Final Report for Publication

PRICING EUROPEAN TRANSPORT SYSTEMS

PETS

ST 96 SC 172

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Project Duration: 22/06/1996 – 21/06/1999

December 2000

PROJECT FUNDED BY THE EUROPEAN
COMMISSION UNDER THE TRANSPORT
RTD PROGRAMME OF THE
4th FRAMEWORK PROGRAMME

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Executive Summary

The main objectives of PETS were:

1. to examine the current pricing situation of passenger and freight modes in Member States;
2. to assess whether such prices provide appropriate price signals in the light of all relevant internal and external costs; and,
3. to forecast the consequences of moving to a more appropriate price level and structure in the light of transport demand and supply developments – as well as financial and other constraints.

The project was divided into three main phases:

- Phase I: Review – where a comprehensive review of theory, current practice and pricing trends, and empirical estimates of appropriate price components were constructed;
- Phase II: Conduct of Case Studies – during which 5 case studies covering a variety of contexts were carried out in order to determine the appropriateness of existing prices and the impact of moving to prices that better reflect external costs; and,
- Phase III: Synthesis and Conclusions – during which the Phase I and Phase II findings are drawn together and the pricing policy implications established.

The methodological approach used in the conduct of case studies was to fully identify the producer, user and external costs associated with passenger and freight transport and to compare the prices associated with those categories with existing taxation and charging levels and structures. This was carried out for the year 2010, for the case studies:

- Cross Channel passenger and freight study;
- Transalpine Freight study;
- Finnish passenger and freight study;
- Oslo-Gothenburg passenger study; and,
- Lisbon, Tagus Crossing passenger study.

Each of the case studies included all the key passenger and/or freight modes of relevance in the study area in a modelling framework.

The key conclusions reached are as follows:

1. A major conclusion is that the methodology to calculate marginal social cost for all modes exists, although many of the valuations remain subject to considerable uncertainty. No support is found for the argument which says that the concept of marginal cost pricing cannot be implemented in practice because it is unmeasurable. However, this does not mean that all the relevant agencies currently possess the information and ability to estimate marginal social cost, so further efforts to disseminate this may be needed. The case studies have illustrated that marginal social cost may be estimated for a range of circumstances in a range of countries.

2. It has been shown that a purely commercial approach to transport pricing is not appropriate and may push prices in the wrong direction. The reason is the prevalence in the transport sector of economies of scale, including the Mohring effect, whereby increases in demand for scheduled public transport services lead to increased service frequency and therefore better services for existing passengers, and because of the importance of externalities. Whilst the former lead to commercial prices being too high, and the latter too low, the relative strength of the two effects differs enormously between the modes and locations.

3. In measuring externalities for pricing purposes, it is important to estimate the marginal external cost rather than starting with the total cost and then dividing it by the amount of traffic. This is particularly important in the case of congestion, accidents, and noise, for which there are important non-linearities.

4. The effects of moving to a more efficient pricing system are likely to be diverse, both because of differing circumstances between countries and because of different starting points. For instance, in some countries rail fares are held very low, whereas in others they are close to commercial levels. This makes it difficult to generalise about the effects of efficient pricing from a small number of case studies.

5. Further extension of deregulation and commercialisation may not necessarily benefit rail transport in terms of the relative level of price compared with other modes as - while the process has led to substantial reductions in terms of prices in road freight and air transport - it has tended to raise prices for bus and rail. The explanation is in terms of the very different starting points in terms of pricing policies and subsidies between the modes. However, recent trends may imply that significant scope remains for reductions in unit costs in the bus and rail industries.

6. The simple belief that a move to more efficient pricing would uniformly benefit the more environmentally friendly modes at the expense of other modes is also found to be not universally true. For instance, the current price of inter urban motoring is seen to be too high relative to 2010 marginal social cost. This gives little support for the introduction of additional charges on inter-urban roads except for specific cases of serious congestion or especially strong environmental effects. On the other hand, the case for urban road pricing in congested cities is reaffirmed. Similarly whilst there is generally a case for lower prices and increased traffic for public transport, in some cases existing subsidies are already excessive. Only in the urban case study is a substantial diversion of traffic to public transport justified.

7. In the case of road freight, the picture is mixed but generally there is under-charging of long distance road freight. This is partly a problem of the structure of the existing taxation system. Fuel taxes do not increase sufficiently with the weight (and particularly the axleweight) of the vehicle to reflect the marginal social cost of heavy vehicles. An annual charge over-charges low mileage vehicles and under-charges vehicles used intensively on long distance work. Even the vignette, as currently utilised, is related to

time rather than distance run. Thus there is a clear case for reform of road freight vehicle taxation, to introduce a charge based both on vehicle characteristics and distance travelled.

1. Objectives of the PETS Project

The intention of the project was to provide practical advice on how to establish appropriate pricing policies and on what the consequences of changing transport prices would be, rather than to further extend the long running academic debate on appropriate transport pricing. Consequences in terms of volume of traffic, choice of mode and aspects such as environmental impacts are of interest. What is new about PETS is the application of existing knowledge to the specification and testing of optimal pricing policies in the context of real corridors.

The main objectives of the PETS project were:

- to inform the Commission of the current situation regarding the pricing of transport modes in member countries;
- to examine the degree to which this provides appropriate price signals in the light of all relevant internal and external costs; and,
- to forecast the consequences of moving to a more appropriate price structure and level, for road, rail, air and short sea shipping transport bearing in mind other likely developments affecting transport prices, and in particular further deregulation of rail and air services, as well as financial and other constraints.

It is helpful to break these three main objectives down into a series of key questions. In pursuit of its three main objectives, the PETS project asks 5 key questions:

1. What should prices be?
2. What are current prices?
3. How close are current prices to what they should be?
4. How should current prices change?
5. What are the consequences of this change?

The principal output of the project is this final report containing detailed recommendations on how to apply optimal pricing policies to each of the above modes and showing the result of implementing the recommended policies on a series of 5 case study corridors combining problems of congestion, geographical and environmental barriers to movement and peripherality.

The chapters in this report are divided into four main sections. Part one of the report comprises Chapters 1 and 2, setting out the context of the project, its objectives and the means by which those objectives were pursued. Part two of the report, comprising Chapters 3-7 sets out the findings of the theoretical component of the project and of the gathering of evidence on current pricing practices across Europe. As such, part two summarises the review stage of the project and provides answers to the first three of the key questions above. Part three, comprising Chapters 8-13 summarises the work undertaken for the five PETS case studies. In doing so it reflects further on the first three of the key questions identified above, as well as providing answers, given differing sets of circumstances, to the fourth key question relating to the consequences of appropriate pricing policies. The final part of the report, comprising Chapter 14 distils the main conclusions from the project, how these conclusions relate to the conclusions from other pricing projects and the implications for the future research agenda in the pricing field.

2. Means Used to Achieve the Objectives

The means used to achieve the objectives were:

?? elaboration of pricing principles – through the examination and development of micro-economic theory applicable to all forms of passenger and freight transport, a framework suitable for the pricing of transport infrastructure use and scheduled public transport was created;

?? development of approaches to the valuation of externalities – by means of building upon the pricing principles and reviewing state of the art valuation studies, guidance was provided on estimating prices for use in the internalisation of externalities;

?? assessment of the current pricing situation in Member States – through the review of current taxation and charging arrangements in Member States, the degree to which efficient pricing policies are currently in use in the various transport sectors was established;

?? analysis of trends in deregulation – quantitative techniques, including the use of econometrics, were used to understand existing and likely future trends in deregulation, and whether trends in different transport sectors would make a positive or negative contribution in moving towards more appropriate pricing;

?? examination of practical pricing problems – through a review of the main technical and organisational issues, the potential opportunities and constraints on pricing policy development were identified; and,

?? conduct of five case studies of strategic transport corridors – by means of the development of studies based on the PETS pricing principles it was possible to explore how taxes and charges compared with relevant marginal costs in a range of contexts for the year 2010; implementation of the implied price changes within a modelling framework enabled conclusions to be drawn on the implications for transport demand and related costs and benefits to be drawn.

3. Pricing Principles

3.1 The Reasons for Establishing Pricing Principles

Pricing principles were explored in order to establish a common methodology for transport pricing decisions that would provide the basis for the PETS case studies as well as being an important output in itself (Jansson and Lindberg, 1998). The three key questions to be addressed through this analysis were therefore:

- what does efficient pricing mean in practice for transport infrastructure and public transport services
- what are the likely financial consequences of following this pricing rule?
- given these conclusions, what alternative pricing scenarios should be adopted in the case studies?

In addressing these questions a number of important related issues will be raised. Firstly, to identify the ideal pricing rule the objective of pricing must be clearly stated. PETS has adopted efficiency, through the maximisation of social surplus, as the primary pricing objective. Cost recovery is considered as the secondary objective and is reflected in the consideration of the financial implications of the efficiency maximising pricing rule (see Section 3.3).

Secondly, there should be clarity in defining the cost categories relevant to the derivation of prices. Throughout PETS cost categories under three main headings were considered:

- producer costs;
- user costs; and
- costs external to the transport sector.

All three categories are considered in this chapter, with user costs and external costs discussed in more depth in Chapter 4.

Thirdly, some comments should be made on how a single pricing rule for transport is applied to different aspects of the transport system. The markets for transport infrastructure and for transport services are different; therefore, price-setting in these markets should, especially given trends towards a vertically separated transport system, be considered separately. There may also be important issues relating to the markets for particular transport modes.

Two of the basic distinguishing characteristics of these markets are:

- the structure of the production cost functions; and
- the large share of the total costs of production of transport services made up of user cost, such as travel time

To clarify how these characteristics influence optimal pricing principles, reference is made to the price-relevant producer cost, user cost, and transport system-external cost.

3.2 The Choice of Pricing Rule for PETS

The starting point of much of the PETS analysis is that social surplus is maximised when price is set to equal to social marginal cost. However, transport "users" are both suppliers of essential inputs and, obviously, consumers of the output. The optimal price will, therefore, differ from the usual definition of social marginal cost, the derivative of the total social cost (TSC) with respect to output, or traffic volume (Q). Note that total social cost is the sum of producer costs, user costs and costs external to the transport sector:

$$TSC = TC_{Prod} + TC_{User} + TC_{Ext}$$

where TC_{Prod}, TC_{User} and TC_{Ext} are functions of Q.

3.3 Pricing Transport Infrastructure

In the case of transport infrastructure services, the definition of the price-relevant marginal cost is the following:

$$MC = MC_{prod} + Q \frac{?\,AC_{user}}{?Q} + MC_{ext} \qquad (1)$$

The reason this differs from marginal social cost is that the part of user cost already borne by the individual user making the decision is not relevant to the price that should be charged; only user costs imposed on others should be included in the price[1].

The relationships between user costs and traffic volume, and, as regards road services, the relationships between external costs and traffic volume, are more important for the setting of optimal prices for transport infrastructure services than is the relationship between producer operating costs and traffic volume. Given the time lags and indivisibilities involved in adjusting transport infrastructure to demand, it is assumed that pricing policy should be based on short run marginal cost, that is marginal cost incurred from adding traffic to a fixed transport infrastructure. If transport infrastructure is optimal, this will however be equal to long run marginal cost. Assuming transport infrastructure to be fixed, the main conclusion both for road and rail track producer operating costs is that empirical evidence suggests that the level of the price-relevant marginal producer cost falls well short of the average producer cost. The revenue from charges based on the price-relevant marginal producer cost will thus fall short of recovering total producer costs, before other price components are considered.

For roads, the price-relevant marginal producer cost of infrastructure use is made up of the costs of current maintenance and the large, but less frequent, costs of reconstruction and resurfacing. Current maintenance plays a secondary role in calculating the price-relevant marginal cost, partly because the relationships are not fully understood.

[1] $TC_{user} = Q*AC_{user}$; $dTC_{user}/dQ = QdAC_{user}/dQ + AC_{user}$; the last component ($AC_{user}$) is already internalised.

The cost of reconstruction and resurfacing is the more relevant. Road vehicles damage the pavement and advance the date when repairs are needed, and the damaged pavement increases the vehicle operating cost for other users of the road; though for some types of vehicle the user cost component is insignificant. The conventional rule is that the damaging power of a vehicle axle on paved roads is approximately proportional to the fourth power of its axle weights. This 'fourth power rule' results in huge differences in the damaging effect between vehicles of different weight and axle configuration, private cars having relatively insignificant damaging potential. One of the conclusions is that the price-relevant marginal cost is the ratio between the resurfacing cost and the cumulative (standard) axles for which the surface is designed, corrected for climate, interest rate, and useful life. This cost will mainly fall on the heavier vehicle s.

For rail track, the price-relevant marginal producer cost of infrastructure use is again made up of current maintenance and of reconstruction costs, again with current maintenance playing a secondary role. Price-relevant marginal costs of rail track services can, hence, be developed within a similar framework to that for roads.

The price-relevant cost of reconstruction mainly consists of the cost related to the reduced lifetime of the current track and the consequent increase in the present value of all future track reconstruction. For passenger trains the axle loading is often low enough to be ignored and although firm conclusions on how the damage and maintenance cost increase with freight train axle loading are not drawn, it is concluded that this relationship is less progressive than the "fourth power rule" of the road sector.

The second component may contribute to infrastructure capital cost recovery is the user cost component. However, the optimal charge is extremely different for different facilities of a particular mode of transport. The fundamental feature is that for transport infrastructure facilities of relatively low capacity, found primarily in rural and minor urban areas, the contribution from optimal pricing is rather modest, whereas for facilities for major cities the contribution would typically well exceed the capacity costs, especially if capacity-expanding investments lag behind demand growth.

For user costs, a basic distinction is made between:

?? "common" transport infrastructure facilities - a road; and

?? "departmentalised" transport infrastructure facilities - airports, seaports and other terminals where a slot or berth is assigned to the users one at a time.

With a common facility, the users' interference with each other results in time costs, as users reduce speed to avoid collisions when traffic density goes up, and in accident costs, when multi-vehicle accidents occur despite speed moderation.

The user costs of transport infrastructure services produced as departmentalised facilities consist of delays and scarcity time costs incurred at occasions of excess demand. For railways, excess demand will lead to delays, though these should be provided for in the scheduling. The train operator cannot, however, avoid rail track scarcit y costs; if there is just one train operator in the system they are internalised in the planning of the timetable but where a number of train companies are using the same rail track, a system of access charges should be levied to reflect the opportunity cost of the slot.

Airport prices can be divided into (passenger and luggage) handling charges, and runway occupancy charges (or aircraft landing/take-off charges). The latter has similar characteristics to the rail infrastructure slot charge.

In seaports and inland freight terminals serving several road hauliers, queuing models are applicable for calculating the price-relevant user cost component. The total price can be divided into handling charges for loading and unloading, and charges for occupying a service station of the facility concerned. The latter could be based on the queuing costs inflicted on subsequent users of the facility. Demand typically has a substantial random component, but also exhibits systematic variations, which should form the basis for peak-load pricing.

External costs of transport infrastructure comprise all costs imposed on third parties by transport infrastructure use. PETS has focused, in particular, on accident costs, noise, air pollution and global warming. There are clearly ethical limits which constrain the boundaries within which pricing policies can operate but with a given regulatory framework of standards, pricing policy may provide appropriate incentives to reduce external costs beyond the minimum standard.

Because the price-relevant marginal cost of non-urban roads, railways, smaller airports and seaports is normally well below the average producer cost the question of who should meet the resulting financial deficit arises.

The surplus from externality charges (particularly those on fossil fuels) could potentially offset a deficit from charges related to producer and user costs.

Note that in the efficient situation fuel taxes and/or electronic kilometre charges should not be earmarked for investments in the road network from where the revenue originates. Road investments should be financed by grants from central or local governments and prioritised by cost-benefit analysis. This is particularly pertinent so far as externality charges are concerned: it would be unreasonable to have the investment funding positively related to the volume of negative externalities produced.

The long-run counterpart to the efficient allocation of short-run variable resources by optimal pricing in the transport infrastructure sector, is investment project prioritisation by cost-benefit analysis. The financial result of an individual project, or an investment program for a particular mode and/or region is inconsequential for the investment resource allocation in this case, and the revenue goes anyway to the Treasury. The possible financial constraints imposed should be regarded as an expression of interest for equity concerns.

In urban areas congestion tolls (in addition to externality charges for accidents, noise, and air pollution) are well above the road capacity costs. The net effect of optimal pricing of transport infrastructure may lead to cross subsidisation from urban to interurban and rural areas and from road to rail.

3.4 Pricing Scheduled Public Transport

The basic three-term MC-formula (equation 1, above), applicable to transport infrastructure services, is reduced to a two-term formula for scheduled public transport.

$$MC = MC_{prod} + B\frac{dAC_{user}}{dB} \qquad (2)$$

The number of trips by the public transport system concerned, B, replaces the traffic volume, Q, and the external marginal cost appears as charges on the vehicles payable by the public transport company. These charges are part of MC_{prod} in equation (2), and will consequently be passed on to the public transport passengers through fares.

It is argued here that the size of the vehicle fleet should be regarded as variable in the costing and pricing analysis, as opposed to previous work (e.g. Mohring, 1972) where it was assumed to be fixed. Unlike the case of infrastructure, the vehicle fleet, and particularly that allocated to any particular service, may usually be quickly adjusted to changes in circumstances by changes in acquisitions and disposals, including via second hand markets. It should be added, however, that although each of the two price-relevant cost components of (2) will take quite different values depending on the way in which additional passengers or freight are added, the sum of the two components is the same in the optimum irrespective of how capacity is augmented. Three examples illustrate this point:

(1) By increasing the occupancy rate, additional passengers or freight shipments can be accommodated without any significant additional producer inputs. This can, however, increase user costs. Hence MC will solely consist of a user cost component, representing queuing and/or crowding costs of passengers or freight.

(2) By increasing the number of vehicles, additional customers are accommodated, MC_{prod} will be fairly substantial, while the user cost component will become negative due to the more frequent service offered to existing users.

(3) By increasing vehicle size, additional customers are accommodated, MC_{prod} is positive (but less than in 2) and user cost remains largely unchanged.

These general principles result in different figures for the marginal cost components depending upon how steeply the average producer cost falls and whether the demand base is sufficient to exploit at least the greater part of the economies of density of demand.

The formula for the financial result of first-best optimal pricing can be written as the ratio of the optimal price to the average producer cost, i.e. the "financial result" of first-best pricing at the optimum:

$$\frac{MC}{AC_{prod}} = \frac{1}{E} + \frac{AC_{user}}{AC_{prod}}\left(\frac{1}{E} - 1\right) \qquad (3)$$

where:

MC = price-relevant marginal cost (which should equal the price in optimum)

AC_{prod} = average scheduled PT-producer cost

AC_{user} = average scheduled PT-user cost

E = scale-elasticity of the production function. (1/E = total producer and user cost elasticity with respect to the density of demand)

The production function, for which the scale-elasticity, E is defined, includes both producer and user inputs. The total cost elasticity with respect to the density of demand, 1/E, is one crucial determinant for the ratio of MC to AC_{prod}. The other determinant which becomes more important as 1/E deviates from unity, is the relative importance of the user costs. The key issues for different sub-sectors of the SPT market are discussed in turn.

In local public transport the economies of density of demand are very pronounced, and the share of the user costs, including walking, waiting, and riding time costs, is relatively big, which together work to make the MC/AC_{prod} ratio quite low.

The pricing policy conflict between allocative efficiency and full cost recovery is apparent. To the extent that price discrimination may be used to charge higher prices to those willing to pay more, without loss of traffic, the conflict may be overcome. Successful, more extensive price discrimination is rather difficult to achieve in local and regional train and bus transport services. In practise the main fare differentiation is by distance, and between single journey tickets and various travel cards for regular public transport users. In both cases demand-side considerations play a certain role. However, there seems to be no way of attracting customers with high purchasing power at high prices, so that tax-payers at large would have to finance the deficit resulting from maintaining the first-best optimal fare level. As long as urban road pricing does not exist, and the environmental problems of urban car traffic remain, this subsidisation seems to be generally accepted in most European countries. The very limited application of peak-load pricing in urban public transport, on the other hand, is deplorable. It is true that it would not make a decisive difference for the modal split in the short and medium term if the price-relevant cost differential between peak and off-peak travel were introduced in urban public transport, but it would be a change in the right direction, which in the longer term might be quite effective.

The sub-sector comprising domestic airlines, middle-distance train and coach services is also generally characterised by a low value of 1/E due to the additional fact of a generally very "limited extent of the market", and a considerable user cost share in total costs. It is noticeable that the economies of vehicle size are far from exhausted on many lines: short trains and small aircraft abound.

However, the opportunities for price differentiation are much stronger; advance purchase tickets, restrictions on time of travel and higher fares for extra comfort are all possible.

Nevertheless, it is not clear that this generally leads to appropriate peak load pricing. This is regrettable, because a good grasp of the marginal cost structure is at least as important for setting second-best train fares that meet a budget constraint, as shrewd market segmentation and "charging what the traffic can bear".

For long-distance services, the Mohring effect is relatively weak, and as a consequence the value of 1/E is close to unity. The preferred departure times for a large majority of travellers are in a rather narrow interval in the morning and evening, respectively. Therefore the MC/AC_{prod} ratio is as a rule close to unity, and subsidies to services are not required. Note however that the assumption is of marginal cost pricing of infrastructure, and infrastructure subsidies may well be required.

3.5 Definition of Pricing Scenarios for the PETS Case Studies

On the basis of this discussion, three core alternative scenarios for pricing policy were proposed for the PETS case studies, conducted for the year 2010. These were:

1. Unconstrained Marginal Cost Pricing - where economic efficiency is the sole determinant of pricing, implying prices are set equal to the price relevant marginal costs, with no other constraints being included.
2. Marginal Cost Pricing Subject to a Budget Constraint - where economic efficiency via marginal cost pricing remains the goal, but present revenues from the transport sector should be maintained. This may require the use of two-part tariffs and/or Ramsey pricing. Other constraints may also be included to make this scenario a more relevant, practical one.
3. (Optional) Full Internal and External Cost Recovery, including infrastructure and environmental costs - where a constraint that transport users in total pay all transport infrastructure and external costs is imposed. Other constraints may also be included.

Scenario 1 draws directly from the core PETS pricing principles, whereas Scenarios 2 and 3 progressively add financial and political dimensions which require some degree of movement away from the core PETS pricing principles. Scenario 3 was to be explored at the discretion of case study leaders. In addition, case study leaders were able to choose to develop further scenarios to examine specific issues of interest in the context of their particular case study.

4. Developing Values for Externalities

4.1 Establishing the Valuation Basis

The purpose of studying externalities was to provide methodologies and values for key cost categories for use in the case studies. As such it aimed to elaborate the analysis described in Chapter 3, bringing into operation the pricing principles set out there. This chapter summarises Christensen et al. (1998). The four key questions to be answered by this part of the work were therefore:

- how do externalities arise?
- how should they be quantified and valued?
- what empirical estimates are provided by recent studies?
- how transferable are these estimated values?

The primary focus of this section relates to marginal external costs of infrastructure use.

In the ExternE project externalities are defined as an effect arising "when the social or economic activities of one group of persons has an impact on another group and when that impact is not accounted for by the first group" (European Commission, 1995). For pricing purposes, however, it is impacts on individuals rather than on groups that are relevant. PETS focuses on technological externalities relating to real resource costs. Externalities arise as a result of both infrastructure provision and infrastructure use. For pricing purposes the main emphasis is on infrastructure use externalities. The externalities considered are congestion, accidents, air pollution, noise and global warming. Externalities of use that are not considered are visual degradation, barrier effects of moving traffic, or water pollution.

The extent to which a negative impact should be reduced, or abated, depends on its marginal external cost and on the marginal cost of abatement[2]. This necessitates specification of both the marginal external cost function and the marginal abatement cost function.

4.2 How do Externalities Arise?

External congestion costs occur between vehicles when the presence of one vehicle increases the journey time of another. For passenger transport there is a distinction between delay (increased journey time) and travel in highly congested conditions, as there is evidence to suggest that people value time spent in congested conditions more highly than time spent in uncongested conditions.

External accident costs imposed on other road users arise out of changes in the risk of an accident occurring with the entry of an additional vehicle to the system. When a vehicle enters into the traffic flow the user:

- exposes himself to the average accident risk for that transport mode;

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[2] The cost of reducing the externality consists of benefit loss or abatement costs, whichever is less costly.

- ?? may increase or decrease the accident risk for all other users of the same mode;
- ?? may increase or decrease the accident risk for users of other transport modes.

Air pollution costs arise from emissions from traffic, the main pollutants being nitrogen oxides, carbon dioxide, particles, carbon monoxide, VOCs, SO_2, and indirect emissions of ozone and acid aerosols. Global warming, the rise in the earth's atmospheric temperature due to man-made emissions of greenhouse gases, describes an important sub-group of external air pollution costs. There is a wide range of potential impacts of global warming, not all of which are necessarily negative but which include the very small possibility of a catastrophe. Whilst there is a wide consensus that temperatures will rise, there is some uncertainty about the size of the temperature increase and much more uncertainty about the forecast impacts.

Noise is a subjective description of sound. The perception of it depends on the frequency involved, the sonar energy and its duration and regularity. Commonly the unit dB(A) is used to integrate these variables to a single indicator. Unlike air pollution, noise does not generally cause instant physical damages to people who are exposed to it. Nevertheless, transport noise leads to various disamenities.

4.3 How Should Externalities be Quantified and Valued?

To determine marginal costs and benefits, the impacts of externalities have to be valued. In cases where market prices do not exist or are not suitable this valuation is based on the Hicksian concepts of compensating or equivalent variation, as determined by any of the following measures:

- ?? how much a person is willing to pay for an improvement;
- ?? how much a person has to be paid to accept a deterioration;
- ?? how much a person is willing to pay to avoid the deterioration; or
- ?? how much a person must be compensated for the absence of an improvement.

There are two main groups of valuation methods, revealed preference methods, which use people's actual behaviour in actual markets, and stated preference methods, which use people's responses to (more or less) direct questions about their valuation, given a set of described circumstances. Both are theoretically acceptable methods of evaluation so neither method is recommended above the other.

Two problems arise with both valuation methods. Firstly, using willingness to pay as an indicator gives more weight to people with higher incomes, though this problem may be avoided by weighting the values in a way that takes income into account. Secondly, for externalities that entail cost in the future, there is a tendency for people to regard future costs and benefits as having a lower value than the same costs and benefits today. This can be accounted for by applying a discount rate to the future stream of costs and benefits, though there is no consensus or theoretical justification for any particular discount rate.

For many categories of externality valuation estimation can be via either top-down or bottom-up approaches. The top-down approach gives a form of average cost. The basis for the estimation is a geographical unit, e.g. a country. The total cost due to an externality is calculated for this geographical unit and this cost is then divided by the total amount of activity leading to the externality. In the case of air pollution, such a national average, however, under-estimates costs for urban areas and over-estimates costs for rural areas. The bottom-up approach is a micro-level approach, as employed, for example, in the QUITS project. In this work the marginal external costs of one vehicle for a single trip is calculated by modelling the path from emissions to impacts and costs.

It is important that the right impacts are valued and that the connection between the activities causing the externality and the welfare loss arising from the externality is understood. The connection can be described by the following causal chain, using air pollution as the example:

A? D? Q? X? W

A is a production or consumption activity that leads to an externality, for example, driving leading to air pollution. D are the emissions connected with driving, for example NO_X and particles. Emissions are expressed relative to the amount of activity, for example NO_X grammes per vehicle km. Q is the state of the emitted substances in nature. This is measured by the ambient concentration of emitted substances or derived compounds. In the example this is the concentration of NO_X or ozone (produced from hydrocarbons and NO_X) in air. X are the effects or impacts caused by the concentration of pollutants Q. The impacts can be directly on people, e.g. health impacts, or can have an indirect impact on people's welfare through consumption and production patterns, e.g. crop damages and damages to buildings. W is the welfare loss inflicted by the impact X measured by the willingness to pay (WTP) to avoid the damages.

The externality of the activity A is the welfare loss W of the impact X. The impact pathway method therefore entails valuing the impacts, combining the empirical determination of the connection between emissions or concentrations of pollutants and impacts.

Marginal congestion costs comprise the additional time costs and vehicle operating costs imposed on others by an additional unit of travel. For road, the calculation of additional travel time can be done using speed flow relationships, for the corridor in question. Likewise the calculation of vehicle operating costs can be done using standard formulae developed for the purposes of evaluation. However, for rail and air the calculation of delay and rescheduling is more problematic and methods are less well developed. Capacity is controlled through the allocation of slots and the main consequence of full capacity is a shift in departure times.

For accidents, the user internalises in her decision the risk she exposes herself to, valued as the willingness-to-pay of her household. They may, or may not, have taken the willingness-to-pay of relatives and friends into account - results are presented with this item both as an external and as an internal cost. The remaining cost, the marginal external accident cost, then comprises:

- the expected cost to the rest of society when the user exposes herself to additional risk - mainly medical and hospital costs;
- the willingness-to-pay of the household, relatives and friends and the rest of society related to the increase or decrease in the accident risk for all other users of the same mode; and
- the willingness-to-pay of the household, relatives and friends and the rest of society related to the changed accident risk in other modes of transport.

For air pollution, one of the most promising methods for valuing the different impacts of air pollution is the impact pathway approach developed by the EU JOULE-financed ExternE projects. This method is used to estimate the value of, for example, health impacts, damage to construction materials, fouling and crop losses. The reliability of results varies and there are still uncovered end-points (impacts) and pollutants. Information on the impacts on cultural heritage assets, forest damage, recreational value of nature, aquatic environment, fauna, visibility and biodiversity is still insufficient.

The preferred method of calculating the costs of global warming is to calculate the costs of actual future damages due to climate change. The marginal cost of CO_2 (the main climate change gas) emissions, usually expressed as cost per tonne of carbon emitted, is the extra damage incurred by adding a tonne of carbon to emissions. Since damages are dependent on the concentration of CO_2, a stock variable, while emissions is a flow variable, the association between emissions and damages is complicated. Given a set of assumptions about the past and future path of emissions, marginal cost is calculated as the difference between damage costs with and without a pulse of CO_2 emissions. However, calculating the present value of damages for an actual emission path requires knowledge of the cost of damages for all times in the period considered, or the damages for different temperature increase. No study has made such extensive damage calculations. Damage costs are usually determined for a doubling of CO_2 equivalent, assuming optimal adaptation. A further complicating factor is that damages are dependent not just on temperature level, but also on the rate of change in temperature. In addition, damages from global warming lie in the future so the discounted cost will therefore be sensitive to the choice of discount rate.

Monetary evaluation of noise disturbance per affected person can make use of several methods:

- change in the market value of properties (hedonic pricing);
- cost of medical care and production losses;
- cost for abatement measures;
- cost for avoidance or prevention; and,
- willingness to pay, based on questionnaires.

It is generally accepted that direct valuation by revealed (hedonic pricing) or stated preference methods is the most appropriate approach.

4.4 The Valuation of Congestion

For values of time the use of local, which most often means national, values is generally recommended – as opposed to Europe-wide averages. For passenger travel in working time, there are established values based on the cost of employing workers. For passenger travel in non-working time, the use of empirically determined national values is recommended, or, in the absence of these, by factoring the wage rate by 25%.

Beyond this, there is evidence that inter-urban travel is valued more highly than urban travel, on which most values of time are based (Wardman, 1998). The recommendation is therefore made that for inter-urban travel (over 50 kms) the value of time should be increased by 60%, except for air leisure but including air business travel. Air travel is normally inter-urban or international and again values of time are higher. It is recommended that values of time for air should be increased by another 50% (in addition to the 60% for inter-urban for business only).

Time spent in road congestion is also valued more highly by passengers. It is thus recommended that time on congested conditions (for passengers only) is valued at 150% of normal time. For rail and air the appropriate values for delay/late and wait time should be used and added to congestion if both are present. Suggested values are shown in Table 4.1.

Table 4.1: Weights for Journey Time Components

Weight for	Working time	Non-working time
Wait time	1.31	2.0
Delay/late time	1.16	1.5
Reliability ratio	1.0	1.0

Note: relative to in-vehicle time.

For road freight transport, a value of around 37 ECU per hour should be used for LGVs. The value of time for HGVs should be 10% more, at 41 ECUs per hour. The value of time for rail should be only 25% that for LGV. If the proportion of the driver costs of these recommended values can be established, then different values across countries can be used according to variations in drivers' wage rates.

Reliability is generally highly valued by freight operators. The recommendation is made that a value of reliability (defined as a percentage of on time arrivals) of 5% of the freight rate for a 1% improvement in reliability - i.e. the proportion of consignments arriving on time (Tweddle et al, 1995).

4.5 Accident Valuation

Fatality and injury risk varies widely between different Member States so the relevant accident externality charge should be estimated for each Member State. For values per casualty or per accident the following recommendations apply:

a. the willingness-to-pay value for a statistical life should be based on stated preference techniques. – This value comprises approximately 90% of the total cost of fatalities, 80% of severe injuries and 60% of slight injuries.

b. regarding willingness-to-pay for safety on the part of relatives and friends, in the absence of results from any recent study focused on this question it is suggested that this component may be 40% of the a-component is suggested.

c. country specific estimates of the net material losses, i.e. the cost of medical treatment, net lost output, property damage and administration.

The relevant accident statistic should be expressed in risks for "occupants" and "non-occupants" respectively. Country specific information should be used and if possible statistics relating to the corridor in question.

On interurban roads marginal external accident cost is likely to be low because the risk elasticity related to intrasystem accidents is negligible and the number of intersystem accidents is limited. For heavy goods vehicles the externality charges are expected to be higher because, even on interurban roads, a significant number of accidents involving other user groups occur. In urban areas the magnitude of the marginal accident cost will be much higher and the structure more complex than on interurban roads. On balance, the total external marginal cost will be u-shaped with decreasing costs at low traffic volumes and slowly increasing costs at higher traffic volumes.

Railway transport is generally a safe transport mode. The risks for the groups of railway users are limited, but the risk for road users in some countries may be significant, e.g. car users at level crossings, and have important implications for the size of the external component.

For accident risk per flight kilometre it is assumed that accidents only affect the occupants themselves.

4.6 The Valuation of Air Pollution

For air pollution, the findings of some of the latest European research projects were examined including: ExternE Transport (Bickel, 1997); QUITS (Weinreich et al, 1998); IWW-Infras (Mauch & Rothengatter, 1994); Perkins (1997), Trenen II Stran; Mayeres et al. (1997); and, national studies in Finland, France, Sweden and Switzerland.

ExternE Transport analysed passenger and goods transport by road, rail and inland waterway via case studies in Germany, the UK, the Netherlands, France, Greece and Italy. It concluded that health impacts dominate the quantified damages and that the population density along the road is a key parameter for the magnitude of impacts, particularly with diesel-fuelled vehicles.

The external costs caused by airborne pollutants from diesel cars and three-way-catalyst passenger cars are shown in Table 4.2. As regards trains, the cost of damage per passenger kilometre (pkm) ranges from ECU 1.1, for high-speed trains in the Netherlands, to ECU 6.6/1000 pkm, for diesel trains in Greece.

Table 4.2: External Costs due to Airborne Pollutants (ECU/ 1000 vkm)

Vehicle	Agglomerations[1]			Urban areas			Non-urban areas (motorway drive)	
	Paris	Athens	Milan	Stuttgart	Amsterdam	Barnsley	Stuttgart-Mannheim	Tiel drive
Diesel car	559.1			63.0	84.8	103.9	28.2	36.1
TWC car[2]	72.9	6.2[3]	7.4[3]	9.2	4.5	9.7	7.8	4.5

Notes: 1 Agglomeration = high population density over a large area
2 TWC car = three-way -catalyst passenger car
3 Does not include primary particles

The QUITS Project uses a bottom-up approach, similar to that introduced in the ExternE Project, to calculate the environmental and health externalities caused by air pollutants from road, railway and air on three routes; Frankfurt-Milan, London-Lille and Patras-Munich. The costs of air pollution on the first reference route caused by road traffic in 1995 were estimated. The costs are ECU 95/1000 vehicle km and ECU 69/1000 passenger km. Some of the external costs of railway traffic are caused by electricity generation and therefore depend highly on the fuel mix used. The costs of air pollution on the reference route caused by railway traffic were estimated at ECU 0.4 million in 1995, ECU 0.068 per train-km and 0.22 per 1000 passenger-km.

Unlike for other impacts of transport, a single set of unit values is not recommended for air pollution because externalities are specific in time, place and context. Instead, valuation principles are given. However, it is possible to use existing values per tonne of pollutant, per vehicle-km or per tonne-km from previous studies provided that some adjustments are made and caution is exercised. Costs and benefits should be transferred carefully to another context; criteria for transferability should be considered, and the transfer procedure should be systematic and transparent.

Some factors to be considered include the choice of an appropriate reference study, validity of exposure-response functions used in the reference study and the validity of unit values used. The most important factors affecting external costs are population density, building area in the vicinity of the road, agricultural area and forest area, but also transport volume, technology, fuels and the environment.

The pollutant-specific cost per tonne of emission does not normally depend on the vehicle type from which the pollutant is emitted. For that reason, it is easier to adjust the cost if technology changes are anticipated. Therefore, costs per tonne of pollutant should be preferred to costs per passenger-km, tonne-km or vehicle-km for transfer purposes.

4.7 Global Warming Valuation

Regarding global warming the IPCC report (IPCC, 1996c) gives marginal costs varying from 5 $ tC to 125 $/tC for carbon emitted now. There are however examples of even higher marginal cost. Azar & Sterner (1996), cited in Rennings (1997), use a time-variant discount rate and equity weighting find damage costs of 250-590 \$/tC. Hohmeyer & Gärtner (1982), quoted in Hohmeyer (1996) find even higher cost of 800 \$/tC. This is not a marginal cost but is obtained by dividing the total costs for CO_2 equivalent doubling by cumulated emissions.

The values recommended are based on a very recent a study within ExternE project that has calculated the marginal costs of CO_2 emissions (Eyre et al, 1997). The models which were used in the study are the FUND model (version 1.6) at IVM Amsterdam and the Open Framework for Climate Change Impact Assessment (OF) model (version 2.2) at ECU Oxford. The costs that will be used here are derived from their baseline assumptions which are as follows:

- damages are discounted to 1990;
- time horizon: 2100;
- scenario: IS92a; The main components of the definition of this scenario is a population of 11.3 billion by 2100, an economic growth of 2.9 per cent for 1990-2025 and 2.3 per cent for 1990-2100 and energy supplies of 12 000 EJ (10^{18} J) or 2000 billion barrels for conventional oil;
- equity-weighted;
- no socially contingent effects.

At least two of these assumptions need an explanation. The equity weighting compensates for the effect on willingness to pay of income. IPCC and also the studies quoted above used local willingness to pay values, which lead to lower values in poorer countries. In this study it is assumed, as is commonly done, that the marginal utility of income declines logarithmically. In that case the appropriate weighting is the inverse of income. When this equity correction factor is applied, the utility loss for any impact is the same in all countries.

Socially contingent damages can be explained as follows. Most studies of climate change impacts have considered benchmark damages on a world with the current socio-economic characteristics. But marginal damages of emissions are dependent on socio-economic as well as climatic scenarios. The IPCC scenario IS92a is not specific enough for assessing climate change impacts. Additional assumptions are therefore required, for example socio-economic development patterns for those societies most vulnerable to impacts of climate change. In these cases, there are potentially some additional damage categories - like famine and conflict - the risk of which will depend largely on the underlying socio-economic conditions, but which climate change could exacerbate. These socially contingent damages are difficult to estimate.

For the marginal cost of CO_2 emissions the values for the period 2005-2014 from the ExternE study (EYRE et al, 1997) are recommended. For a discount rate of 3% the marginal cost is 50 \$/tC and for a discount rate of 1% the marginal cost is 160 \$/tC. These are recommended as low and as high values. Transformed from 1990 \$ to 1995 ECU, the values are 85 ECU/tC and 240 ECU/tC. Over time, values need to be increased by forecast growth in real GDP.

4.8 Noise Valuation

Seven studies concerned with transport noise were evaluated (INFRAS/IWW) to identify appropriate reference cost factors for transport noise. With one exception, the cost values in these studies are based on the willingness-to-pay-approach. They are evaluated either by hedonic pricing (CBA SWEDEN, Finland, Iten, and IRER) or by survey methods (Sweden, Weinberger). The values are given as annual costs per capita within 5 dB(A)-classes of noise exposure. The share of social noise costs in relation to the average available income at a noise exposure of 70 dB(A) presented in the studies evaluated ranges between 1.76% (willingness-to-pay, Sweden) to 4.96% (Finnish cost values). While the Finnish cost values represent a linear function of the noise exposure, the values presented by Hansson and Markham are rapidly growing with increasing noise levels.

The Swedish CBA-values represent an average of others and the gradient of the noise function is growing with increasing levels of exposure. These values have been chosen to calculate national noise costs for each country on the base of the number of disturbed inhabitants. Transferred into ECU and prices of 1995, the costs stated by the Swedish values range between 72 ECU per capita and year at an exposure level of 55-60 dB(A) and 1430 ECU per capita and year at an exposure level over 70 dB(A). Noise costs then are allocated to different types of vehicles in road, rail and air transport (passenger and freight) by vehicle-specific transport performance (passenger-km or ton-km) weighted by noise emission equivalents.

European mean values found by INFRAS/IWW (1995) are 4.5 ECU/1000 pkm for cars, 4.2 ECU/1000 pkm for buses and 3.1 ECU/1000 pkm for rail passenger trains. For HGVs an average value of 12.7 ECU/1000 tkm and for freight trains 4.7 ECU/1000 tkm was estimated by the study. These values are recommended as a basis for the determination of noise externality charges in average cost scenarios.

In terms of determining marginal costs of noise caused by an additional vehicle entering a road, railway track or approaching an airport, the application of noise models is recommended. Although the parameters of these models, used in road investment planning of different European countries, vary, their structures are similar. The pragmatic approach is to determine a basic noise level that is measured at a particular distance to the emission source as a function of traffic volume and traffic mix. This basic noise level then is adapted by additive terms describing the influence of additional vehicles, traffic mix, and permissible speed as well as the influence of link characteristics and the structure of the surrounding area. The correction terms are only to apply in case the "standard values" assumed in the basic noise level has to be adjusted to the current situation.

The function describing the relationship between noise level and traffic volume of these models pays attention to the fact that the relationship between the perception of sound by the human ear and the respective sound energy is observed to be logarithmic. This property of sound causes the volume measured at a road, railway track or airport to grow less than proportionately with the current traffic volume.

Noise costs per capita are derived by setting the noise levels (as a function of traffic volume) into a continuous noise cost function. The cost function is estimated as an exponential function of noise exposure exceeding a given target level. The function was estimated on the base of the values used in INFRAS/IWW (1995). The inputs for the noise level function are assumed to be provided by transport models. Applying this cost function to every inhabitant affected by the investigated transport infrastructure then leads to the total costs of traffic noise. Differentiating this function by the traffic volume gives the marginal costs of noise.

As an example, the application of the German noise model leads to average noise costs of 11.28 ECU/1000 pkm and marginal costs of 8.21 ECU/1000pkm. The deviation to the values proposed in INFRAS/IWW (1995) can be explained by the high sensitivity of the area examined - a recreational settlement alongside a motorway.

4.9 Conclusions on Valuing Externalities

In this section the general methodologies to be used for valuing externalities in the case studies have been proposed, along with accompanying recommended values. Furthermore, a range of case studies has been examined, and proposals made as to how to transfer values from one context to another. Except in the case of global warming, it is considered that for pricing policy the most appropriate valuation to use is that of the individuals in the country or area in which the transport activity takes place – as they bear the brunt of the external effects. Whilst it will be preferable in the case studies to develop direct estimates of the impacts of the externalities and then apply valuations to these impacts, it is accepted that within the resources available, the case study approach will be more often to transfer values of externalities from similar case studies elsewhere, paying full regard to differences in factors such as incomes and population densities.

5. The Current Pricing Situation

5.1 Practical Considerations

Having considered some of the theoretical background issues in Chapters 3 and 4, this chapter turns to considering more practical issues (based on Viegas and Fernandes, 1997). The purpose is to provide information about what exists today, so that the different pricing schemes in existence and the difficulties of moving from any of those schemes to more appropriate ones can be examined. Hence, issues of market structure, regulation, subsidy and taxation, in addition to pricing itself, both across Europe and across modes are covered.

Key questions are:

- What is the current situation regarding transport pricing in the Member States?
- How do relevant factors - market structures, industrial organisation, regulation, subsidies, taxation etc - currently impact on the setting of prices?
- What pricing policies are currently followed?
- What are the consequences of current pricing policies?

5.2 Market Structure, Regulation and Subsidy

Transport has a history of state intervention by way of regulation, ownership and subsidy. In more recent years, due to growing financial pressures, there has been a general trend towards reducing this state intervention by way of deregulation and privatisation, with a corresponding reduction in subsidy levels. Nevertheless, Governments still often intervene either to establish the prices or to define maximum prices for certain categories. These interventions are the result of political decisions, possibly not wholly void of economic reasoning, but certainly also balanced by other considerations.

Urban public transport fares are, almost universally set by the state, and only rarely does the revenue generated cover the costs of production. Most authorities are often reluctant to increase real fares, and so the basis for the current level is lost in history. The method of allocating subsidy varies from block grant to the producers to bids on the basis of gross cost or net cost for particular services or groups of services. Regional bus services are, with the exception of Britain and France, controlled by the state.

Road haulage rates are now largely commercially determined by the workings of a competitive market and are subject to negotiation between haulier and shipper.

Rail transport fares have generally been heavily regulated by the state and borne little relation to market conditions. However, in recent years, prices for long-distance passenger and freight services have been increasingly based on revenue maximisation subject to constraints imposed by inter-modal competition and by governments. The practice of charging for use of rail infrastructure varies widely, from no charge currently in the Netherlands through short-run marginal cost pricing in Sweden to commercially based (but regulated) charges in Germany and Britain.

In the air transport sector, the historical regulation of entry and fares and the subsidy granted to some national airlines is found to cause significant diversion from both fully commercial pricing and from marginal social cost pricing. There is still a substantial degree of market power held by the incumbent operators, with consequent monopolistic pricing tendencies coupled with extensive price discrimination.

Airport pricing procedures vary enormously. Although most charges take into account a combination of factors including landing and take-off charges, passenger charges and charges for the various services offered, there is little consistency in the relative importance of such charges in the total price charged and consequently prices are seldom closely related to the different types of aircraft and traffic. The cost of airport facilities is often subsidised by governments (national, regional and local) and cross-subsidised by the commercial non-traffic activities of airports. Although some airports impose higher fees on noisy aircraft, there is little evidence of congestion-related charging at EU airports.

The pricing of shipping services is commercially oriented, although the role of liner conferences in keeping up prices in inter-continental shipping remains strong. Pricing policy in ports again varies widely across countries, with a mix of public and private ownership. In some cases, a country's ports compete against each other while the operations are centrally controlled. Pricing varies from a full commercial approach with all monetary costs covered to a marginal (private) cost pricing policy.

5.3 Taxation

Transport taxes are not treated consistently across Member States notwithstanding the recent moves towards harmonisation. There is no evidence that the differences in the level of taxes is in any way related to different valuations of externalities. Taxes are, with rare exceptions, either related to access to and use of infrastructure or used to raise revenue. The level of annual motor vehicle taxes varies widely across the Union, although all states have such a tax. When charging for road use, all states levy indirect charges through duties on fuel, with broad comparability of the proportion of the retail price which is due to fuel duties and VAT. This ranges from 67% to 79% for unleaded petrol to 60% to 72% for diesel. Tolls are primarily used on motorways, but even then they are not universal, and vary from a flat rate charge for access to the system to a distance-related charge.

5.4 Current Pricing Policies

The insurance systems in Europe seems to cover surprisingly well the accident costs for personal injury and material damage. Some Member States have introduced limits on the maximum compensation payable to victims, which is in opposition to efficient internalisation. In the case of fatalities the difference between the victims' willingness-to-pay for risk reductions and the possible compensation to victims and their households is huge. The insurance systems therefore are far from bringing about an internalisation of the accident costs related to fatal accidents. Furthermore, in some Member States the general health insurance system covers the medical costs of traffic accidents. In Sweden the traffic insurance system only covers 25% of total insurable costs.

5.5 Summary of Current Pricing Practice

In conclusion, it is clear that there is a wide variety of practice in charging for the use of both transport services and transport infrastructure. In many areas, there remain signs of protection of incumbent and domestic suppliers, although the recent trend to liberalisation should cause these differences to diminish. Marginal cost pricing is not commonly found either in those sectors of the market which have become commercialised, where concern with profit is a prime motive, or in those areas under public control, where public acceptability is a key issue.

6. Deregulation and Pricing

6.1 The Rationale for Examining Deregulation

Having surveyed the current situation, the objective of this chapter is to comment upon the likely effects of further deregulation on the prices charged by transport operators in the road, rail, short-sea shipping and air sectors. A detailed review is contained in Betancor et al. (1997). In order to see the overall impact of pricing reforms it should, however, be remembered that these charges need to be brought together with charges for use of infrastructure and for costs external to the transport sector. The two key questions to be addressed in this chapter are:

- How stable is the current regulatory position?
- What would be the effects of further deregulation?

In addressing the first of these questions, consideration is needed of what further regulatory reform is likely to take place, based on current proposals and recent policy trends. In addressing the second, evidence is sought on cost levels and structures, particularly for those modes where deregulation has been actively pursued, and the effects deregulatory policies have had on costs and prices. Ultimately, the aim is to be able to determine whether deregulation assists or detracts from a move towards more optimal pricing approaches.

The term deregulation is used throughout this chapter in a wide sense, and will be defined as a combination of different sets of policies aiming at the achievement of two main objectives:

- **market liberalisation**, by promoting free competition and the removal of factors that hinder it, and/or
- **privatisation** of state-owned (or controlled), and, often monopolistic or dominant, firms.

As compared to non-European experience, one of the most distinct features of the European deregulation process is that it has been accompanied by a set of harmonisation measures intended to unify national criteria and to avoid further dispersion. Different countries naturally use different methods and have different paces of deregulation. Therefore, the EC has sought to promote a unified environment and supervised its enforcement in support of a single market.

The work reported here faced two main difficulties. Firstly, transport deregulation policies, common as they are in all European countries, have, in general, only been in place for a relatively short period. This limits the scope of data analysis and comparisons that can be carried out. Secondly, it must be born in mind that the deregulation process does not necessarily yield optimal results due to the presence of market failures. These difficulties may constitute drawbacks to this work so it is suggested that the results are interpreted with caution.

6.2 How Stable is the Current Regulatory Position?

One of the primary goals of the Common Transport Policy (CTP) has been to solve transport problems through the effective establishment of an internal market in the transport sector, in accordance both with general principles of the Treaty of Rome (1957) and its reform through the Single European Act. Accordingly, the transport system is currently undergoing important on-going structural changes aimed at introducing market forces, governed by the general rule that all transport users should pay the full costs, internal and external, of the transport services that they consume (even if these costs are in some cases paid by the society to assist those in need). However, transport policy in the EU is not applied uniformly. There was considerable diversity in starting conditions amongst the Member States and the way in which each country adapts to the general rule differs.

Road haulage is one of the sectors in which the greatest change has occurred in regulatory environment. Traditionally most countries in Europe regulated entry, and many regulated tariffs, partly because of a fear of cut-throat competition within the industry leading to low standards of maintenance and safety, and partly to protect railways. For many years, the growth of international road transport in Europe was hindered by the limited quota of international permits, and cabotage was not permitted. However, after 1985 rapid progress was made in extending quotas, and in 1990 price controls were removed for international traffic. In July 1998 quota restrictions were completely removed and cabotage permitted. Thus the process of completing the single market in road freight is essentially fulfilled.

By contrast the bus industry is still characterised by complete regulation of entry and fares, and monopoly public sector ownership in many countries. Great Britain is unique within Europe in having completely deregulated fares and entry, and largely privatised its bus system, although franchised private sector bus operations do exist in other countries such as France and Sweden. Local public transport is seen as an area where subsidiarity rules, so that the interest of the Commission in this area is in promoting best practice rather than in European legislation. This is certainly an area in which the pressures of government finances and the wish to increase market share may lead to regulatory change at the level of the individual state.

Starting in 1989, EC rail policy has moved towards the promotion of new entry in to the operation of rail services, promoted by the separation of infrastructure from operations. New entry may take the form of open competition or of franchising. The two countries to have implemented this policy most fully are Britain and Sweden. In Britain separation is complete and both the infrastructure company and all the operating companies have been privatised. In Sweden, infrastructure and operations have been separated into separate state owned companies, but some operations have been franchised to the private sector. Most other countries have now instituted some form of separation of infrastructure and operations within a single publicly owned organisation. However, the introduction of market forces within the rail sector is still only at its beginnings and further significant change may be expected.

One of the most clear aims attributed to European air transport policy is the removal of infrastructure bottlenecks. There exist several provisions, including a code of conduct

(January 1993) which is currently being revised, designed to give maximum priority to providing sufficient airport capacity and to developing a European level air traffic control system.

When the Treaty of Rome was signed the huge differences among Member States' air industries made it impossible to reach an overall agreement on how this sector should be regulated. Therefore, only the general principles on competition were enforceable. This situation sparked several conflicts between the EC and the Member States. In 1984 the EC's Memorandum on Air Transport proposed that all but several policies, such as pricing or capacity management, be under the influence of the articles from the Treaty relative to competition.

In 1987, the first of a series of liberalisation packages was released. Successive packages progressively eased the controls on fares and entry until completion of an open European market in air transport in April 1997. Thus effectively the deregulation process in air transport is complete. However, the repercussions in terms of alliances and mergers between airlines may not be complete, and entry remains seriously constrained by the issue of grandfather rights to slots at airports.

The implementation of the Common Transport Policy in the ports sector has made limited progress. Despite considerable concern at practices such as unfair competition and subsidies, and many reports, little has actually been achieved. The ports sector currently remains a mix varying from tightly controlled government owned ports to privatised ports with complete commercial freedom. It is a sector in which more tight regulation on pricing to prevent unfair competition may come about, at the same time as greater private ownership and commercial freedom in other directions.

6.3 What Would be the Effects of Further Deregulation?

Without explicit theoretical formulation in this work and relying on reduced form equations derived from the literature, a general economic model is postulated in which pricing policy for each mode is mainly explained by the regulation regime faced by the economic agents in that sector and the current demand and supply conditions.

Therefore, three types of variables are relevant:

?? price – the dependent variable;

?? deregulation - dummy variables representing the regulation regime faced by each unit of analysis within each mode;

?? demand/supply - a set of variables intended to capture all other effects on prices that cannot be attributed to the regulation regime.

Datasets were developed for air transport, rail transport, urban bus transport and port infrastructure. The main difference between them is the unit of analysis which has been used in each case. The selection of the unit of analysis is important because it defines the deregulation level to be examined.

The analysis of urban bus transport was carried out using cross-sectional data for bus companies across Europe, for 1994. Therefore, the results of the estimation do not represent the evolution of a deregulation process (defined as markets in which free entry is possible), but a simple comparison between firms with different market conditions in a given year. This comparison has been conducted by using two different samples with different companies, so that the results, despite their static value, are robust to changes in the company's selection criteria.

According to the evidence found in the analysis above, firms operating in deregulated markets would be 75% more efficient in covering total costs than firms in more controlled markets (double-log model). Furthermore, when comparing private companies versus public ones the ratio is more than doubled.

In addition, and for firms operating under free market conditions, it is found that they are more able to breakeven in spite of getting up to 90% lower unit revenues in terms of revenues per bus-km. This indicates that there has been an important reduction in costs as a result of the introduction of competition in the market, that is consistent with the sort of relationship between costs and revenues per bus-km, as described above.

Finally, there is also a sort of preference order, so that free entry markets would produce better financial results than those under a concession regime, whilst the latter would be superior to regulated markets in terms of economic efficiency and lower unit revenues. This evidence is consistent with literature.

For the rail sector, estimates allow two types of deregulation effects to be distinguished: the effect of ownership (state control on full commercial autonomy) and the effect of separation of services from infrastructure.

Regarding the former, it has been found that unit revenues measured in terms of passenger-km and tonne-km are always higher the greater the degree of commercial autonomy of railways. This translates also into a higher unit revenue per train-km that is of the order of 6%, and a lower level of required subsidies that goes down to 37%. However, the results suggest that there would not be significant differences in terms of unit costs.

Results for the case of separation of infrastructure and services with the double-log model indicate that unit revenues per passenger-km and per train-km are higher for UK and Swedish companies relative to other companies where separation has not taken place - on average around 78% and 13% higher respectively. On the other side, unit costs per train-km are 51% lower. As a consequence they require lower unit subsidies per train-km, of the order of 49%.

It seems deregulation, either understood as the separation of infrastructure and services, or as the separation from public control have produced an efficiency effect. Unit costs are decreasing (at least for the former) while unit revenues (and hence fares) are increasing in order to meet reductions of subsidies, thought these effects are more pronounced in the case of the UK and Swedish experiences.

In the case of air, an empirical analysis has been carried out of the effects of deregulation on the pricing policies of the European air industry from 1986-1994 for scheduled passenger traffic. The basic unit of analysis is the city-pair route, since this is considered as the basic unit of competition for this sort of traffic.

Two types of deregulation effects have been modelled. First, strict route-deregulation effect, according to the existence or not of liberal bilateral agreements between the countries involved in any single route. Second, a pure time-deregulation effect, according to the progressive influence of the EC deregulation packages that came into place at years 1987, 1990 and 1992.

To capture these effects different fare types are compared over forty-four different international intra-EU routes consecutively observed for nine years. In order to make the comparison valuable, deregulation variables are used as controls, but so also are several supply and demand variables, such as passengers-kms, number of flights, distance, and load factor. Control for unobservable individual effects that may possibly affect the validity of the estimated coefficients is also undertaken.

As expected, it can be confirmed that the basic standard fare is around 12% lower in those routes where liberal bilaterals are in force (double-log model). However, if the presence of unobservable characteristics related to the route is taken into account (fixed effects) there is not any statistically significant difference between types of routes for the excursion fare. Finally, with regards to levels of the discounted fares they are similar (log-form model) or lower (linear form). Accordingly, discounts have to be necessarily lower or similar, as found in panel regressions estimates. Hence, the effect of liberal bilaterals in Europe seems to be very weak in terms of the analysed price levels, except for the case of the standard fare.

However, the most striking impact of such bilateral agreements has been the proliferation of tariffs, allowing passengers to choose among a greater number of fare types that could be now on average 84% higher. Airlines are working with a greater number of discounted fares, this might also indicate they could be now be getting lower yields if these tariffs were actually widely available in terms of seats being offered on a discounted basis. This information is not published in Europe, however significance of the load factor parameter and relevant literature for the US (Keeler, 1991) case would support it. In addition, these effects of a larger number of discount tariffs would be enlarged by an increase in demand, as figures for 1993-1994 suggest.

In relation to EC deregulation packages, it is also the case that effects on levels of fares have been negligible so far. Again, its impact is found in the greater number of fares that are now available to passengers. Thus, as compared to non-European experiences, the effects of deregulation in Europe should be much more gradual. Unlike the US, the European deregulation process has been phased in over a lengthy period. For example, before the 1978 US Deregulation Act, regulation of inter-state markets had been conducted for several decades in a uniformly restrictive manner.

In Europe, in contrast, at the point of introduction of the Third Package the nature and intensity of government intervention varied enormously between different countries. Some governments had insisted on continuing to regulate their airlines closely in pursuit of their individual policies while others had already adopted more liberal approaches in anticipation of the forthcoming Single Market.

These very different starting positions have clearly affected the extent, and in some cases, the direction of change in the competitive environment of different EU countries. To avoid this source of bias due to diversity, it is important to focus on comparable figures and use a representative sample in order to capture as many particular characteristics as possible.

However, even if the source of data is corrected for, another important element to consider in the analysis, due to its influence on the results, is the different pace at which Member States have been transposing the European legislation to their national contexts. The delayed or strictly limited liberalisation in a number of the most important domestic markets have favoured the major flag airline's pre-existing dominance in their national markets and constitutes a current barrier to competition that still pervade the sector.

In effect this means, according to a recent publication (The Single European Market: Progress so Far; CAP 654, CAA, 1995), that the first two years of the Single Market (1993-1994) had not seen a uniform flourishing of competition across the EU, either between the major carriers or from new entrants or existing smaller airlines. These results are in agreement with those of this section, which shows that the effects of the deregulatory process, especially on tariffs, are weaker in Europe than expected.

For ports, a before and after study of UK experience of ports privatisation was carried out. Several control factors have been incorporated to econometric models, including special features of ports (fixed effects). It seems that the main consequence on ports of the changing ownership pattern has been the increase of profits, and that traffic tonnes have almost doubled relative to pre-privatisation levels.

It is difficult to determine the exact cause of this effect. The results suggest that price increases are unlikely to be the main reason behind them, as can be checked in regressions on average turnover. Finally, the results on average expenditure seem the less conclusive, since they depend on the concrete model specification. Thus, for the linear model the results indicate that privatisation has yielded cost increments on average. However, log-specification (even considering significant individual effects) implies that costs might be falling after privatisation, although this result is supported at a lower confidence level.

6.4 Conclusions on Deregulation

In conclusion, it has been found that deregulation does not necessarily lead to lower prices. This depends on the circumstances. Where deregulation introduces competition into a sector formally dominated by monopoly it does usually reduce prices, although not necessarily all prices - in the field of air, for instance, it has been the range and level of discounted fares that has been most affected. Where deregulation is necessarily accompanied by a more commercial approach to transport pricing and the removal of subsidies it may actually raise prices.

Further extension of deregulation and commercialisation may not benefit rail transport in terms of the relative level of price compared with other modes as - while the process has led to substantial reductions in terms of prices in road freight and air transport - it has tended to raise prices for bus and rail. The explanation is in terms of the very different starting points in terms of pricing policies and subsidies between the modes.

Finally, the deregulation process in some sectors may lead to a movement away from the appropriate pricing principles as set out in Chapter 3, particularly for sectors that experience increasing returns to scale.

7. Practical Pricing Systems

7.1 Objectives and Key Questions

The objective of this chapter is to highlight the main technical and organisational problems involved in designing systems for implementation of appropriate pricing principles, drawing on TRT, CIRTRAS (1997). The term 'systems' refers to the mechanism by which prices are calculated, collected and enforced and by which travellers are informed about prevailing prices. The ability of technological advance to capture cost components which correspond to the underlying economic concepts was of particular interest. The key questions to be addressed are:

?? what are the requirements of practical pricing systems?

?? how well can these requirements be met?

?? how do the are current regulatory and organisational structures relate to the appropriate pricing principles?

7.2 What are the Requirements of Practical Pricing Systems?

The following list represents the basic specification for a pricing system and provided the starting point for the technical investigations:

?? charges should be closely related to the amount of use;

?? charges should be variable according to different locations, different times of day, week or year, and different classes of vehicle;

?? charging criteria should be stable and readily ascertainable by users before they embark upon a journey;

?? payment in advance should be possible, although credit facilities may also be permissible under certain conditions;

?? method of payment should be easy to understand;

?? any equipment used should have a high degree of reliability;

?? the method should be applicable without difficulty to infrequent users;

?? the method should collect data indicating the strength of demand in different places so as to give information both for monitoring and for planning purposes.

7.3 How can these Requirements be Met?

The utilisation of road and parking pricing as a means to manage the mobility in particular urban areas is an idea largely diffused among public regulators and traffic experts, as it provides a more flexible way to make vehicles pay for the use of public space and it can be used to influence the behaviours of road users environment-related objectives with net welfare gains.

By adopting road pricing, a new philosophy is introduced, that substantially consists in the application of economic principles to regulate traffic flows. To most successfully obtain these results, full advantage of the possibility offered by telematics and distributed electronic intelligence both for monitoring and measuring purposes has to be taken, and for an efficient and flexible application of appropriate tariffs to vehicles flowing in and out or through a road infrastructure.

Technology offers practical means to achieve these results in a reliable and economically sustainable way. The most suitable systems adopt barrier-less methods, which are able to make the vehicles pay without any stop or delay.

These systems are based on on-board equipment, necessary to transmit the vehicle identification parameters to a detector placed at the entry of the controlled area, without any interference with the existing traffic, as the technology offers systems able to recognise vehicle at very high speed, also running on multi-lane road.

The occasional user could be managed by a barrier system, or by an automatic optical recognition of the car number plate by a camera.

The cost of these devices is expected to decrease, especially when they are widely diffused. In five years the technology could be mature enough to bring efficient and reliable products to the market at sustainable costs.

However it is acknowledged that the practical application of road pricing technologies may be difficult due to obstacles deriving from non-technical matters, such as: existing legislative constraints and obligations, conflicting interests among different groups involved (communities, private park operators, etc.), lack of social acceptance of the costs, of the rules and the constraints imposed by the system.

Some more research on the subjects of comparative local legislation as well as on the feasibility of new organisational structures - such as “private-public partnership” schemes with reference to a number of typical European cities would be desirable in order to supply more information and suggestions for successful practical implementation of road pricing systems.

Electronic Payment Systems based on advanced technology enable sophisticated pricing schemes as well as the gathering of accurate traffic data. They will allow the establishment of sound flexible pricing policies, suitable to take into account public objectives, as well as the processing of all information needed for the analysis of traffic and for cost partition in integrated systems of multiple operators.

The technological trends clearly indicate that the contact-less smart-cards incorporating a microprocessor are likely to be the most suitable fare collecting instrument in transit transport for the years to come.

Nowadays technology is ready for supplying the devices and systems (both tickets, validators and telematic system). In five years the economic cost of microchip cards is expected to decrease to a point that even the problems of occasional city travellers might be solved by using disposable microchip cards, as assumed by the microchip suppliers.

Smart cards can have a multi-purpose use; furthermore the transport payment system based on smart-cards may be integrated into a co-ordinated bank-managed payment system.
This opportunity, that may be highly appreciated by the users, opens a number of questions that have still to receive a firm answer. First of all, banks require cards that are read by a full contact, while transport applications work better with contact-less reading. Hybrid cards (equipped for both transport-type applications and banking-type applications) are now being developed, but their cost is still much higher compared to regular cards; furthermore, an agreement between banks and transport operators requires the solution of a wide number of institutional problems.

In conclusion, the technology is ready, and the costs are becoming progressively more sustainable. However, for full success of the applications, it is important to get social acceptance by maximising and demonstrating all advantages to the users. Multi-purpose cards and co-operation with banking system are among the issues to be thoroughly considered when planning new applications.

7.4 Regulation and Organisation

One of the main practical pricing issues, particularly in the rail and air sectors, is due, in large part, to the formerly widespread view that such industries were natural monopolies. National governments, through legal and regulatory frameworks, tended to foster monopoly organisations, often with infrastructure services and vehicle services bundled together within a single organisation based on the model of the integrated public enterprise. As a result, a relatively small number of powerful, nationally based organisations developed. However, this view has, over the past two decades, been challenged and increasingly replaced by the view that it is only the market for infrastructure services which exhibits natural monopoly characteristics and that the market for transport vehicle services is contestible or even competitive. Hence, there has been a move towards organisationally separating infrastructure from services and creating the potential for competition within the market for services, e.g. airline and railway liberalisation policies within the EU and the US. This process has been complex and is, as yet, incomplete. Certain aspects of the previous regime still remain and pose potential problems for the implementation of appropriate pricing principles. Even if the situation has changed in the last few years, partly due to European Commission's directives, resistance and practical implementation problems are again relevant. The main practical implementation problems are twofold:

- vertically-integrated monopolistic public enterprises, often reinforced by legally protected monopoly, can give rise to distortions of international competition because of frequent recourse to direct or hidden public subsidies to the firms.
- a range of social obligations, associated with continuity, safety and universality of services and low tariffs are assigned to the suppliers of railway, airline and other Network Public Utilities, necessitating, so it is argued, centralised government control.

The problem of co-ordinating paths is particularly acute in rail transport, because of the fixed capacity of the rail network and its rigid constraint on service mix. The regulation of access prices and subsidy is particularly difficult to manage because of the complexity of access control. Complex price structures are therefore likely.

The air sector is experiencing a liberalising process for airline services and services provided by the airports (for operators). The process comes into conflict with "grandfather's rights" held by flag incumbent companies, monopolists of national air transport. The crucial point of conflict in the slot allocation method emerged in the implementation of Third Party Access method. An allocation through a "Willingness To Pay" approach is widely believed to stimulate efficient behaviour, there is a strong consensus about the ability of European Free Auctions, to overcome the current bilateral agreements between Member States. The liberalising process has not yet shaken down the slot co-ordination system currently used by the airline companies and will at best provide incentives to limit "grandfather's rights". In the light of a gradual liberalisation, it is likely that a "use-it-or-lose-it" rule for allocating single slots or packages of slots will be implemented.

In medium or long term this could bring about a complete secondary market for slots, in the short term this may imply the setting of some pool slot auctions, not necessarily without public interventions, when marginal or off-peak slots are involved.

Deregulation and privatisation may lead to more severe airport congestion; at the same time average cost pricing at less congested airports, fails to provide optimal incentives for their use.

7.5 Implications of Technological and Institutional Development for the Case Studies

The case studies are concerned with specific corridors, with specific services and infrastructures. The practical pricing problems that are of most interest are technological ones, although regulatory issues of "strategic" organisation are of interest in so far as it affects the final price.

For transit and road pricing, as stated above, the technological picture shown by this report is quite a favourable one and no major reasons can be foreseen to prevent the availability of all the relevant automated technologies at reduced costs, for the case study year (2010). However a key aspect for road pricing will be public acceptability.

Technological issues are not critical for rail and air transport. Since the infrastructure users are small in number, known to the infrastructure operator, and the slots are all amenable to individual pricing; no technological issue arises. Of more interest will be the development of organisational issues which may affect the price of access to rail track or airports.

The following predictions for technological and organisational development by 2010 are made:

- Road Pricing - Electronic systems for road pricing will be widely available, using either Automatic Vehicle Identification or smart card technology;
- Transit Pricing - Electronic systems will be widely available, using either contact or

smart cards;

?? Rail Transport - Open access for international freight transport only along the freight freeways proposed by the EU. Less likely for other services; and,

?? Air Transport - There may be limited forms of auctions and the creation of a secondary market in slots, but it is likely that severe problems of congestion caused by average cost pricing will persist.

The forecasts for the year 2010 (reference year) are in general favourable on the technical issues, but less so are on the policy side: for railways in particular the incumbents have been highly successful in avoiding competition on track, and even in the UK most of the capacity has up to now been sold in lump form, with the practical result of keeping out new entrants in the short run (i.e. some form of monopoly has been auctioned, instead of leaving full-open access to the lines).

Although by 2010 technological constraints are not seen as a barrier to implementation of more differentiated pricing systems, there remains a need to justify the case for pricing reform on a case-by-case basis (e.g. road pricing for an individual city or part of the motorway network). Furthermore, the level of sophistication should also be subject to cost-benefit analysis in order to affirm the case for reform.

8. Overview of the 2010 Case Studies

8.1 Introduction

A number of case studies relating to strategic transport routes in Europe were carried out within the PETS project. These case studies examine practical implications of improved transport pricing, i.e. prices for transport use which more effectively reflect the social costs that transport users impose on others, and the implications for modal shares for the year 2010.

The five PETS case studies that were carried out for 2010 were:

Case Study	Coverage	Reference
Cross Channel	Passenger and freight	Sansom et al. (1999)
Transalpine	Freight	Suter et al. (1999)
Finnish	Passenger and freight	Peura et al. (1999)
Oslo-Gothenburg	Passenger	Jule (1999)
Lisbon	Passenger	Viegas (1999)

8.2 The Pricing Scenarios

Four pricing scenarios were examined. The first is the base case and serves as a reference scenario for 2010. It corresponds to the current pricing structure projected forward to 2010 and is fundamental as a reference mark to quantify the changes made by the introduction of the new pricing principles.

Three scenarios were examined in relation to the base, as explained in Section 4.5.

- Scenario 1, the pricing scenario tested for all case studies, corresponds to equating all prices to the price-relevant marginal costs. This is the pricing scenario which maximises the sum of producer's and consumer's surplus and internalises external costs.
- Scenario 2 seeks to achieve the most efficient pricing system possible, subject to a budget constraint that the overall requirement for government funding should not be increased.
- A further scenario, scenario 3, was examined in some cases. This introduces a constraint that transport users should collectively pay the full economic and social costs of the transport system. This constraint was introduced because in some countries this was seen as an important political or equity requirement.

8.3 Key Questions Addressed

The case studies were selected to present an interesting range of circumstances relating to the trans European networks. They include case studies relating to the congested core of Europe and to the periphery. Each case study chapter seeks to answer the following questions:

- What are the key characteristics of the corridors studied?
- What are the current pricing and demand conditions?

?? How do appropriate prices compare with the base case?
?? What are the implications of appropriate prices?

9. The Cross Channel Case Study

9.1 Characteristics of the Cross Channel Case Study

The scope of the Cross Channel case study was passenger and freight transport in the corridors from London to Brussels and London to Paris. The main modes included for passenger travel were car, train and air, and for freight travel, goods vehicles and train. For road traffic, crossing the Channel by means of Le Shuttle train services or ferry was examined.

At present the balance between transport demand and supply results in limited periods of time when transport capacity presents severe constraints. These peak periods typically relate to weekday commuting movements, in particular in the wider areas surrounding the capital cities. Additional peak periods may be observed in relation to leisure travel periods. In contrast to the situation for most modes in the study area, following the 1994 opening of the Channel Tunnel, cross-Channel links by ferry and Channel Tunnel can be characterised by the availability of substantial spare capacity for the foreseeable future.

Limited infrastructure expansion is envisaged in the period to 2010, with the most substantial piece of infrastructure being the Channel Tunnel Rail Link in the UK.

The main pricing scenario explored in the case study was Scenario 1, unconstrained marginal cost pricing. This analysis was supported by two demand forecasting models for passenger and freight, both of which focused on international travel and had fixed total travel demand. The passenger model was based on the cross Channel model for the 4th Framework STEMM project (Baxter Eadie, 1998). The mode choice and route choice sub-models for three purpose categories (business, private/commuting and tourism) were augmented with an algorithm to calculate the marginal cost of congestion. For freight, the case study had access to the results of the STEMM cross Channel freight model, an inter-modal freight model applied to multiple categories of commodities.

9.2 The Current Pricing Situation

A range of taxation and charging regimes apply in the three countries that encompass the case study area. For car, fuel taxes, VAT on fuel taxes and road tolls (France only) were incorporated. Value added tax, although not strictly an internalisation tax due to its application to a range of consumer goods, was incorporated, due to the high degree of variation within the transport sector. For passengers travelling by train, the average Eurostar and Le Shuttle fare were estimated. For air, the only tax or charge included was the passenger tax, since current fares were assumed to reflect marginal producer costs. For freight travel, HGV fuel taxes and annual vehicle taxes were included; the latter due to the assumption that high levels of vehicle utilisation mean that demand changes result in direct changes to fleet sizes – although obviously a crude internalisation mechanism. No taxes apply to rail freight, and tariffs were not included, as it was assumed that these were offset by marginal producer costs. Le Shuttle tariffs for HGV were calculated separately, and ferry tariffs were not included since they were assumed to cancel with marginal producer costs. This assumption was based on the fact that the UK government, in privatising rail freight services through the Channel Tunnel, effectively relieved them of charges for use of the tunnel and of the rail infrastructure within Britain. By contrast, Eurostar passenger fares still have to make a substantial contribution to these costs. This, and the relevance of the Mohring effect for passenger services, means that the same assumption was not made for passenger services. Instead, marginal producer cost was estimated directly.

The values for taxes and charges for the main modes included in the analysis, weighted across route segments, are shown in Table 9.1.

Table 9.1: Current Taxes and Charges – Main Modes

Component	Passenger (ECU/100 pkm)			Freight (ECU/100 tkm)	
	Car	Train	Aircraft	HGV	Train
Taxes					
Fuel taxes	3.79	0.00	0.00	2.45	0.00
VAT on fuel (average)	0.88	0.00	0.00	0.00	0.00
Other tax	N/A	N/A	4.25	N/A	N/A
Annual vehicle tax	N/A	0.00	0.00	0.28	0.00
Charges					
Road tolls (France)	0.27	N/A	N/A	0.13	N/A
Fares / tariffs	N/A	17.02	cancel	cancel	cancel
Total current taxes and charges	**4.94**	**17.02**	**4.25**	**2.87**	**0.00**

Note: Occupancies for passenger modes (passengers/vehicle): 1.8 car; 356 Eurostar; 84 air. Net loads for freight modes (tonnes/vehicle): 8 HGV; 280 train.
"Cancel" means this is a cancelling item with corresponding producer cost categories (see preceding text in this section);
Note that the road toll figure is a weighted average for all route segments

The applicable charges for the cross-Channel route segment, approximately 45 km, are presented in Table 9.2.

Table 9.2: Charges for the Cross Channel Segment

Component	Passenger (ECU/100 pkm)			Freight (ECU/100 tkm)		
	Le Shuttle	Eurostar	Ferry	Le Shuttle	Trainload	Ferry
Fares / tariff	106.42	17.02	89.44	117.50	N/A	106.90

Note: Occupancies for passenger modes (passengers/vehicle): 165 Le Shuttle; 356 Eurostar; 1000 ferry. Net loads for freight modes (tonnes/vehicle): 280 train; 105 Le Shuttle.

9.3 How do New Pricing Scenarios Compare with the Base 2010 Case?

In addition to marginal producer costs, the cost categories considered in the development of 2010 prices included the externalities: congestion, the Mohring effect for public transport, accidents, air pollution, global warming and noise.

Congestion was the only cost element that, due to its non-linearity with increasing vehicle kilometres, was integrated within the modelling framework – making use of the German (EWS Manual) speed-flow curves and a case study–specific value of time. The Mohring effect was estimated for Eurostar, on the basis of a value of time for international rail travellers. For accidents, risk rates were estimated for the respective modes using corridor or country specific data and using the valuation approaches recommended in Christensen et al. (1998).

For air pollution, bottom-up estimates for the Lille-London corridor from the QUITS study were available for adaptation to all corridors under examination. Global warming and (top-down) noise estimates were also adapted for application to the case study corridors.

In the following tables, Tables 9.3 and 9.4, the marginal cost estimates for 2010 are compared to existing taxes and charges – for the main modes and the Cross Channel modes. Low and high ranges for prices result from the range of unit values applied to accidents and global warming.

Table 9.3: Difference between Current and Scenario 1 Charges for 2010: Main Modes

Component	**Passenger ECU/100 pkm**			**Freight ECU/100 tkm**	
	Car	**Train**	**Aircraft**	**HGV**	**Train**
Components of the Price Relevant Cost					
Producer Cost					
Infrastructure wear and tear	0.351	inc.below	cancel	0.939	cancel
Increased PT Frequency	N/A	16.360	cancel	cancel	cancel
User Cost					
Congestion (time delays)[1]	0.12	N/A	N/A	0.054	N/A
Mohring effect	N/A	-2.856	N/A	N/A	N/A
External Costs					
Accident cost[2] (low)	0.164	0.012	0.001	0.516	0.011
Accident cost[2] (high)	0.898	0.058	0.007	0.883	0.054
Air pollution	0.397	0.098	1.366	0.832	0.046
Global warming (low)	0.363	0.070	0.608	0.255	0.032
Global warming (high)	1.035	0.197	1.718	0.719	0.091
Noise	0.794	0.319	N/A	1.536	1.412
Total Price-Relevant Costs					
Low	**2.189**	**14.017**	**1.976**	**4.078**	**1.504**
High	**3.595**	**14.201**	**3.091**	**4.909**	**1.611**
Total Taxes and Charges	**4.944**	**17.020**	**4.247**	**2.869**	**0.000**
Change in charge (low)	**-2.754**	**-3.003**	**-2.272**	**1.208**	**1.504**
Change in charge (high)	**-1.348**	**-2.819**	**-1.156**	**2.040**	**1.611**

Notes: [1] Average value for road links in study area;
[2] Includes the component of accident costs that is internal to the transport sector;
Occupancies for passenger modes (passengers/vehicle): 1.8 car; 356 Eurostar; 84 air; 165 Le Shuttle, 1000 ferry. Net loads for freight modes (tonnes/vehicle): 8 HGV; 280 train; 105 Le Shuttle;
"Cancel" means offset by corresponding fares or tariffs.

Table 9.4: Difference between Current and Scenario 1 Charge for 2010: Cross Channel Modes

Component	Passenger (ECU/100 pkm)			Freight (ECU/100 tkm)		
	Le Shuttle	Eurostar	Ferry	Le Shuttle	Trainload	Ferry
Components of the Price Relevant Cost						
Producer Cost						
Infrastructure wear and tear	0.00	0.00	0.00	0.00	cancel out	0.00
Increased PT Frequency	53.21	16.36	89.44	58.75	cancel out	106.90
User Cost						
Congestion (time delays)	N/A	N/A	N/A	N/A	N/A	N/A
Mohring effect	-4.00	-2.86	0.00	N/A	N/A	N/A
External Costs						
Accident cost (low)	0.01	0.01	0.00	0.01	0.01	0.00
Accident cost (high)	0.06	0.06	0.00	0.06	0.06	0.00
Air pollution	0.34	0.34	1.02	0.54	0.00	1.02
Global warming (low)	0.25	0.11	incl. above	0.25	0.05	incl. above
Global warming (high)	0.71	0.30	incl. above	0.71	0.15	incl. above
Noise	N/A	N/A	N/A	N/A	N/A	N/A
Total Price-Relevant Costs						
Low	**49.82**	**13.96**	**90.46**	**59.55**	**0.06**	**107.92**
High	**50.32**	**14.20**	**90.46**	**60.06**	**0.20**	**107.92**
Total Taxes and Charges	106.42	17.02	89.44	117.50	0.00	106.90
Change in charge (low)	**-56.61**	**-3.06**	**1.02**	**-57.95**	**0.06**	**1.02**
Change in charge (high)	**-56.10**	**-2.82**	**1.02**	**-57.44**	**0.20**	**1.02**

Note: refer to footnotes for Table 11.3 for occupancies, load factors.

The above tables reveal that current passenger taxes and charges are in excess of costs incurred. The main distortion is if cars use Le Shuttle services, and this is emphasised when the price changes need to achieve marginal costs are calculated for the complete journeys:

	London-Paris		London-Brussels	
ECU/100 pkm	low estimate	high estimate	low estimate	high estimate
for car using ferry	-2.71	-1.57	-2.03	-0.78
for car using Le Shuttle	-9.00	-7.80	-7.20	-5.91
for train	-2.98	-2.76	-2.94	-2.72
for air	-2.27	-1.16	-2.27	-1.16

For freight, the same distribution is apparent for HGVs using Le Shuttle, but for HGV using ferry and for train, increases in prices are implied:

	London-Paris		London-Brussels	
ECU/100 tkm	low estimate	high estimate	low estimate	high estimate
for HGV using ferry	+0.62	+1.31	+1.18	+1.93
for HGV using Le Shuttle	-5.81	-5.07	-4.11	-3.32
for train	+1.30	+1.43	+1.48	+1.61

The relative changes in passenger prices (decreases) and freight charges (increases), combined with the likely financial surpluses from urban pricing based on marginal costs, imply that in overall terms Scenario 1 is revenue neutral. Thus, Scenario 2, marginal cost pricing subject to a budget constraint, was unnecessary for this case study.

However, a major issue that arises is pricing relating to the financial deficit that would arise from Scenario 1 charges for the Le Shuttle services. It would be possible to consider, for the transport sector as a whole or for international transport, the design of two-part tariffs or forms of Ramsey pricing suitable for making up this deficit.

9.4 What are the Implications of the New Pricing Scenarios?

The impacts on modal shares for the overall Cross Channel passenger market are summarised in Table 9.5. Due to the use of a fixed demand model, the changes in modal shares are a function of relative price changes. It is seen that the changes are not dramatic, with the rail share being most affected.

Table 9.5: Impact on Passenger Demand of Scenario 1 Prices

	Rail	Road[3]	Air	Total
Transport Volumes (millions of passengers pa):				
1996	4.77	13.33	19.88	37.99
Base 2010	7.50	18.40	28.92	54.82
Scenario 1 low	8.03	18.37	28.42	54.82
Scenario 1 high	8.27	18.28	28.27	54.82
Modal Shares:				
Base 2010	13.7%	33.6%	52.8%	100%
Scenario 1 low	14.6%	33.5%	51.8%	100%
Scenario 1 high	15.1%	33.3%	51.6%	100%
Changes Relative to Base:				
Scenario 1 low	7.1%	-0.2%	-1.7%	-
Scenario 1 high	10.3%	-0.7%	-2.2%	-

For freight, the relative difference in price changes for road compared to rail depends on the use of low or high externality values. However, the change in relative price is not great enough to lead to a significant change in mode split.

The overall financial implication that appears to flow is that for the corridors in the case study the outcome of passenger and freight charges based on marginal cost prices is a minor reduction in revenues. However, and setting aside distributional issues, the likely financial outcome of marginal cost pricing applied to both urban and inter-urban areas for the countries concerned would be broadly revenue-neutral.

The main conclusions from the Cross Channel case study are that in the year 2010:

[3] The combination of car and Le Shuttle is a minor mode in overall terms, so that the dramatic price reduction for this combined mode is not reflected in an overall gain for car passenger travel.

?? for all the main passenger modes in the inter-urban corridors studies – car, train and air – all modes cover the key marginal costs associated with them;

?? conversely, for the main freight modes – HGV and train – there is a degree to which current taxes and charges do not cover the marginal costs associated with the individual modes;

?? for both passenger and freight, the prices for all modes move in the same direction, so that the implications for passenger and freight modal shares are limited;

?? in relation to Channel crossing modes, Le Shuttle services for passenger and freight have existing charges that are significantly in excess of the marginal cost-based charged that would maximise economic efficiency;

?? the tentative conclusion on the financial outcome of marginal cost-based pricing in the corridors examined is that a minor revenue reduction may arise, but setting aside distributional issues, that marginal cost pricing applied at a national level for the countries concerned would be broadly revenue-neutral when surpluses from urban areas are considered; and,

?? charging for new links on a single mode on a commercial basis may seriously distort relative prices.

10. The Transalpine Case Study

10.1 Characteristics of the Transalpine Case Study

The coverage of the Transalpine case study included the so-called "Arc of the Alps" – the 14 land corridors between the Ventimiglia corridor at the Ligurian coast and the Wechel corridor in the southeast of Austria. The case study refers to freight transport by road, rail, combined transport and rolling motorway. Because the larger part of the distance covered by freight using the Transalpine corridor occurs in areas outside the Transalpine region, the analysis was extended to the European level.

Key aspects of recent transport demand trends are that:

- Between 1986 and 1997, total Transalpine freight transport has increased by 50 per cent, from 97.7 million tonnes to more than 146 million tonnes.
- Though some parts of rail transport also exhibit a substantial increase, the growth of road freight transport (59.8 per cent) has been substantially higher than that for rail transport (36 per cent). In particular, rail wagonload transport has not been able to achieve growth that is comparable to that for road transport. The opposite is true for combined transport and rolling motorway services. The latter, however, plays a negligible role if the volume of total transalpine freight transport is considered.

These developments have shifted the modal split of Transalpine freight transport in favour of road transport. The share of road transport on total Transalpine freight transport increased between 1986 and 1997 from 58.5 per cent to 62.3 per cent.

Table 10.1 provides an overview of the key corridors included in the analysis.

Table 10.1: Key Road and Rail Corridors

Corridor	Modes	Description	Length in km[4]
Ventimiglia (F) Savona - Nice	Road, RWL, CT	not an „Alpine“ corridor in the true sense, important corridor for movements between Italy and France and especially the Iberian Peninsula, high share of transit traffic (50%), very limited volume of CT	Road: 141 Rail: 142
Fréjus / Mont-Cenis (F) Region Chambéry - Region Torino	Road, RWL and CT	the most important corridor for movements between France and Italy, rather low share of transit transport (28%)	Road: 200 Rail: 205
Mont-Blanc (F) Region Geneva - Ivrea	Road	high transport volumes and very high share of long-distance transit traffic (60%)	Road: 202
Gr. St. Bernard (CH) Martigny - Ivrea	Road	comparatively unimportant corridor with low transport volumes, important for regional	Road: 134

[4] As defined in the IWW transport model. For some corridors the relevant length can easily be derived with a look at a corresponding map (i.e. the length within an Alpine environment). For others, e.g. for the corridors in Eastern Austria (Tauern to Wechsel), the situation is less clear. In these cases assumptions have been made taking into account the length of the surrounding corridors to avoid distortions caused solely by the corridor definition.

Corridor	Modes	Description	Length in km[4]
		movements (Switzerland - Northern Italy)	
Corridor	**Modes**	**Description**	**Length in km**
Simplon (CH) Sion - Region Stresa Thun - Region Stresa	Road, RWL, CT	unimportant for long-distance road transit traffic, important transit corridor for rail transport, RMW services after 2001, rail includes the Lötschberg tunnel	Road: 141 Rail: 170
Gotthard (CH) Luzern - Chiasso	Road, RWL, CT, RMW	second most important transalpine corridor, highest rail transport volumes of all transalpine corridors	Road: 190 Rail: 181
San Bernardino (CH) Chur - Chiasso	Road	unimportant for long-distance transit traffic, high share of inland (40%) and regional traffic	Road: 161
Reschenpass (A) Bludenz - Bolzano	Road	very low transport volumes but high share of transit traffic (68%), regulations more and more limit transit traffic(5)	Road: 227
Brenner (A) Border D/A - Bolzano	Road, RWL, CT, RMW	corridor with the highest transport volumes and the highest share of transit traffic (90%), most important corridor for international movements, comparatively low shares of CT and RMW	Road: 186 Rail: 195
Felbertauern (A) St. Johann - Lienz	Road	unimportant for freight transport, almost no transit traffic	Road: 78
Tauern (A) Region Salzburg - Spittal	Road, RWL, CT, RMW	second most important Austrian corridor for transit traffic, important corridor for inland and export/import traffic, low shares of CT and RMW in comparison to road	Road: 137 Rail: 151
Schoberpass (A) Windischgarsten - Graz	Road, RWL, CT, RMW	important for inland transport, very low share of transit traffic (6%), low shares of CT and RMW in comparison to road	Road: 145 Rail: 162
Semmering (A) Region Wiener Neustadt - St. Michael	Road, RWL, CT	important corridor for inland traffic, limited importance for transit traffic (primarily from Italy to Eastern Europe and vice versa), low share of CT in comparison to road	Road: 121 Rail: 138
Wechsel (A) Region Wiener Neustadt - Region Fürstenfeld	Road, RWL	first of all important for inland traffic, road transport only (there is a - very modest - rail link with some RWL but almost no CT)	Road: 184 Rail: 140

Four main pricing scenarios were explored in the Transalpine case study, reflecting the range of pricing policy issues relevant to the case study. These were:

?? Scenario 1: unconstrained marginal cost pricing, where economic efficiency is the price setting determinant;

?? Scenario 2: marginal cost pricing subject to a budget constraint, where existing Transalpine freight revenues are maintained;

?? Scenario 3: average cost pricing, where each individual mode has to cover its full social costs; and

5 See VKS (1997), VKS Handbuch des internationalen Strassengüterverkehrs, p. A-12.

?? Scenario 4: marginal cost pricing and full cost recovery, where Transalpine freight transport as a whole covers its full social costs, but road freight contributes substantially to under-recovery of costs in rail transport.

Each of the scenarios included low and high estimates for the cost categories included in the analysis.

The modelling framework used in determining the impact of price changes incorporated mode choice and rout choice. Total commodity movements and their distribution were held fixed.

10.2 The Current Pricing Situation

Due to the diverse range of countries in the case study (including Austria, France, Italy and Switzerland) a wide range of mechanisms exist for charging for road infrastructure use, with considerable variation in the charge level for any given mechanism. Road freight taxes and charges included in the analysis were fuel tax, annual vehicle tax[6], and road user charges and tolls (motorway tolls in France and Italy, mileage tax for HGVs in Switzerland).

In the case of rail, the charges considered refer to infrastructure-related costs. Infrastructure use charges that are incorporated in the modelling relate to track maintenance, station use and energy use.

For all forms of road and rail transport, the tariffs faced by freight service users are assumed to offset all other categories of direct operating cost. For this reason, tariffs are not explicitly included within the analysis.

Estimates of current taxes and charges for road and rail transport are presented in Table 10.2. For both road and rail a distinction is shown between the two geographic levels of the case study – the Transalpine area and the European level.

[6] Included for the reasons stated in the cross-Channel case study.

Table 10.2: Current Taxes and Charges (ECU / 100 tkm)

Transalpine road freight transport		
	Basics figures	ECU / 100 tonne-kilometres
Fuel tax	0.37 ECU / litre	0.97
Annual vehicle tax	1'003 ECU / year	0.07
Road user charges, tolls	12'585 ECU / year	0.82
Total „European level“		1.85
Total „Alpine corridors“ (without „road charges, tolls“)		1.13

Tolls and charges of the different transalpine road corridors

Corridor	ECU/passage	ECU/100 tkm	Corridor	ECU/passage	ECU/100 tkm
Ventimiglia	49.5	2.86	Reschenpass	100.9	3.63
Mont-Cenis	160.3	6.54	Brenner	145.7	6.39
Mont-Blanc	168.1	6.79	Felbertauern	68.8	7.20
Gr. St. Bernard	188.5	11.47	Tauern	59.8	3.56
Simplon	112.6	6.56	Schoberpass	44.7	2.52
Gotthard	152.8	6.56	Semmering	21.6	1.46
San Bernardino	129.5	6.56	Wechsel	16.6	1.61

Transalpine rail freight transport, in ECU / 100 tkm

	Rail wagonload	Combined transport	Rolling motorway
Maintenance of track	0.48	0.58	2.09
Stations	0.15	0.14	0.51
Energy	0.42	0.45	1.43
Total	1.05	1.17	4.04
Total Alpine corridors	1.09	1.22	4.18

Note: Model assumptions for the net loads: Road freight transport: 12.26 t / HGV; Rail wagonload: 723 t / train

Combined transport: 765 t / train; Rolling motorway: 212.6 t / train.

10.3 How do the New Pricing Scenarios Compare with the Base 2010 Case?

The Transalpine case study focused on producer costs and transport system external costs. For road, producer costs included reconstruction and pavement, wear and tear, and maintenance activities. For rail, reconstruction, track maintenance and energy supply were incorporated. External costs included air pollution, noise, global warming and accidents.

Congestion costs for road and scarcity costs for rail were not included in the analysis for the year 2010. At the current time, congestion is largely associated with peaks in passenger movements for both road and rail. By 2010, substantial rail infrastructure capacity is envisaged, along with additional road infrastructure. For these reasons, congestion is likely to continue to be confined to days associated with high passenger transport volumes (e.g. start/end of school holidays).

For all cost categories, care was taken to distinguish between Alpine-specific and Europe-wide estimates. Low and high values were also used to reflect the ranges of relevant values found in reviewing existing estimates.

For producer costs, a range of existing cost estimates were reviewed in developing the values used. For air pollution and noise, existing bottom-up estimates were adapted to suit the corridors under examination, and to take account of developments by 2010. For global warming, damage costs common to all the PETS case studies were combined with emission factors relevant to the Alpine corridors. Accident and cost estimates were made based on extrapolations of corridor-specific rates for road and rail.

The estimated price-relevant marginal costs are reported in Table 10.3.

Table 10.3: Marginal Cost Components (ECU/ 100 tkm)

	Road freight transport				**Rail freight**			
	European level		Alpine corridors		European level		Alpine corridors	
Cost type	Low	High	Low	High	Low	High	Low	High
Producer costs	0.41	2.04	0.45	2.45	0.93	1.16	1.02	2.47
Air pollution	0.33	0.82	0.65	1.63	0.05	0.15	0.05	0.15
Noise	0.16	0.29	0.19	0.33	0.05	0.21	0.05	0.23
Climate change	0.19	0.54	0.22	0.62	0.06	0.25	0.06	0.25
Accidents	0.08	0.16	0.09	0.18	0.03	0.06	0.03	0.06
Total	1.17	3.84	1.60	5.21	1.11	1.83	1.43	3.17

Note: Average net loads: road 12.26 tonnes, rail 645 tonnes.

For the unconstrained marginal cost pricing scenario, Scenario 1, the implied price changes from those shown in Table 10.2 are reported in Table 10.4.

Table 10.4: Difference between Current and Scenario 1 Charges for 2010

Area/Corridor and Mode	Low	High
European Level		
Road	-36.8%	+108.0%
Rail wagonload	-4.9%	+56.5%
Combined transport	-19.6%	+32.4%
Rolling motorway	-16.1%	+38.1%
Transalpine Corridors (road)		
Ventimiglia (F)	-44%	+83%
Mont-Cenis	-76%	-20%
Mont-Blanc	-76%	-23%
Gr. St. Bernard (Ch)	-86%	-55%
Simplon	-76%	-21%
Goatherd	-76%	-21%
San Bernardino	-76%	-21%
Rechenpass (A)	-56%	-44%
Brenner	-75%	-19%
Felbertauern	-78%	-28%
Tauern	-55%	-46%
Schoberpass	-36%	+107%
Semmering	+10%	+257%
Wechsel	-1%	+224%
Rail		
Rail wagonload	+0.7%	+65.8%
Combined transport	-14.7%	+40.4%
Rolling motorway	-10.7%	+46.9%

For road transport in Transalpine corridors the implications of the unconstrained marginal cost pricing scenario vary substantially by corridor, largely due to the wide variation of current price levels on different corridors. At the European level the low estimate of costs implies the need for a cut in road charges of over one third, with the high estimate suggesting that prices should more than double.

In the case of rail – wagonload, combined transport and rolling motorway – the low scenario suggests a modest reduction in current charges in nearly all Transalpine and European contexts. The opposite picture emerges for the high cost estimate scenario, with typical price rises of around 50% implied.

In the case of marginal cost pricing subject to a budget constraint, scenario 2, the revenue constraint was assumed to apply to the combined road and rail sectors, for all traffic making use of the Transalpine corridors. Since the high marginal cost scenario implied a revenue surplus, this scenario was only constructed for the low marginal cost estimates. The analysis identified that the means of covering the scenario 1 (low) deficit that caused least disturbance to scenario 1 base road and rail demand, were passage charges that split the financing proportions according to 75% road and 25% rail.

Scenario 3, average cost pricing applied to each of the road and rail freight sectors, implied price changes for road broadly comparable to those in scenario 1. The main difference related to the rail sector, where low average cost estimates indicated a doubling of prices for Transalpine rail modes, with prices in the high cost estimates increasing by a factor of four.

Scenario 4, marginal cost pricing subject to full cost recovery for freight modes in the Transalpine region, included the political constraint that uncovered costs would be met 75% by road freight and 25% by rail freight. This was not intended to be an "optimum" scenario for the treatment of Scenario 1 deficits, but was included illustrate how an "acceptable" balance between road and rail freight demand could be achieved. The additional financing burden here relates to Transalpine transport infrastructure.

10.4 What are the Implications of the New Pricing Scenarios?

For the unconstrained marginal cost pricing scenario, figures are shown in Table 10.5.

Table 10.5: Impact on Freight Demand of Scenario 1 Prices

	Road	Rail wagonload	Rolling motorway	Combined transport	All rail
Transport volumes (million tonnes lifted pa):					
Base 2010	133.6	39.1	3.7	22.8	65.6
Scenario 1, low	137.8	29.7	3.9	23.8	57.4
Scenario 1, high	133.8	34.2	3.4	26.9	64.5
Modal shares:					
Base 2010	67.1%	19.6%	1.9%	11.5%	32.9%
Scenario 1, low	70.6%	15.2%	2.0%	12.2%	29.4%
Scenario 1, high	67.5%	17.2%	1.7%	13.6%	32.5%
Changes relative to base demand:					
Scenario 1, low	+3.1%	-24.0%	+5.4%	+4.4%	-12.5%
Scenario 1, high	+0.1%	-12.5%	-8.1%	+18.0%	-1.7%

Price changes in favour of road result in an overall shift away from rail transport, which is small for high marginal costs, but significant for low marginal costs (-12.5%). If impacts by country are examined, a more dramatic picture emerges. For example, in the case of road traffic using Swiss corridors, the low marginal cost scenario results in an almost doubling of road traffic – mainly due to diversion from Austria (Brenner Pass) and French routes. Limited changes in mode shares result in negligible changes in total external costs (environmental and accident costs).

The results of applying average cost pricing are reported in Table 10.6, from which it can be seen that average cost pricing results in a substantial switch from rail to road.

Table 10.6: Impact on Freight Demand of Scenario 3 Prices

	Road	Rail wagonload	Rolling motorway	Combined transport	All rail
Transport volumes (million tonnes lifted pa):					
Base 2010	133.6	39.1	3.7	22.8	65.6
Scenario 3, low	144.3	29.7	3.9	23.8	54.6
Scenario 3, high	148.6	34.2	3.4	26.9	50
Modal shares:					
Base 2010	67.1%	19.6%	1.9%	11.5%	32.9%
Scenario 3, low	72.5%	15.2%	2.0%	12.2%	27.5%
Scenario 3, high	74.8%	17.2%	1.7%	13.6%	25.2%
Changes relative to base demand:					
Scenario 3, low	+8.0%	-24.0%	+5.4%	+4.4%	-16.8%
Scenario 3, high	+11.2%	-12.5%	-8.1%	+18.0%	-23.8%

The results reported for average cost pricing relate to one iteration of the transport model. If the model were re-run with the higher prices needed to make up for reduced rail demand, a 'downward spiral' in rail demand would be observed.

Finally, Scenario 4 examines marginal cost pricing (with high cost estimates) combined with full cost recovery. The positive impact on rail demand, due to the 75% of uncovered rail costs met by road is clearly reflected in an increase of 45% relative to the base case (Table 10.7).

Table 10.7: Impact on Freight Demand of Scenario 4 Prices

	Road	Rail wagonload	Rolling motorway	Combined transport	All rail
Transport volumes (million tonnes lifted pa):					
Base 2010	133.6	39.1	3.7	22.8	65.6
Scenario 4, low	133.8	29.7	3.9	23.8	64.5
Scenario 4, high	103.2	34.2	3.4	26.9	93.5
Modal shares:					
Base 2010	67.1%	19.6%	1.9%	11.5%	32.9%
Scenario 4, low	67.5%	15.2%	2.0%	12.2%	32.5%
Scenario 4, high	52.5%	17.2%	1.7%	13.6%	47.5%
Changes relative to base demand:					
Scenario 4, low	+3.1%	-24.0%	+5.4%	+4.4%	-12.5%
Scenario 4, high	-22.9%	-12.5%	-8.1%	+18.0%	+45%

In addition to the results illustrated in the figure above, the main findings of this analysis can be summarised as follows.

Starting from the PETS pricing principle - or the price-relevant costs as assessed in this report, a need for action can be identified. The current pricing schemes do not accurately reflect short-run marginal social costs, either in road or in rail transport. In the case of road freight, the need for action is a priority at the European level (i.e. outside the Alpine area) and for the transalpine corridors with low existing charges and tolls (e.g. Ventimiglia and the corridors in Eastern Austria).

The marginal cost pricing scenario does not lead to a substantial increase in rail transport. In the case of road transport the marginal cost estimates derived from the literature and additional own calculations are not high enough to change the prices in a way that induces road transport to switch extensively to rail transport.

Switzerland cannot hold its high share of rail transport if marginal cost pricing is introduced. In the case of the lower bound, the road transport volume on the Swiss corridors almost doubles whereas it decreases on the French and Austrian corridors. First of all traffic from the Brenner and the Mont Blanc divert back to the Gotthard if Switzerland gives up its rail-friendly transport pricing policy and changes to marginal social cost pricing using values for the price-relevant costs as assessed in this report.

If cost recovery is demanded from each mode and not from the transport sector as a whole (i.e. total transalpine freight transport), rail freight transport has to bear a very large financial burden. It can be assumed that with this burden rail freight transport would largely cease to exist.

The results calculated suggest that pricing based on economic efficiency objectives alone will not save rail - if it starts from the price-relevant cost rates assessed in this project. Substantially higher productivity gains than assumed in the case study are needed if rail wants to increase its market share under a marginal cost pricing scheme. Major efforts are needed from the railway companies. There is a urgent need to design the general set-up for rail in way that such incentives are induced. It is crucial that the introduction of more competition in the rail freight transport market as intended by the liberalisation efforts in the rail sector is successful.

Scenario 4 shows that only with additional pricing measures in favour of rail can a change in the modal split in favour of rail be achieved. There might be reasons for such additional measures, even though short-run marginal social cost pricing is the first best pricing principle from an efficiency point of view:

– in the case of plausible capacity constraints in the road network it might be cheaper to increase the rail share of total transalpine freight transport than to extend the road infrastructure.
– the external cost estimates presented underestimate the real external costs of transport because a range of Alpine-specific cost factors had to be neglected in the assessment due to limited data availability.
– the predicted, compared to the current situation, may entail significantly higher road transport volumes in the case of marginal cost pricing than the public are prepared to tolerate, given the sensitive Alpine environment and sustainability considerations.

In this case study, marginal social cost pricing does not yield lower revenues from transalpine freight transport compared to the current situation unless one starts from very low marginal cost estimates. If this is done, the remaining revenues could be collected by a passage charge. The analysis using the transport model then suggests that road freight transport should bear a large part of the financial burden.

Changes in pricing schemes cause changes in revenue flows and therefore redistribution of revenues. These effects of revenue re-distributions in moving towards a more allocatively efficient pricing policy would become a focus of attention in the policy debate. It would be decisive for the political acceptance of the introduction of a new pricing scheme.

11. The Finnish Case Study

11.1 Characteristics of the Finnish Case Study

The study on the corridor "The Nordic Triangle" within Finnish borders (from the City of Turku to the Russian border at Vaalimaa and Vainikkala) tests alternative pricing policies for passenger and freight traffic at the periphery of the EU. The internal and external costs are estimated for car, bus and rail, and the consequences of alternative pricing policies are examined.

The corridor comprises the Road E18, and the related railway network. The study concentrates on the part of the corridor that is within the Finnish borders, and on Finnish national traffic. The E18 is, for the most part, a dual carriageway, the highest traffic volumes occurring along the section nearest to Helsinki and the lowest on the section nearest to Russia. Between now and 2010, substantial investment is planned both for the road and rail routes. As a consequence, congestion costs are not included because it is estimated that the upgrade to E18 will result in there being minimal congestion in 2010.

Three pricing scenarios are tested:

1. Unconstrained Marginal Cost Pricing ;
2. Marginal Cost Pricing Subject to a Budget Constraint; and
3. Full Internal and External Cost Recovery by the transport sector.

11.2 What are the Current Pricing and Demand Conditions?

Prices for road traffic in the current situation consist of special road traffic taxes as follows:

??	fuel taxes	54% of the price of fuel in 1995;
??	vehicle sales tax	100% of the customs value, which equates to approximately 29% of the price of the car; and
??	annual motor vehicle tax	ECU 121/year for cars registered in 1994-98, ECU 86/year for older cars.

The publicly owned rail operating company (VR) provides transport services and pays government an annual track fee of ECU 50 million/year. It also pays fuel taxes, which are ECU 3.7 million per year. Insurance premia paid by road users and by rail authorities are also included in the price calculations. The railway insurance is system-wide and unrelated to train kilometres and therefore the implications for pricing are very limited.

Approximately 86% of all passenger trips on the corridor are currently made by car, with bus accounting for 9% and rail for 5%. It is estimated that 41% of freight on the corridor is transported by rail and the remaining 59% by heavy goods vehicles (HGV).

Table 11.1 Current Taxes and Charges

Component	Passenger Modes (ECU/100 pkm[a])			Freight Modes (ECU/100 tkm[a])	
	Car	Bus	Train	HGV	Train
Current Taxes and Charges					
Taxes:					
Fuel Tax	2.14	0.84	0.03	0.63	0.03
Vehicle Tax	1.45	n/a	n/a	0.17	n/a
Value added tax on fuel	0.70	0.31	0.01	0.23	0.01
Value added tax on vehicle tax	0.26	n/a	n/a	0.03	n/a
Charges:					
Track fee	n/a	n/a	0.45	n/a	0.41
Fares for Scheduled PT (excl above taxes)	n/a	6.18	6.18	n/a	n/a
Total current taxes and charges	4.55	7.33	6.67	1.06	0.45

Note: Occupancy rates: car 1.59, bus 12, train 140 passengers.
Net load factors: HGV 12.1, train 1000 tonne

Road traffic on the corridor is expected to increase by 39% by the year 2010, with a similar increase assumed for rail.

11.3 How do Appropriate Prices Compare with the Base Case?

The marginal cost pricing scenarios (1 and 2) result in lower prices for bus and train trips than those in the base case. However, whilst changes in the prices of public transport are significant, the change in the price of car trips is relatively low. The prices for heavy goods vehicles in all scenarios are higher than in the base case.

Table 11.2 Differences between Current and Optimal Charges for Scenario 1 in 2010

Component	Passenger Modes (ECU/100 pkm)			Freight Modes (ECU/100 tkm)	
	Car	Bus	Train	HGV	Train
Components of the Price Relevant Cost					
Producer Cost					
Infrastructure wear and tear	n/a	0.12	0.12	0.20	0.05
Additional capacity for SPT[d,g]	n/a	5.85	5.33	n/a	n/a
User Cost					
Accident cost Low	0.52	0.63	0.22	0.44	0.056
High	1.66	0.72	0.24	0.51	0.063
Mohring effect for SPT[g]	n/a	-3.67	-3.34	n/a	n/a
External Costs					
Air pollution	1.30	1.03	0.099	1.14	0.028
Global warming Low	0.33	0.17	0.001	0.21	0.001
High	0.94	0.48	0.03	0.59	0.002
Noise	0.16	0.24	0.18	0.20	0.050
Total Price Relevant Cost[e] Low	**2.31**	**4.37**	**2.61**	**2.19**	**0.185**
High	**4.06**	**4.77**	**2.63**	**2.63**	**0.193**
Total Current taxes and charges	**4.55**	**7.33**	**6.67**	**1.06**	**0.45**
Changes in charges to reach optimal price Low	**-2.24**	**-2.96**	**-4.06**	**1.13**	**-0.265**
High	**-0.49**	**-2.56**	**-4.04**	**1.58**	**-0.257**

Note: Occupancy rates: car 1.59, bus 12, train 140 passengers. Load factors: HGV 12.1, train 1000 tonne; additional capacity for SPT and the Mohring effect result from higher frequency services.

11.4 What are the Implications of the New Pricing Scenarios?

Choice of mode and external effects are not significantly changed because the change in the costs of car trips is relatively low and the role of cars is so dominant. Even if public transport were to double its share of trips, 70% of all trips would still be made by car.

The lower prices for public transport in scenarios 1 and 2, as compared to those in the base case, result in a slight decrease in car mileage and an increase in public transport mileage. The higher prices for heavy goods vehicles in all three scenarios result in the increased use of train in freight transport. The drop in HGV and car mileage reduces air pollution and greenhouse gas emissions in all scenarios.

In all scenarios cars remain a dominant transport mode in passenger traffic. The proportion of car trips varies from 83.6% (Scenario 1, high values of externalities) to 85.6% (Scenario 3). Bus trips account for 9.2-10.4% and train trips for 5.2-6.0% in the alternative scenarios. In freight transport the proportion of heavy goods vehicles varies from 56.0% to 58.8% and that of train from 41.2% to 44.0% in the corridor. General government revenues are naturally the highest in Scenario 3, in which the capital costs of infrastructure are levied on the users of infrastructure.

The most important mode in interurban transport systems such as the E18 corridor in Finland is the car. The level of taxes on car ownership and use of car today corresponds roughly to the level of charging in Scenario 1. The main difference is that almost half of the taxes levied are vehicle taxes. The effects of moving from vehicle taxes towards km-charging could not be fully modelled. However, it is clear that if vehicle taxes are removed, the number of cars would probably increase but at the same time, the average mileage of cars would probably decrease. The results of this study may be regarded only as an approximate estimate of what might happen.

Table 11.3 Impact on Demand of Prices in Scenarios 1-3

	Passenger Modes			Freight Modes	
	Car	**Bus**	**Train**	**HGV**	**Train**
Modal Shares					
The Base Case	85.5%	9.4%	5.2%	58.8%	41.2%
Scenario 1	84.6%	9.7%	5.7%	56.7%	43.3%
Scenario 2	84.1%	10.0%	5.8%	56.4%	43.6%
Scenario 3	85.6%	9.2%	5.2%	57.5%	42.5%
Change relative to base					
Scenario 1	-1.4%	+3.7%	+12.1%	-5.9%	+7.4%
Scenario 2	-2.3%	+7.5%	+16.4%	-6.6%	+8.2%
Scenario 3	+0.2%	-1.3%	-1.3%	-3.4%	+4.3%

In general terms, the main distortion of current, relative to optimal prices (Scenario 1), is the over-pricing of passenger public transport, resulting from the use of prices that approximate to average costs in a situation where marginal cost is much lower than average cost. Current prices for car traffic are more or less correct given the current values for external costs, where as heavy goods vehicles are underpriced, given the externalities they create.

This study does not, however, suggest which pricing policy should be preferred. This is because, although economic efficiency is a starting point in interurban transportation, regional equality and fairness are also important in countries like Finland with low population density and long distances.

12. The Oslo to Gothenburg Case Study

12.1 Characteristics of the Oslo-Gothenburg Case Study

The study on the corridor "The Nordic Triangle" the road E6 corridor from Oslo to Gothenburg tests alternative pricing policies for passenger traffic at the periphery of the EU. The internal and external costs are estimated for car, bus, rail and air, and the consequences of alternative pricing policies are examined.

Congestion is not included because it is estimated that the planned upgrade of the E6 road will result in there being minimal congestion in 2010. This assumption was verified for a range of road links in the study area. It could be contended that the absence of congestion is indicative of a degree of over-capacity in infrastructure provision in the corridor.

Due to relatively short distances involved, transport by road and rail is dominant in the area.

Two pricing scenarios are tested:

1. Unconstrained Marginal Cost Pricing; and;
2. Marginal Cost Pricing Subject to a Budget Constraint.

12.2 What is the Current Demand and Pricing Situation?

Prices for road traffic in the current situation consist of special road traffic taxes on fuel and vehicles as follows:

?? petrol tax - comprising a base rate and a CO_2 tax element, which (including VAT) make up approximately 75% of the car fuel price;

?? auto diesel tax - comprising a base rate, CO_2 tax element, and a sulphur tax element; and

?? Annual vehicle tax - for passenger cars, this was 190 ECU per year in 1995.

Diesel-powered buses and diesel-powered trains are charged the CO_2 tax and a tax dependent on sulphur content, but are exempted from the base rate of the auto diesel tax. Trains that run on electricity are charged an electricity fee. From 1 April 1995 national scheduled air services between cities where there is a parallel railway line were liable to a tax. In 1996 these seat tax rates were set at ECU 16 on international flights and ECU 8 on national flights.

The above taxes are Norwegian values. Swedish taxes are assumed to be approximately at the same level.

Due to relatively short distances involved, transport by road and rail is dominant in the corridor. Approximately 83% of all long distance, land-based border crossing passenger trips are made by car; buses accounting for a further 4% and trains accounting for a further 13%. Air travel between Oslo and Gothenburg is limited. On average, heavy goods vehicles account for 12% of the traffic.

Table 12.1 Current Taxes and Charges (ECU per 100 pkm)

Component	Passenger Modes			
	Car	Bus	Train	Aircraft
<u>**Current Taxes and Charges**</u>				
Taxes				
Fuel taxes	2.78	0.13	-	-
Other tax (electricity tax for rail, seat tax for air)	-	-	0.10	3.41
Value added tax on fuel taxes	0.64	0.03	-	-
Other Value added tax	0.37	-	-	-
Fares	-	10.61	10.38	31.69
Total current taxes and charges	**3.79**	**10.77**	**10.48**	**35.1**

Note: Occupancy rates: car 1.82, bus 11.3, rail 90, aircraft 63

Overall demand for long distance travel (longer than 100 km) is predicted to increase by 2.3% per annum between 1995 and 2000, and by 1.9% annually up to 2010; a total increase of 35% between 1995 and 2010. Within this overall growth in demand, demand for long distance car journeys is estimated to increase by 37% over the period, with an increase in demand for air of 48%. The growth of long-distance passenger transport by bus and rail will be lower, 12% and 26%, respectively. Short distance travel will experience a more moderate increase, 12% for car in the 15-year period, and 3% for scheduled public transport.

12.3 How do Appropriate Prices Compare with the Base Case?

Compared to the base case, prices for all modes decrease in Scenario 1, irrespective of whether price calculations are based on high or low values for accidents and global warming externalities:

- ?? car (operating costs) – 7.5%
- ?? bus – 4.7%
- ?? rail – 11.6%; and,
- ?? air – 12.9%.

For car and air, the decrease is due, to a large extent, to the high current tax levels imposed on these modes. It has been shown that interurban car transport pays higher taxes than its actual marginal cost responsibility.

The differences between tax revenues in Scenario 1 and in the base case are very small. Therefore, in Scenario 2 a total deficit of only 1.7 MECU/year, amounting to 1.5% of government revenue from this corridor, has to be covered using a ‘two-part-tariff’. As the difference is small, and car is the dominant transport mode in the area, the additional ‘entry fee’ was included for cars only. The entry fee, however, cannot be modelled so was, instead, included in the kilometre tax. The extra charge would correspond to 0.06 ECU per 100 passenger kilometre, which would increase the price for car, in comparison to Scenario 1, by only 1%. This can be assumed to have small effects on the mode choices and transport volumes.

Sensitivity tests using low values for accidents and global warming externalities were also examined for Scenario 1. The choice between low and high alternatives has a significant impact on the prices, and thereby the traffic volumes of the different modes. The largest impact is on car, the price referred to being the operating car costs, including charges in each scenario. In addition, a coarse analysis of the level of the entry fee was made for the low alternative of Scenario 1.

Table 12.2 Changes to reach Scenario 1 prices, 2010 (ECU per 100 pkm)

Component	**Passenger Modes**			
	Car	**Bus**	**Train**	**Aircraft**
Components of the Price Relevant Cost				
Producer Cost				
Infrastructure wear and tear	0.05	0.63	1.26	0.78
Additional capacity for SPT (larger capacity vehicles)	-	7.5	7.3	27.2
User Cost				
Congestion (time delays)	-	-	-	-
External Costs				
Accident cost Low	0.51	0.74	0.40	0.01
High	1.61	0.85	0.44	0.06
Air Pollution	0.12	0.16	-	0.14
Global Warming Low	0.37	0.30	-	0.61
High	1.04	0.86	-	1.73
Noise	0.17	0.26	0.26	0.65
Total Price Relevant Cost Low	**1.22**	**9.59**	**9.22**	**29.39**
High	**2.99**	**10.26**	**9.26**	**30.56**
Total Taxes and Charges	**3.79**	**10.77**	**10.48**	**35.1**
Changes in charges to reach optimal price Low	**-2.57**	**-1.18**	**-1.26**	**-5.71**
High	**-0.80**	**-0.51**	**-1.22**	**-4.45**

Note: Occupancy rates: car 1.892, bus 11.3, rail 90, aircraft 63; increased Scheduled PT capacity is provided by larger vehicles, rather than increased frequencies, so that the Mohring effect is zero.

The resultant deficit from Scenario 1 prices implied the need to examine how marginal cost pricing subject to a budget constraint could be developed (in Scenario 2). The role of two-part tariffs was examined, focusing on examining the potential entry fee if the full financing burden was met by car owners. This resulted in an entry charge ranging from 168 ECU/year for Scenario 1 low cost estimates to 5 ECU/ year for Scenario 1 (high).

12.4 What are the Implications of the New Pricing Scenarios?

The lower prices in Scenario 1 result in a increased level of passenger demand – in the Scenario 1 (low) case by 14.6%, and in the Scenario 1 (high) case by 4.7% (Table 12.3). In both cases, the share of passenger kilometres by car and air rise, generally at the expense of loss of market share by bus and rail.

Table 12.3: Impact on Passenger Demand of Scenario 1 Prices

	Car	Bus	Rail	Air	Total
Transport Volumes (millions of passenger km pa):					
Base 2010	3139	188	712	73	4113
Scenario 1 low	3814	168	653	78	4712.8
Scenario 1 high	3332	180	714	79	4305
Modal Shares:					
Base 2010	76.3%	4.6%	17.3%	1.8%	100.0%
Scenario 1 low	80.9%	3.6%	13.8%	1.6%	100.0%
Scenario 1 high	77.4%	4.2%	16.6%	1.8%	100.0%
Changes Relative to Base:					
Scenario 1 low	21.5%	-10.5%	-8.4%	6.8%	14.6%
Scenario 1 high	6.2%	-4.4%	0.2%	8.9%	4.7%

Scenario 1, low and high, both result in user benefits due to cheaper travel, partially offset by reductions in government revenues and increases in the external costs associated with more travel.

Thus in this corridor the effect of moving to economically efficient pricing is a shift of traffic from the less polluting modes of bus and train to the more polluting modes car and air.

The objective of this case study was to test alternative pricing policies in the periphery of the European Union. The Oslo-Gothenburg study reveals that in inter-urban areas the main problem is not high volumes of traffic and external effects. Congestion costs are shown to be low. Air pollution and noise costs are also rather low, partly due to the fact that these roads run through areas with low population density.

At the present time, transport by private car is rather heavily taxed in Scandinavian countries, at approximately 75% of the fuel retail price. A so-called seat tax is levied on air transport between cities where there is a parallel railway line, as a means of strengthening the competitiveness of rail. Bus and rail service currently have fairly low taxes.

Introducing the marginal cost principle lowers charges for all modes, but particularly for car and air. The implications are increasing use of car and air transport, and decreasing transport by bus and train. It should be noted that this only applies to inter-urban traffic situations. In a congested city traffic situation, marginal costs of car transport are likely to be even higher than today's taxes.

As expected, marginal cost pricing applied to relatively low-volume corridors yields more, not less, transport than today, given the high level of taxation on transport of Norway and Sweden. From an economic efficiency perspective, current levels of taxation may be considered excessive. The increase in transport demand resulting from the overall reduction in charges is economically beneficial to society as a whole, because the marginal benefit to individuals exceeds the marginal costs imposed on society as a whole.

These conclusions hinge on a number of important premises, namely:

- that marginal costs are correctly estimated;
- that the proposed programme of infrastructure improvements on the corridor is carried out, largely eliminating any problems of congestion that are currently experienced on parts of the corridor; and,
- the Oslo-Gothenburg corridor is an important link connecting Norway to the continent. Transport from Norway to destinations on the continent and vice-versa is not considered in this case study. For such transport, the calculated marginal cost prices will only yield a first best solution if competing modes and corridors are correctly priced. The main competing mode in this case is ferry transport between Norway and Denmark/ Germany.

13. The Lisbon Case Study

13.1 Characteristics of the Lisbon Case Study

The Tagus River crossing case study is the only urban case study within PETS and covers the Lisbon Metropolitan Area. The Tagus River itself forms a natural barrier, which divides the metropolitan area in the middle and, for many years, formed an obstacle to development on the south side. Following the completion of the old suspension bridge in the 1960s, the south side is now one of the City's main satellite areas. There is a high level of demand to cross the river which has resulted in severe congestion at the entrance to the old bridge during a large part of the day. A new bridge, the Vasco da Gama Bridge, opened in 1998 and currently, more than 260,000 passengers, in both directions, cross the river each day by road and ferry. It is felt that the new bridge and the introduction of a heavy rail line on the old suspension bridge are likely to induce a fast increase in North-South flows within the area over the next decades.

The Case Study only examines pricing scenario 1 and focuses on commuter and work-related travel using the following passenger transport modes on the corridors across the Tagus River:

?? private car;

?? bus;

?? rail;

?? ferry;

?? private car/public transport mixed; and

?? private car/public transport mixed motivated by new park and ride facilities.

13.2 What is the Current Demand and Pricing Situation?

The prices for road traffic currently consist of special taxes and of tolls charged for different facilities. The main special taxes are a vehicle acquisition tax, which varies with engine cylinder capacity, and the fuel tax (currently 57%), both collected by the government. Additionally there is an annual fee for use of motor vehicles [in favour of] councils, but with a relative lower value. There are also the tolls on the Tagus bridges, on some of the motorways and parking fees in the central city. All services and charges have an additional VAT tax with a margin of 17%, in the case of vehicle acquisition or fuel price, and a margin of 5% in the case of other charges, which is transferred to the government. Public transport is regulated, with the creation of transport services delegated to public companies, which have the legal monopoly within their area of operation. There are no special taxes on public transport services – the only additional is VAT at a margin of 5%. Table 13.1 summarises the taxes and charges levied.

Table 13.1: Taxes and Charges

Component	Car	SBus	Train NS	Ferry	Under-ground	Train N	UBus	Tram
Fuel tax (ECU/ 100vkm)	2.80	-	-	-	-	-	-	-
VAT on fuel (ECU/ 100vkm)	0.80	-	-	-	-	-	-	-
Charge 1: Tagus River bridges toll, ex-VAT (ECU/100vkm)	2.90	9.71	-	-	-	-	-	-
VAT on charge 1	0.14	0.49	-	-	-	-	-	-
Charge 2: motorway tolls, ex-VAT (ECU/ 100 vkm)	0.82	5.24	-	-	-	-	-	-
VAT on charge 2	0.04	0.26	-	-	-	-	-	-
PT fares, ex-VAT (ECU/ 100 pkm)	-	4.14	3.40	8.74	4.39	2.43	5.43	9.00
VAT on PT fares (ECU/ 100pkm)	-	0.21	0.17	0.44	0.22	0.12	0.27	0.45
Total user charges, ex-VAT (ECU/ 100pkm)	4.65	4.14	3.40	8.74	4.39	2.43	5.43	9.00
Total user charges, incl-VAT (ECU/ 100 pkm)	5.36	4.35	3.57	9.18	4.61	2.55	5.70	9.45

Notes: car occupancy rate 1.4; total user charges, ex-VAT, are used in the calculation of the impact on the Transport Sector budget; fuel taxes on public transport vehicles are not shown, since these are incorporated into the final passenger fare; Charge 2 is a weighted charge, that reflects the proportion of vehicle-kms travelled on tolled motorways.

Transport activities are financed from the general budget and no earmarking occurs. Public operators are financed in two ways: through concessionaire fare mechanisms, including gross network subsidies at the end of the financial year; and, through the coverage of their deficit since the state is the shareholder. Private bus operators receive no state subsidy.

13.3 How do Appropriate Prices Compare with the Base Case?

The price changes implied by Scenario 1 are shown in Table 13.2 and 13.3. Prices for car increase substantially, particularly in the peak period due to the congestion element of the price.

For public transport, the main reason for the increase in peak period prices is the current difference between fares and marginal operating costs. In the off peak, substantial excess capacity exists, and it has been assumed that a change in passenger demand would not result in a corresponding increase or decrease in PT service levels. For this reason, the marginal cost of PT in response to changes in passengers are assumed to be zero.

Table 13.2: Difference between Current and Scenario 1 Charges for 2010: Peak Period (0700-0900, 1730-1930)

Component	Car	SBus	Train NS	Ferry	Under-ground	Train N	UBus	Tram
Producer Cost								
Infrastructure wear and tear	0.46	0.08	0.13	-	-	0.13	0.03	-
Increased PT Frequency	-	4.53	3.99	11.37	10.40	2.47	6.70	26.00
User Cost								
Congestion (time delays)[1]	2.79	0.27	-	-	-	-	0.26	-
Accident cost (low)	0.96	0.01	0.01	0.00	0.00	0.01	0.01	0.03
Accident cost (high)	2.05	0.03	0.02	0.01	0.01	0.02	0.03	0.06
Mohring effect	-	-	-0.57	-3.98	-	-	-	-
External Costs								
Accident cost[2] (low)	1.20	0.15	.013	-	-	0.13	0.15	0.32
Accident cost[2] (high)	1.49	0.19	0.16	-	-	0.16	0.18	0.39
Air pollution	1.02	0.32	0.04	0.12	0.07	0.04	0.30	1.39
Global warming (low)	0.49	0.06	0.01	0.02	0.01	0.01	0.06	0.24
Global warming (high)	1.38	0.17	0.02	0.07	0.03	0.02	0.16	0.69
Noise	0.45	0.10	0.06	-	-	0.06	0.17	0.15
Total Price-Relevant Costs								
Low	7.37	5.53	3.79	7.54	10.48	2.84	7.68	28.12
High	9.64	5.69	3.84	7.58	10.51	2.89	7.83	28.67
Total Taxes and Charges	5.36	4.35	4.08	9.18	4.61	2.55	5.70	9.45
Change in charge (low)	**+2.01**	**+1.18**	**-0.29**	**-1.64**	**+5.87**	**+0.29**	**+1.98**	**+18.67**
Change in charge (high)	**+4.28**	**+1.34**	**-0.24**	**-1.60**	**+5.90**	**+0.34**	**+2.13**	**+19.22**

Note: Occupancy rates: car 1.4, sbus 62, train NS 787, ferry 420, train N 478, underground 787, ubus 65, tram 30.

Table 13.3: Difference between Current and Scenario 1 Charges for 2010: Off-Peak Period

Component	Car	SBus	Train NS	Ferry	Under-ground	Train N	UBus	Tram
Producer Cost								
Infrastructure wear and tear	0.46	0	0	0	0	0	0	0
Increased PT Frequency	-	0	0	0	0	0	0	0
User Cost								
Congestion (time delays)	1.39	0	0	0	0	0	0	0
Accident cost (low)	0.96	0	0	0	0	0	0	0
Accident cost (high)	2.05	0	0	0	0	0	0	0
Mohring effect	-	-	0	-	-	-	-	-
External Costs								
Accident cost (low)	1.20	0	0	0	0	0	0	0
Accident cost (high)	1.49	0	0	0	0	0	0	0
Air pollution	0.88	0	0	0	0	0	0	0
Noise	0.45	0	0	0	0	0	0	0
Global warming (low)	0.39	0	0	0	0	0	0	0
Global warming (high)	1.10	0	0	0	0	0	0	0
Total Price-Relevant Costs								
Low	5.73	0	0	0	0	0	0	0
High	7.81	0	0	0	0	0	0	0
Total Taxes and Charges	5.36	4.35	4.08	9.18	4.61	2.55	5.70	9.45
Change in charge (low)	**+0.37**	**-4.35**	**-4.08**	**-9.18**	**-4.61**	**-2.55**	**-5.70**	**-9.45**
Change in charge (high)	**+2.45**	**-4.35**	**-4.08**	**-9.18**	**-4.61**	**-2.55**	**-5.70**	**-9.45**

Note: Occupancy rates: car 1.4, sbus 14, train NS 227, ferry 197, train N 98, underground 227, ubus 20, tram 20.
Since at present there is substantial off-peak capacity, any change in passenger numbers in the off-peak does not lead to a change in public transport service levels; hence price relevant costs are zero for all public transport modes.

13.4 What are the Implications of the New Pricing Scenarios?

Transport demand changes are summarised in Tables 13.4 and 13.5. A strong switch from private car to public transport (train and ferryboat) is expected. In the off-peak period, the decrease in private car is stronger due to the increase of car charges and decrease to zero of public transport fares. Bus patronage decreases slightly in the peak period.

Table 13.4 Impact on Passenger Demand of Scenario 1 Prices: Peak Period

Component	Car	Car & ferry	Car & train	Bus	Ferry	Train	Park & ride	PT total
Transport Volumes (passengers per day)								
Base 2010	32498	9097	17268	2033	16465	30263	26365	48761
Scenario 1, low	25519	9603	17823	1882	18823	33939	27426	54644
Scenario 1, high	22012	10121	18399	1988	19907	35197	28520	57092
Changes relative to Base:								
Scenario 1, low	-21.5%	+5.6%	+3.2%	-7.4%	+14.3%	+12.1%	+4.0%	+12.1%
Scenario 1, high	-32.3%	+11.3%	+6.5%	-2.2%	+20.9%	+16.3%	+8.2%	+17.1%

Note: park & ride = car & ferry + car & train; PT total = bus + ferry + train.

Table 13.5 Impact on Passenger Demand of Scenario 1 Prices: Off-Peak Period

Component	Car	Car & ferry	Car & train	Bus	Ferry	Train	Park & ride	PT total
Transport Volumes (passengers per day)								
Base 2010	76204	14049	25846	4431	19523	31694	39895	55648
Scenario 1, low	51648	13984	27498	6016	26229	46388	41482	78633
Scenario 1, high	47233	15402	29689	6091	26498	46845	45091	79434
Changes relative to Base:								
Scenario 1, low	-32.2%	-0.5%	+6.4%	+35.8%	+34.3%	+46.4%	+4.0%	+41.3%
Scenario 1, high	-38.0%	+9.6%	+14.9%	+37.5%	+35.7%	+47.8%	+13.0%	+42.7%

Note: park & ride = car & ferry + car & train; PT total = bus + ferry + train.

To summarise, the following conclusions may be drawn about price changes:

?? as expected in an urban area, significant increases in the price of private motoring are implied, particularly when congestion externalities are internalised;

?? also as expected, the car price increases are particularly pronounced for the peak period (between +38% to +80%), but are also significant in the off-peak (+7% to +46%);

?? for public transport in the peak period, a generalisation for all modes in Lisbon is that prices would need to rise in order to reflect marginal social costs. However, there is a wide range of changes in prices for the different PT modes; and,

?? in the off peak, because public transport service levels are dictated by social factors (as opposed to responding to passenger demand), and because substantial excess capacity exists, service levels are unlikely to change with changes in demand. No change in service level implies a zero marginal cost when passenger numbers vary.

Demand responses reflect the changes in prices, and in the context of the fixed total passenger demand matrix used in the case study, are as follows:

?? private car demand falls substantially – by between 20% and 40%, depending on the time period and the low or high valuation of externalities; and,

- public transport increases – by between 12% to 43%, again depending upon context.

In terms of economic welfare, substantial economic gains arise from reductions in congestion, accidents, air pollution and other environmental impacts. Implicit in the case study is the ability to implement prices that are specific to individual links, i.e. in the case of roads, the mechanism would have to be some form of electronic road pricing. Clearly, a full socio-economic analysis would also have to include the costs of implementing and operating such a system before it could be concluded that a sophisticated pricing mechanism were economically justified.

Finally, the case study raises interesting methodological issues, among which may be highlighted:

- the successful modelling of the impact of prices imposed on individual links, with equilibrium reached through successive iterations of the route choice/ modal choice model and re-calculation of prices;
- a related issue, the resource-intensive nature of coding the road network to a level at which this methodology is possible – such models effectively assume that drivers have "perfect information", so that a high degree of accuracy is necessary if the results are to be robust; and,
- the constraints of a modelling approach that makes use of a fixed total travel demand matrix, and simulates behaviour in individual time periods (peak, off-peak) but not switching between time periods – which is a likely response to road pricing with time period differentiation.

In overall conclusion, the case study has provided strong evidence that in a congested urban environment prices fail to reflect the social costs that arise from transport. Thus, there is a clear need for action to reconcile the beneficial use of the transport network with the wider costs imposed on society by this use.

14. Conclusions of the Pricing European Transport Systems Project

14.1 Synthesis of Case Study Results

In the preceding chapters, results were presented for the five case studies. These included 4 passenger studies and 3 freight case studies. In this section the results are drawn together in order to reach some conclusions.

Tables 14.1 presents the changes in passenger prices implied by the low and high valuations of externalities. It is seen that for all the inter-urban case studies, the price of motoring should be reduced, with the reduction naturally being very much more for the low values than the high values. The reason for this is the relatively high level of taxation on motoring, and the expected reductions in externalities per vehicle km by 2010.

In particular, it has been assumed that full implementation of the AUTO-OIL proposals regarding tighter emissions controls will take place, greatly reducing the level of air pollution, and in all the inter-urban corridors further road building is assumed, leading to modest levels of congestion in 2010.

Of course the question should be asked whether the proposed infrastructure investment is justified in social cost-benefit terms. Although that issue lay outside the scope of the current project, the level of infrastructure capacity provision is a major determinant of the implied price changes in all case studies[7].

Table 14.1: Changes in Passenger Prices, Unconstrained Marginal Cost Pricing Scenario (ECU /100 passenger km)

Case Study	Cost Estimates	Car	Bus	Train	Air
Cross Channel	low	-2.14	-	-3.02	-2.27
	high	-0.74	-	-2.85	-1.16
Finnish	low	-2.24	-2.96	-4.06	-
	high	-0.49	-2.56	-4.04	-
Oslo - Gothenburg	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	-

Note: 1995 prices, 2010 values.

It is also the case that inter-urban bus, rail and air all appear to be overpriced according to these case studies. In the case of air, this is because all the countries concerned do have some form of taxation on air transport, such as the air passenger duty in the UK, or the seat tax in Norway. For the other modes, the principle reason is the application of commercial

[7] This does not necessarily mean that there is over-provision of infrastructure capacity. In some circumstances, increased provision may be justified on grounds of enhanced quality (e.g. straighter roads, grade separation) and not purely in order to relieve congestion.

pricing systems in a sector where there are effectively economies of scale. In rail these are created partly through economies of scale in infrastructure, but also for all modes the combination of economies of large vehicles or trains together with the Mohring effect whereby additional passengers lead to the provision of more frequent services which confers a benefit on existing passengers. The net effect of these price changes is a general increase in overall inter-urban traffic, but particularly for rail and air. The changes are not generally dramatic, however.

Naturally, the urban case study is very different. Even at the low value of externalities, car prices should increase significantly, particularly in the peak. In overall terms, bus prices should fall. However they should rise in the peak, the existing subsidies being excessive, but much less than car. For rail a modest reduction is called for. The changes in traffic here are much more significant, with a reduction of car traffic of up to 40% and an increase in public transport of up to 42%.

In the case of freight (Table 14.2), the results are more diverse. Road freight appears to be undercharged, with the exception of the Transalpine corridors through Switzerland, where the existing high charges mean that at the low valuation of externalities charges are too high. Even though road freight annual registration taxes have been treated as variable charges for the purposes of this analysis, due to a small change in freight demand leading to a direct change in taxes, under-charging for road freight still occurs in the Cross Channel and Finnish case studies. This distortion is even more pronounced than Table 14.2 indicates, since the registration tax does not vary with distance travelled.

Table 14.2: Changes in Freight Prices, Unconstrained Marginal Cost Pricing Scenario (ECU /100 tonne km)

Case Study	Cost Estimates	HGV	Train
Cross Channel	low	+1.26	+1.50
	high	+2.09	+1.60
Finnish	low	+1.13	-0.27
	high	+1.58	-0.26
Transalpine*	low	-0.68	-0.06
	high	+1.99	+0.66

Note: 1995 prices, 2010 values.
* figures presented refer to the wider area of Europe around the Transalpine corridors.

Rail freight charges are also found to increase in the Cross Channel case study, and in the Transalpine case study when the high valuation of externalities is adopted. In these circumstances, it is found that existing subsidies to rail freight are excessive. In the Finnish case study there is a modest reduction in rail tariffs. In no case is the change in freight tariffs sufficient to cause a dramatic change in mode split, although in the Swiss case study the low valuation of externalities leads to rail losing its existing high market share for transit traffic.

Of course these conclusions must be subject to caveats. No attempt has been made to value all external effects - for instance water pollution has been ignored, and since the focus is on the costs of transport infrastructure use, upstream effects of production of inputs for the transport sector such as vehicles was outside the scope of the project. Moreover, there is a history of both the number of externalities identified increasing and of increases in the valuation of the known externalities, and there is particular uncertainty about the effects of high altitude emissions from aircraft. However, it is asserted that these omissions would not lead to a major change in the conclusions from the case studies.

14.2 Key Conclusions from PETS

This section seeks to draw together the key conclusions from the PETS project. These relate to both the conceptual analysis and the empirical case studies:

1. A major conclusion is that the methodology to calculate marginal social cost for all modes exists, although many of the valuations remain subject to considerable uncertainty. No support is found for the argument which says that the concept of marginal cost pricing cannot be implemented in practice because it is unmeasurable. However, this does not mean that all the relevant agencies currently possess the information and ability to estimate marginal social cost, so further efforts to disseminate this may be needed. The case studies have illustrated that marginal social cost may be estimated for a range of circumstances in a range of countries.

2. It has been shown that a purely commercial approach to transport pricing is not appropriate and may push prices in the wrong direction. The reason is the prevalence in the transport sector of economies of scale, including the Mohring effect, whereby increases in demand for scheduled public transport services lead to increased service frequency and therefore better services for existing passengers, and because of the importance of externalities. Whilst the former lead to commercial prices being too high, and the latter too low, the relative strength of the two effects differs enormously between the modes and locations.

3. In measuring externalities for pricing purposes, it is important to estimate the marginal external cost rather than starting with the total cost and then dividing it by the amount of traffic. This is particularly important in the case of congestion, accidents, and noise, for which there are important non-linearities.

4. The effects of moving to a more efficient pricing system are likely to be diverse, both because of differing circumstances between countries and because of different starting points. For instance, in some countries rail fares are held very low, whereas in others they are close to commercial levels. This makes it difficult to generalise about the effects of efficient pricing from a small number of case studies.

5. Further extension of deregulation and commercialisation may not necessarily benefit rail transport in terms of the relative level of price compared with other modes as - while the process has led to substantial reductions in terms of prices in road freight and air transport - it has tended to raise prices for bus and rail. The explanation is in terms of the very different starting points in terms of pricing policies and subsidies between the modes. However, recent trends may imply that significant scope remains for reductions in unit costs in the bus and rail industries.

6. The simple belief that a move to more efficient pricing would uniformly benefit the more environmentally friendly modes at the expense of other modes is also found to be not universally true. For instance, the current price of inter urban motoring is seen to be too high relative to 2010 marginal social cost. This gives little support for the introduction of additional charges on inter-urban roads except for specific cases of serious congestion or especially strong environmental effects. On the other hand, the case for urban road pricing in congested cities is reaffirmed. Similarly whilst there is generally a case for lower prices and increased traffic for public transport, in some cases existing subsidies are already excessive. Only in the urban case study is a substantial diversion of traffic to public transport justified.

7. In the case of road freight, the picture is mixed but generally there is under-charging of long distance road freight. This is partly a problem of the structure of the existing taxation system. Fuel taxes do not increase sufficiently with the weight (and particularly the axleweight) of the vehicle to reflect the marginal social cost of heavy vehicles. An annual charge over-charges low mileage vehicles and under-charges vehicles used intensively on long distance work. Even the vignette, as currently utilised, is related to time rather than distance run. Thus there is a clear case for reform of road freight vehicle taxation, to introduce a charge based both on vehicle characteristics and distance travelled.

14.3 Key Conclusions from Related 4th Framework Programme Projects

In this section the results of other projects on European transport pricing are reviewed, with comparisons made with PETS.

Of the other studies considered, that most similar to PETS in its objectives is the study TRENEN II STRAN (Proost and van Dender, 1999). The objective of the TRENEN II STRAN project was the development of strategic models for the assessment of pricing reform in transportation, and their application to the European Union. The strategic models were designed, as in PETS, to examine the extent to which existing prices differed from marginal social costs, and to look at the consequences for traffic and mode split of moving to marginal social cost pricing, as well as examining a range of intermediate pricing reforms.

The models are used in 5 urban case studies and in 2 interregional case studies. In urban areas, TRENEN shows that urban motorists pay only one half to one third of their full marginal social costs. This is due both to externalities and to unpaid parking costs. The PETS urban case study shows a similar but somewhat smaller underpayment of marginal social cost but PETS did not regard unpaid parking costs as relevant, regarding these as essentially fixed in the short run (however, parking space may well have a scarcity cost that should be taken into account).

The interregional model focuses on passenger and freight transport simultaneously. Interregional passenger transport pricing inefficiencies are in general less important than in the case of urban transport. Prices of peak period car use do not cover marginal external congestion costs. The congestion cost itself is however smaller than in urban areas. In the off-peak period, cars pay slightly more than their marginal social cost. Public transport pricing inefficiencies exist but are less important per kilometre than in urban markets. Non-urban bus transport is heavily subsidised and underpriced in both cases.

For trucks, the prices are smaller than the marginal social costs in the peak period. The major external cost is again congestion. When subsidies are not excessive, as they are in Ireland, the prices of rail are closer to the marginal social cost. Because external costs of inland waterways are small, prices and marginal social costs are roughly in line with each other.

These results do not differ greatly from PETS, although in the PETS inter-urban case studies congestion was generally found to be small in 2010, and therefore motoring charges somewhat higher relative to marginal social costs than in TRENEN. Also PETS tended to find that fares for inter-urban public transport were too high rather than too low. These differences probably reflect in part differing starting conditions in the countries examined; these in PETS tended to have relatively high public transport fares. They may also reflect different assumptions about the amount of investment in roads that will have taken place by the modelled year, and about the marginal cost of carrying additional public transport passengers. It must also be remembered that TRENEN models 'average' conditions in the networks concerned, whereas PETS models specific long distance corridors, making use of full, network-based transport models.

In the QUITS project, a comprehensive valuation framework to measure the global quality of the transport system was established in the form of a "total cost of travel", which is the straightforward sum of the costs of:

?? travel time (or value of the travel time)

?? direct costs, and

?? external costs.

The results of QUITS were extensively used in PETS to assist in the estimation and valuation of external costs. However, because QUITS was not concerned explicitly with pricing policies, it will not be considered further here. It is an important application of bottom-up techniques for the estimation of external costs.

The Eurotoll project was very different from PETS because it examined the results of actual pricing innovations rather than modelled case studies. Due to the EUROTOLL focus on short-term reactions, the case studies have not studied or detected changes of destination. What they have shown is that variation of charges by time of day/week/year on inter-urban motorways can be effective in reducing congestion, mainly by means of drivers changing route or time of travel. They have also shown the importance of combining information on tariffs and alternatives in order to reinforce the effects of pricing.

TransPrice examined trans modal pricing options by means of case studies involving both modelling and demonstration projects. It was based on actions and analyses in eight European cities: Athens, Madrid, Como, Leeds, York, Goteborg, Helsinki and Graz, thus covering a wide range of urban areas. Demonstration of pricing measures by real life application and experimental initial limited field trials of systems and measures is included in Athens, Como, Madrid, Leeds and York.

The integrated trans modal pricing measures examined in TransPrice comprise: Road Use Charging (Cordon Pricing, Area Licensing, Expressway Tolls); Integrated Public Transport Fares and Payment Systems; Parking Charges (On-Street, Off-Street, Private Non-Residential); Intermodality (Park & Ride, Bus/Rail/Metro/Tram); Public Transport System Financing and Revenue Support; Smart Card Payment Systems (Travel and Multi-Purpose Use); and, Combination with Other Measures (Access Control, Urban Traffic Control, HOV Lanes, Regulatory Traffic Restrictions, Public Transport Prioritisation, Pedestrianisation/Cycling Facilities).

The results from Transprice indicate that road use pricing is an effective way of changing modal split from private car to public transport and park & ride. The Athens road use pricing demonstration indicated diversion rates of 15-22% from car to park & ride and 5% to public transport. Modelling tests for five cities 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.

Clearly the reduction in car use implied by the PETS Lisbon case study, which is of the order of 30% for low externality valuations and 35% for high, is higher than found in any of the Transprice case studies. However, the PETS figure results from a pricing policy aimed at charging marginal social cost for all modes in a very congested environment, whereas the Transprice studies test a range of likely but not necessarily optimal charges. The two results are not necessarily inconsistent.

14.4 Priorities for Further Research

The PETS project has made a valuable contribution both to developing the methodology for calculating prices based on marginal social cost, and to understanding the consequences of implementing such a pricing system.

However, there remain many issues on which further research is needed. These include further work on issues covered in PETS, such as:

- estimation of marginal social costs for a wider range of circumstances in a wider range of countries, for urban, inter-urban, and semi-urban contexts, as an input into pricing policy formulation;
- ideally, estimation on a country-wide basis, enabling the overall implications to be determined for a country (e.g. the treatment of financial surpluses and deficits from new pricing approaches);

- examination of the implications of over- or under-investment in infrastructure capacity for pricing policy;
- further refinement of the estimates of external cost, including in particular environmental effects such as water pollution and the effects of high altitude emissions from aircraft; and,
- development of a methodology for taking into account the costs of scarcity of infrastructure capacity on scheduled modes of transport.

More importantly; a host of issues which were outside the remit of PETS require further research including:

- detailed consideration of the optimal package of pricing and regulatory measures, in the light of the cost and availability of pricing instruments;
- examination of implementation issues in the further development of marginal social cost pricing in practice, including in particular the development of packages of measures which yield the best possible tradeoff between efficiency, equity and acceptability and ways in which social cost information may be best disseminated.

Many of these issues are now being taken forward in the context of further research, initiated by the European Commission.

References

Baxter Eadie (1998) *Final report, STEMM Project.* Baxter Eadie, London.

Betancor, O., Campos, J. (1997) *Deregulation and pricing*. Pricing European Transport Systems, deliverable 3. Institute for Transport Studies, Leeds.

CAA (1995) *The single European Aviation Market: progress so far*. Civil aviation authority. CAP 654.

Christensen, P., Beaumont, H., Dunkerley, C., Lindberg, G., Rothengatter, W., Doll, C. (1998) *Internalisation of externalities*, Pricing European Transport Systems deliverable 7. Institute for Transport Studies, Leeds.

European Commission (1995) *ExternE - Externalities of Energy*. DGXII, Brussels.

Eyre, N., Downing, T., Hoekstra, R., Rennings, K. & Tol, R. S. J. (1997) *Global warming damages*. In: ExternE. Global warming subtask Final report, November 1997.

Friedrich, R., Bickel, P., Krewitt, W. (1998) *External costs of transport*. IER, University of Stuttgart, Stuttgart.

Hohmeyer, O. (1996) *Social costs of climate change. Strong sustainability and social costs*. In: Hohmeyer, O., Ottinger, R. L. & Rennings, K. (Eds): Social costs and sustainability – Valuations and implementation in the energy and transport sector. Springer Verlag. Berlin. 1996.

INFRAS/IWW (1995) *External Effects of Transport*. Study for the UIC. Zürich, Karlsruhe.

Intergovernmental Panel on Climate Change (1996) *The science of climate change.* Contribution of working group I to the second assessment report of the IPCC. IPCC, Cambridge.

Jansson, J.O., Lindberg, G. (1998) *Transport pricing principles.* Pricing European Transport Systems deliverable 2. Institute for Transport Studies, Leeds.

Jule, R. (1999) *Oslo-Gothenburg case study*. Pricing European Transport Systems deliverable 11b. Institute for Transport Studies, Leeds.

Keeler, T.E. (1991) *The revolution in airline deregulation* In Weiss, L. and Klass, K. (eds.) Case studies in regulation, revolution and reform. Little, Brown and company.

Mayeres I. et al. (1997) *Report on Valuation Rules, Transport Externalities.* TRENEN II STRAN -Project. European Commission.

Mohring, H. (1972) *Optimisation and scale economies in urban bus transportation.* American Economic Review, Papers and Proceedings.

Perkins S. (1997) *The Relevance of Valuation Indicators for Pricing Policy.* European Conference of Ministers of Transport (ECMT), the ECMT Task Force. QUITS Workshop, Rome 10 April 1997.

Peura, J., Otterstrom, T. (1999) *Finnish case study.* Pricing European Transport Systems deliverable 11a. Institute for Transport Studies, Leeds.

Proost, S., Van Dender, K. (1999) *TRENEN II STRAN Final report for publication.*

Centre for Economic Studies, Katholieke Universiteit, Leuven.

Rennings, K. (1997) *Selected issues of economic valuation of transport externalities*. Paper prepared for the EU DG VII seminar on "External costs of Transport" in Rome, April 10, 1997.

Sansom, T., Still, B., Nash, C. (1999) *Cross Channel case study.* Pricing European Transport Systems deliverable 9. Institute for Transport Studies, Leeds.

Suter, S., Neuenschwander, R. (1999) *Transalpine freight case study.* Pricing European Transport Systems deliverable 10. Institute for Transport Studies, Leeds.

TRT, CIRTRAS (1997) *Practical pricing problems*. Pricing European Transport Systems deliverable 4. Institute for Transport Studies, Leeds.

Tweddle, G., Fowkes, A.S. and Nash, C.A. (1995) *Impact of the Channel Tunnel: A Survey of Anglo-European Unitised Freight.* Working Paper 443, Institute for Transport Studies, University of Leeds.

Viegas, J., Fernandes, C. (1997) *Review of current situation.* Pricing European Transport Systems, deliverable 1. Institute for Transport Studies, Leeds.

Viegas, J., Macario, R., Martins, P. (1999) *Lisbon case study.* Pricing European Transport Systems deliverable 12. Institute for Transport Studies, Leeds.

Wardman, M (1998) *A Review of British Evidence on the Valuations of Time and Service Quality*. Working Paper 525. Institute for Transport Studies, University of Leeds.

Weinreich, S., Rennings, K., Gessner, C., Schlomann, B. (1997) *QUITS: quality indicators for transport systems: external quality validation.* Centre for European Economic Research, Mannheim.