distortions caused by different pricing principles in different member states were increasingly seen as a problem. The framework contained in the Green and White papers represented the Commission's endeavours to provide a comprehensive pricing principle across modes and countries that would ensure that in times of change there was an underlying scientific basis for the development of pricing in the transport market.

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, 1998b). 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, 1998b) 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, 1996a; CEC, 1998a) 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.

The "Eurovignette" directive (CEC,1996b) 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.

Directive 91/440 (CEC, 1991) 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 (CEC, 2001a) requires marginal social cost to be used as the basis of charging, whilst permitting supplementary charges where necessary for cost-recovery purposes.

Policy has also developed with regard to air and sea ports. The directive on airport charges (CEC, 1997b) seeks to establish principles for airport access charging based on the underlying costs of airport operations and the need to ensure fair competition between airports. The green paper on seaports and maritime infrastructure (CEC, 1997a) has sought a similar system of charging to that for airports, again based upon underlying cost structures and a desire to ensure fair competition between ports – particularly those in adjacent countries. Both of the latter documents still seem to emphasise total cost recovery rather than marginal social cost pricing, perhaps because the issue of preventing the use of state aids to give unfair competitive advantage has long been a major issue in these sectors.

The most recent 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.

Despite this 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. It is in this area that this thematic network aims to make a particular contribution.

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.

Why charging for all these costs is the most efficient basis for charging is something that economists have been very bad at explaining to the outside world. The principle is that all costs are valued at the compensation needed for those incurring them willingly to do so. Those users, who value their use above the costs they impose by adding to traffic flows, will travel. Those who value their use below that cost will not travel or will use some alternative means. Consequently, when expanding traffic to the level implied by short run marginal cost pricing, it would be possible to make everyone better off by the move; users could fully compensate all those bearing costs by the move and still be better off themselves. Similarly if traffic were currently at a higher level than that implied by this principle, those suffering the costs of the higher level of traffic would be able to fully compensate marginal users for giving up their journeys and still be better off themselves. (Fig 1). Of course, the fact that the losers could be compensated does not mean they will be, but this potential for benefiting everyone is something one would expect to be of interest, not least to politicians.

What the principle of short run marginal cost pricing translates into, in terms of infrastructure charging, is that we need to measure three components of cost for the addition of extra traffic to the existing infrastructure. Firstly the cost imposed by additional use on the infrastructure provider. This comprises additional maintenance and renewals costs plus maybe some 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. Then there is a cost imposed on those people who are simply excluded from access when they want it. And the third element is the cost imposed outside the transport system and that is mainly environmental cost, but also 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 you add traffic to public transport systems, either you raise load factors (operate larger vehicles or longer trains), in which case the marginal cost to the operators is very low, or you increase services, 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. If you don't get 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.

The title of the Green Paper used the words 'fair and efficient'. The concept of fairness is one where there is little consensus. The Green Paper appeared to mean by fairness some version of the polluter pays principle, whereby the user paid the costs they imposed. But this principle might be applied at the margin, 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. that all users of a particular mode of transport should collectively bear the total costs this mode of transport imposes.

The principal approach taken to equity in transport economics (e.g. in TRENEN) sees equity as concerning the overall package of costs and benefits experienced by each individual or group of individuals in society. 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 could 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, one would be more likely to favour expanding 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. In other word there is frequently a trade-off between efficiency and fairness.

4. Criticisms of the EC Approach

As part of the 4th framework, we were responsible for a project called CAPRI, which was somewhat similar to IMPRINT except that it focussed more on pricing principles than implementation issues. A key part of that project was to identify and understand better the objections to this approach to transport pricing, and a number of objections were identified.

The first factor that many people find unacceptable about short run marginal cost pricing is that it 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 if 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. In this case it is hard to see an argument in favour of long run marginal cost pricing, since to do so would be to charge costs that have not been incurred in practice.

If we moved entirely to long run marginal cost as the basis for charging then congestion pricing would essentially be an irrelevance; the case for charging higher prices in urban areas would be based on the high cost of expanding capacity in such locations. 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 inter-urban road network, where capacity expansion is actually likely to take place, that there is a case for long run marginal cost pricing.

Our conclusion was that the provision of extra infrastructure is so subject to indivisibilities, so subject to time lags and so subject to political considerations about what capacity is provided that it is more efficient to charge to get efficient use of whatever infrastructure is there and then to look at adapting infrastructure using the principle of cost benefit analysis. Having said that we would certainly accept that existing prices give signals to users which cause them to get locked into a particular situation - thinking particularly of commuting journeys, where home and work location are influenced by the current price. Then, there is a case for taking account of plans for new capacity to charge what the short run marginal cost will be in the longer term, rather than incur violent fluctuations in these prices. If in the long run, capacity will be optimal, this amounts to long run marginal cost pricing. In any event, we would accept that in these circumstances those responsible for pricing decisions would do well to look at long run marginal cost as well, and to consider the implications for their plans and assumptions about future capacity if short run and long run marginal cost differ.

It is worth commenting on some commonly given reasons for adopting the long run marginal cost approach which are certainly not valid. One is that this will achieve higher revenue and cost coverage than short run marginal cost pricing. This is basically only true where there is excess capacity, and it is commonly argued that the big problem of transport infrastructure is inadequate capacity. The argument is probably based on a common misunderstanding of short run marginal cost pricing which sees it as covering only wear and tear costs, and not the costs of congestion and other externalities. A second is that short run marginal cost pricing cannot be implemented because the pricing instruments for such a differentiated pricing scheme are not available or are too expensive. Both short run and long run marginal cost pricing require highly differentiated prices; if these are not possible then in both cases a high degree of averaging is required but both approaches remain feasible.

Whilst in Britain and France the argument between long run and short run marginal cost pricing predominates, in Germany the whole approach of marginal cost pricing is subject to major criticism. The most dramatic illustration of this is a report of the German Scientific Advisory Council on Transport entitled Fair Payment for Infrastructure Use: Outline of an Alternative Approach to the European Commission's White Paper (German Scientific Advisory Council on transport, 2000). This council consists of 15 professors including most of the leading names from German transport economics.

The key criticisms of the short run marginal cost approach, put forward in this paper, are as follows:

(a) It will lead to violently fluctuating prices, given that there are indivisibilities and time lags in adjusting capacity to demand
(b) It will fail to recover total cost, and result in a combination of cross subsidy and direct subsidy from taxpayers
(c) It fails to give appropriate signals for the efficient provision of infrastructure

(d) It assumes that all other markets are priced at marginal social cost and ignores indirect effects such as effects on land use.

The first point has already been discussed above and the case for some deviations from marginal social cost pricing in order to smooth fluctuations accepted. We will now discuss the other three points.

Point (b) reflects the most common objection to marginal cost pricing - that it does not recover total cost. It is clear that there is a big conflict between marginal cost pricing and recovering the total costs of providing the system. At the aggregate level, pricing to recover total cost typically implies big increase in rail and other public transport charges, and 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 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 still involve substantial marginal cost and therefore substantial charges. So the likelihood is that if you move to marginal cost pricing what you will find is that you get substantial surpluses on urban roads; they would far more than cover their costs. Whereas on rural roads and much public transport, there will be deficits. This leaves two big 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 from a number of studies that actually the surpluses in urban areas are so big that maybe the budget constraints problem is not such a big issue (Roy, 2000). But then we have a second issue, and that is - is this system equitable? Is a system whereby urban road users greatly cross-subsidise rural road users and public transport users, perceived as fair?

If the answer to either of those questions is "no", then of course we have to depart from marginal cost pricing, but that does not mean we throw the principles away. There are well-established rules for supplementing the revenue raised in the way which is least damaging to the efficiency of the system. We will then be thrown into debate about two part tariffs and about differentiating pricing structures but with marginal social cost as a starting point, and then looking for the optimal departures from that base.

The German report in a sense takes the 'dual' approach to this. It takes as its starting point the need to achieve total cost recovery on each mode, and then explores Ramsey pricing and multi-part tariffs as ways to do this with the least damage to efficiency possible. The logic behind the German position is the argument that transport infrastructure is what is known to economists as a ‘club’ good. A club good is a good where the marginal costs of use may be small but it is possible to confine use to those who funded provision of the good. The argument is that it is both fair and efficient to require users to fund provision of the good through a membership fee (vehicle excise duty, or the fixed element of a two-part tariff would be such a membership fee). It is fair because the consumers of the good are paying for it, and it is efficient because it prevents excessive lobbying for better provision at the taxpayers' expense.

Those supporting this argument generally also reject the notion of congestion as a cost that needs to be recovered through pricing. The reason is that congestion is largely a cost imposed by some users of the transport system in question on other users. Thus it is a cost that is, in total, already borne by users of the system in question without further pricing action.

Obviously whatever the structure and ownership of the transport industry, there is a sense in which total cost coverage is essential, at least in terms of the cost of providing and maintaining the infrastructure. If infrastructure managers do not receive sufficient income to pay the efficient costs of providing and maintaining the system then rundown and inadequate infrastructure is the inevitable result. The argument therefore becomes one of whether the government might provide part of that

income, perhaps out of surpluses on other infrastructure, and require appropriate expansion of capacity in return for doing so.

Point (c) reflects the problem that 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 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 that governments are not so entirely benevolent in their motives. Moreover, part of the German argument is that efficiency requires infrastructure managers to be constituted as commercial organisations exploiting private capital to fund their investment.

The final argument of the report is that the case for marginal cost pricing assumes marginal social cost pricing elsewhere in the economy. Again few advocates of marginal social cost pricing would deny this. 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 avoid distorting 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. That would not be an issue if marginal cost pricing were adopted throughout the transport sector. But the German report raises another important issue. If the costs of urban sprawl are inadequately reflected in market prices, then transport prices should be configured in part to offset this distortion and 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.

In essence, up to a point 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. Perhaps then we should talk, following Baumol and Bradford (1970) of optimal departures from marginal cost pricing rather than of marginal cost pricing itself. (Colleagues have suggested that 'marginal cost based pricing' is a phrase which reflects the fact that pure marginal cost pricing is not a sensible aim whilst sounding less negative). That of course does pose difficulties for European legislation on the subject of pricing. It is a common problem of EU Directives that, because they represent the results of political compromises, they are typically relatively unspecific and general. Directives based on the principle of optimal departures from marginal cost pricing would of necessity be vague and leave the way open for neighbouring countries to take incompatible and distorting decisions on pricing policy.

But at the end of the day there is a crucial difference between the philosophy behind the German report and the Commission approach, and it reflects a deep philosophical difference between the member states of the European Union. The Commission's approach assumes that governments will take decisions about pricing and investment in transport infrastructure. The private sector may be involved but very much as the agent of the government, for instance, under concessioning or other contractual arrangements which maintain government control of decision-taking. The German approach seeks to get away from this. Thus it sees the prime need as being to establish infrastructure managers as commercial organisations, reacting to market incentives. Yet even then the difference in philosophy is not complete. The German report does not see 100% cost coverage from users as an automatic rule; contributions from governments are possible where they are justified. A fully commercial infrastructure manager may still have the government as one of its customers, as was the case in Britain when Railtrack received grants from the Strategic Rail Authority. Again the two approaches are not so totally incompatible as they may seem.

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.

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.

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.

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 8-10%. 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.

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 (ITS, 2000; CES-KUL, 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) 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 (ITS, 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 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 (although the German critique included the argument that there was no agreement even about measuring congestion costs)
- 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 tends 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 (Schade and Schlag, 2001), PATS (TIS, 2000) and PRIMA (Harsman and Wijkmark, 2000), 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, 2000). 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, 2001a) requires that charges be based on marginal social costs, but with non-discriminatory mark-ups permitted where required for budgetary purposes 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.

There is thus now a Directive coming into force which will implement marginal social cost pricing, or something above that, for rail infrastructure, with almost certainly a greater disparity between marginal social cost and price for the final consumer. At the same time very slow progress is being made in terms of charging for the use of roads. This raises serious second best considerations. As long as heavy goods vehicles in long distance freight traffic are undercharged, charging at or above marginal cost for rail may actually worsen efficiency rather than improve it. For passenger traffic the position is less clear, but the regime may actually favour rail relative to road in long distance markets, whilst leading to too little rail traffic in congested areas.

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.

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. It is the exploration of issues such as these, and the attempt to find solutions to them that command a fair degree of consensus, that form the basis of this project.

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FIGURE 1

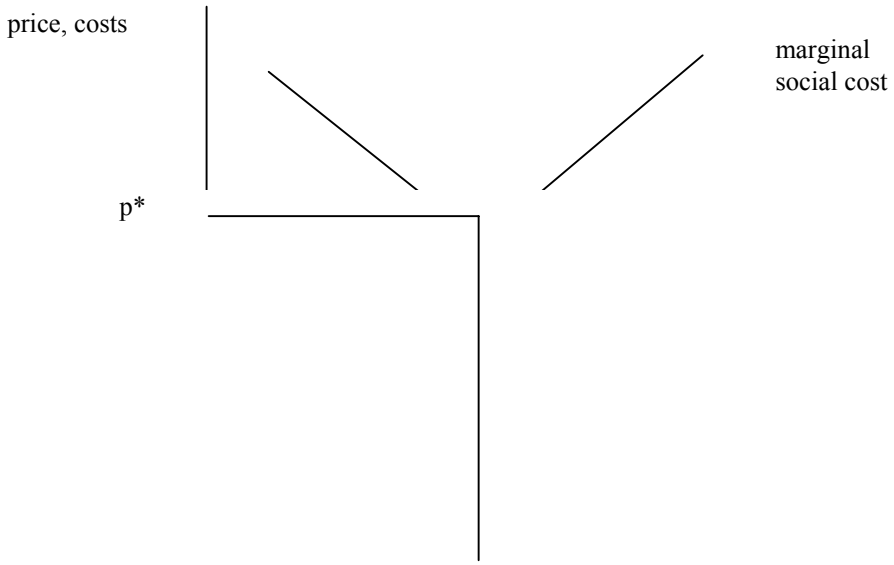

Table 3
CHANGES IN FREIGHT PRICES
(ECU/100 tonne km)
(change compared to 2010 base situation)

Case Study	Cost Estimates	HGV	Train
Cross Channel	low	+1.21	+1.50
	high	+2.04	+1.61
Finnish	low	+1.13	-0.27
	high	+1.58	-0.26
Transalpine	low	-4.80	+0.28
	high	-1.19	+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	+1.2	-3.0
	high	-1.5	+4.0
Finnish	low	-5.9	+7.4
	high	-7.9	+9.7
Transalpine	low	+3.1	-12.5
	high	+0.1	-1.7

Source: As Table 1