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EUROPEAN CONFERENCE OF
MINISTERS OF TRANSPORT

INTERNALISING THE SOCIAL COSTS OF TRANSPORT

Foreword

FOREWORD

Transport activities are vital contributors to OECD economies. Not only is transportation important for the efficient delivery of a wide range of economic goods and services, the transport sector is also a major economic activity in its own right.

Despite this economic importance, transport markets often fail to take account of all social costs (or benefits) generated by transport services, when prices are set. Governments occasionally compound this problem by introducing policies that actually discourage the efficient functioning of transport markets. The result can be a sub-optimal allocation of economic resources to the transport sector, or within it.

Some of these "externalities" occur in the form of increased stresses on the natural environment, such as air and noise pollution. Some occur in other forms, such as increased risk of accidents or increased traffic congestion. Rapid growth in the volume and complexity of transportation services in recent years, coupled with higher levels of concern for the environment in general, has significantly heightened political interest in the problem of transport externalities.

This book presents the results of a 1993 OECD/ECMT seminar dealing with this important problem. After presenting an overview of the main issues involved (Chapter 1), the book surveys some of the growing literature on both the size and the nature of transport externalities (Chapters 2 and 3). Chapters 4 and 5 examine some of the policy options open to governments for resolving the problem, as well as how these policies might be implemented in actual practice. Chapter 6 considers the important issue of how the economic burden for using these policies should be shared. Chapter 7 examines some of the international dimensions of the problem, with special focus on the issue of policy harmonisation among governments. Chapter 8 provides a summary, and contains some broad observations and conclusions.

All reports contained in this volume were prepared under the 1993 "Sector Policy Integration" activity of the OECD Environment Policy Committee and the "Transport and Environment" activity of the ECMT Committee of Deputies (Working Group on Transport and Environment). The opinions expressed are those of the authors, and do not necessarily reflect the views of individual OECD Member countries.

Chapter 1

Overview of Internalising the Social Costs of Transport

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Introduction

Transport confers considerable economic and social benefits on society. It allows for the pursuance of specialisation in production and opens opportunities for industry to exploit economies of scale, density and scope. For the individual, it provides general mobility and, more specifically, affords access to diverse employment opportunities and enables a wide range of recreational and social activities to be enjoyed.

A major problem, however, is that, because of institutional and technical factors, transport often tends to be excessively intrusive on the environment and can, itself, be provided in a less than fully efficient manner, if levels of congestion are allowed to grow beyond the optimal level (OECD, 1988; ECMT, 1990). This report attempts to bring together some of the key issues which are central to reducing these problems and in ensuring that the fullest benefits from transport are, in the very widest sense, reaped.

Initially, there are important matters of definition still to be resolved. Much of the "jargon" employed in debates surrounding transport provision and use emanate from economics. Economics is a very precise subject, however, and in practical terms, there has been a tendency to oversimplification in the interpretation and use of this terminology. It is important, therefore, to be clear at the outset about the meaning of terms and their exact importance in the debate. This should be seen as a mechanism for ensuring that debates are carried through with as much clarity as possible and that they avoid much of the confusion which arises when some parties choose to apply their own interpretation to terms which have a very exact technical meaning.

The paper then goes on to consider the ways in which some of the environmental and efficiency considerations (such as congestion levels) can be brought within in the measuring rod of money. Although this may not be the only way forward, it is often helpful to translate physical effects into monetary measures so that trade-offs can be made between, for example, the financial benefits of a new transport service accruing to the operator and the environmental impacts that are imposed on the local community.

This leads into a consideration of the policy options which are available to contain environmental and congestion costs. In particular, each policy has its own technical advantages and limitations and it is important that these be recognised if progress is to be made. Adoption of any policy package, however, also depends very much on public acceptance of it. There are, for instance, good technical grounds for favouring the wider deployment of economic instruments, such as road-pricing, to tackle excessive congestion and emissions charges to limit environmental damage. To date, however, public acceptance of these measures has tended to have been limited and it is important to appreciate why this is so, if longer term progress is to be made.

Finally, there is the matter of the role of international policy and co-operation in assisting towards the improvement of the situation. Despite the relative newness of this aspect of the situation, a certain amount of progress in this area does seem to be emerging.

Externalities and social benefits

Terms such as "social benefits" and "external benefits" are often confused in popular debate. Since the notions of external costs and benefits, and also of internalisation, and the jargon which goes with these concepts, were initially developed by economists for public policy analysis, it seems reasonable to adopt some economic interpretations in the scientific debate. After all, economists do not reinterpret for their own purposes terms such as "piston" or "pavement depth", which were developed by engineering specialists -- economists accept them as the relevant technical terms. Nor is the important notion of social welfare a novel one in economics -- it has a pedigree going back over a century and a half (Button, 1979).

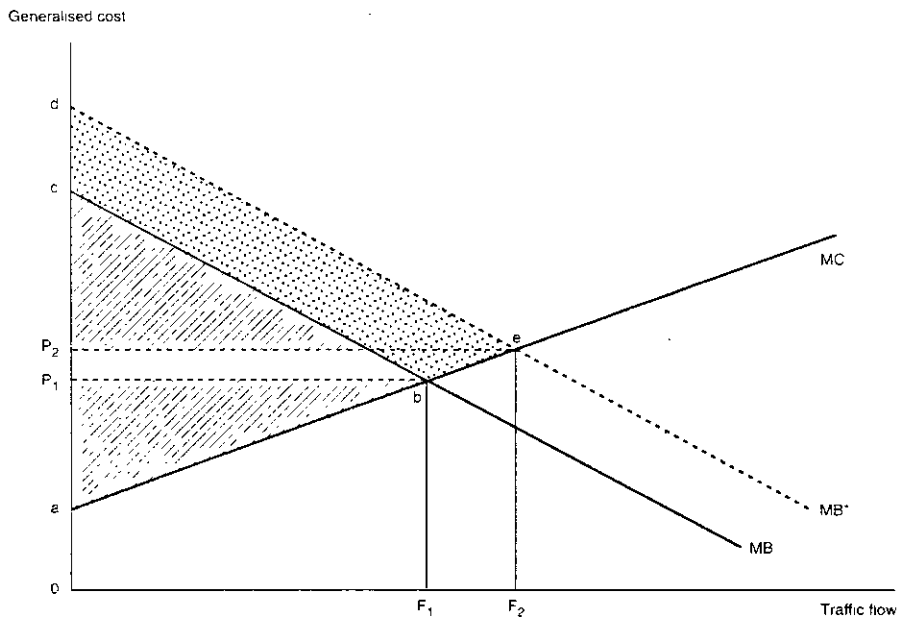
Social benefits are generally viewed by economists as the welfare generated by some activity beyond the costs of production. This can either be benefits to consumers or, in the form of profits, to producers. Some of these social benefits are within the market system -- i.e. they are internal to it -- while others are outside it -- they are externalities. There are parallel definitions of internal and external costs. In simple economic terms, an "externality" exists when there are either individuals or firms whose welfare depends upon the behaviour of others who do not take this interactive effect into account in their decision-making.

A useful way of explaining externalities, and at the same time of highlighting the meaning of social costs and benefits, is to consider a very simple example. A road is provided and the users of the road are charged a toll equal to the marginal financial costs of its up-keep (*MC*). For simplicity, although it makes no material difference to the substance of the argument, we assume that these costs of the road rise with traffic flow -- see Figure 1.1. Consequently, with traffic demand represented by *MB* (the marginal benefit of trip making) in the diagram the optimal traffic flow will be F_1 with each motorist paying a toll of P_1. The road will then generate two types of social welfare:

- There will be the *profits* (or producer surplus) earned by the road authority, as represented by the shaded area abP_1 in Figure 1.1 -- this is simply the excess of total revenue collected from the toll over the total costs associated with the flow F_1.
- There will also be the benefits enjoyed by the users beyond the tolls which they pay, as represented by the area P_1bc -- this is the conventional consumer surplus concept. This *consumer surplus* can arise for a variety of reasons and reflects the fact that users would be willing to pay more than the toll confronting them. In many cases, this willingness reflects such things as the ability of producing companies to earn high profits by using the road, or for land-owners to extract high rents because of the access the road affords to their property. Quite clearly, these net social benefits can be substantial but, unlike some claims (for instance Simons 1992), they are all *internal* to the market.

It should be noted that, even when the price is zero and the road users do not cover their allocated financial costs, there is often a high overall social return associated with road construction and use. This is because the consumer surplus benefits can sometimes outweigh *any* financial losses.

Figure 1.1



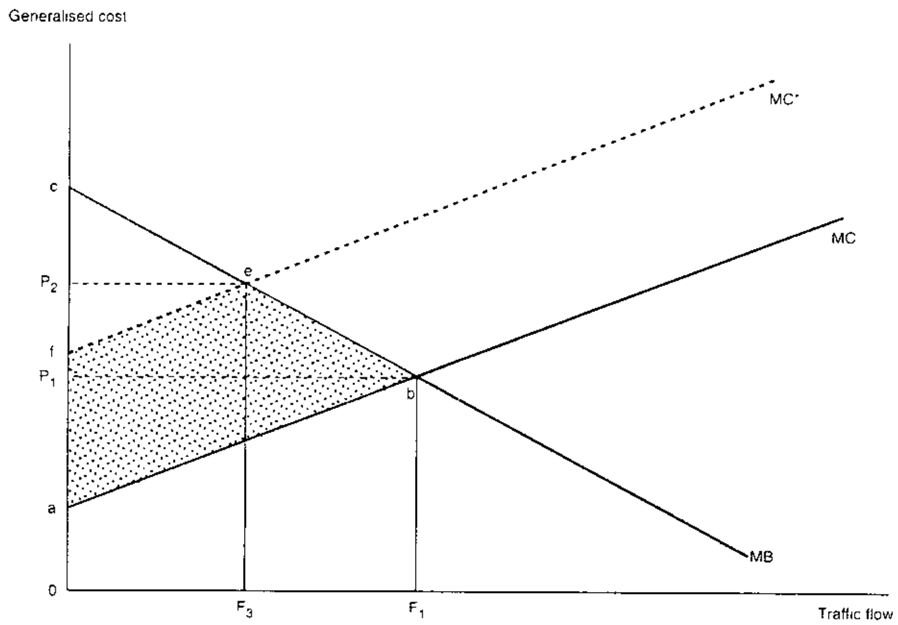
What it is important to remember and re-emphasise is just why transport users would be willing to pay prices above P_1 in the diagram if they had to, and why suppliers would be willing to offer the facility at this price. The reason is that the transport service is conferring substantial benefits on them both; benefits which may take a diversity of forms. In the case of users it may, for example, be because transport makes possible the of development of land (with its associated rent); it may be because transport adds value to other items of capital (factories, ports and so on); or it may be related to consumer considerations (access to sports facilities or shops). The danger in practice is that this social benefit aspect of transport can get confused with external considerations, and that double-counting of benefits thus results.

The externality aspect emerges when there are costs or benefits outside of this process. If there are external benefits (perhaps people appreciate the aesthetics of some pieces of transport architecture, such as bridges) this means that the marginal benefit curve for society is higher than the demand curve -- in Figure 1.1 this can be seen as *MB**. Clearly if the supplier of the facility could charge for this attribute (e.g. by levying a fee on everyone who admires the bridge), then it would be socially desirable to increase the amount of the facility available to reflect this additional benefit. In Figure 1.1, this would effectively mean providing capacity for a flow of F_2. At this flow, the total social benefit of the road system would increase from the area *abc* to *aed*. (The new levels of benefit to produces and consumers are now aeP_2 and P_2ed respectively.) In this case, strict internalisation of the positive externality would increase social welfare by an amount represented by the lightly shaded area *cbed* in the diagram. Alternatively, the additional capacity to handle the larger flow may be justification for subsidies, if internalisation is not possible (perhaps because of the administrative costs involved).

Just as there may be external *benefits* associated with transport there are also external *costs*. These may be associated with the workings of the transport system itself – such as congestion – or with third-party affects that are imposed on non-transport users -- such as air pollution, noise and visual intrusion. In these cases, the costs of transport as paid by users is sub-optimally low. In terms of Figure 1.2, this means that, while the road users are reacting to a marginal cost curve of *MC*, the full costs of their trips are reflected in the higher *MC** curve. The result of this is that if all costs are taken into account through internalisation, then the social benefit of transport would apparently fall from area *abc* to area *fec*. The reason for this is that, while some transport users have been enjoying benefits P_1eba, this has only been possible at the expense of both the overall efficiency of the economy and of the environment.

It is often useful to draw distinctions between various types of external cost to highlight the nature of these implications. External costs can be divided between *user-on-user effects* (sometimes called "club" effects) and *user-on-non-user effects*. In the former, the transport context is typified by congestion, whereby the congestion caused by trips is external to individual trip-makers, in the sense that they ignore the implications of their behaviour on other traffic, but internal to the "club" of road users. The economic efficiency of the transport network is thus reduced for those using it. In contrast, "user-on-non-user" externalities are typified by pollution and noise, because they exist when users of a road adversely affect society more generally, and the welfare of people who do not actually travel, in particular. Economic efficiency in Figure 1.2 will, therefore, have been affected if the external costs are in the form of congestion. The environment suffers because of the excesses of pollutants of all kinds which are emitted into it.

Figure 1.2

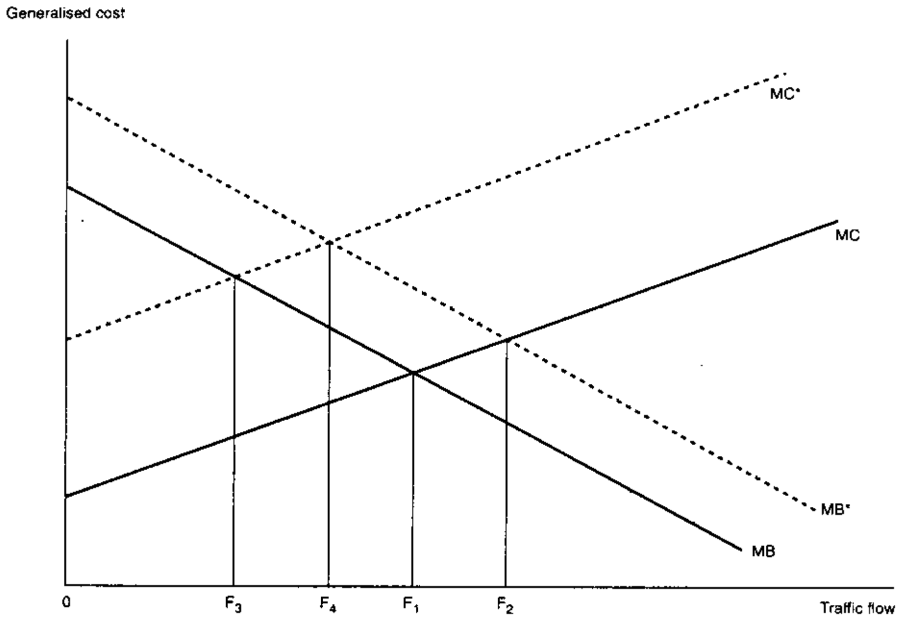


It is important to note that, just as there is sometimes a tendency in popular debate to confuse some elements of internal social benefits with external benefits, so this can also occur on the cost side. In particular, this may be the case with certain aspects of traffic safety which, rather than being entirely an externality issue, are internalised through the insurance market. The degree to which this happens tends to vary quite considerably between countries (and between states in some federal systems), according to the nature of the legal requirement to insure.

Overall, taking the combination of external benefits and costs into account (Figure 1.3) means that, rather than the traffic level being F_1, it should be F_4. Whether this traffic level is greater or less than would occur without any allowance being made for the external effects is an empirical question.

The actual evidence available is that, while there are some external benefits associated with transport, these tend to be quite limited in the long run. The reason for this is that there is a natural incentive for people to seek out benefits and to internalise them in a way which does not exist with external costs. In the case of the aesthetics argument brought up earlier, for example, people may like looking at aircraft taking off and landing, but if they are numerous enough, and it is technically easy to do so, an airport will start

Figure 1.3



charging admission to viewing areas. (A minor example of this used to be the platform tickets sold by British Railways to "train spotters" who spend time at railway stations collecting locomotive numbers -- the return was small, seemed unlikely to have been sufficient to justify additional capacity, and has subsequently been abandoned because of administrative costs.) Of course, significant external benefits may exist in the short term as markets adjust and, for a period, can be quite substantial -- one can think of examples in the land market where this happens -- but in the long term, there are incentives for internalisation. Quite clearly, such incentives for automatic internalisation seldom exist with external costs.

What should also be noticed from Figure 1.3 is that internalisation does not mean that the environmental and congestion costs which are associated with transport use are entirely eliminated. They are *reduced* in the case illustrated, but the important thing is that correct pricing will *optimise* such costs. Such prices provide guidance as to whether the overall social benefits of additional travel beyond F_4 are justified, given the additional costs involved -- in the example provided here, they are not.

In summary, the important point about an externality is that it is not the existence of an effect on others that constitutes an externality, but the lack of incentive to take full account of it. Every economic action may affect others, but in a well-functioning system the price mechanism provides incentives to take account of these effects. This is perhaps one of the main reasons why careful and rigorous studies have isolated few external benefits from transport. Transport unquestionably provides a vast array of *social* benefits, but there are few *external* benefits, quite simply because there is an incentive to internalise them and bring them within the price structure. There is, of course, much less incentive to internalise external costs.

The concept of internalisation

The normal response to the issue of external costs in transport is that they should ideally be "internalised". The aim of internalisation, the bringing of external effects into the market process, is that it will result in a better use of resources. By making all transport users more aware of the full costs of their actions, as well as making those adversely affected of the costs of insulating themselves from these costs, the overall use of economic and environmental resources will be more efficient. Individuals will be able to make more informed judgements about the costs and benefits of the alternatives which are open to them.

Just as there is often confusion between the ideas of social costs and externalities, the term "internalisation" is also frequently used in a cavalier manner. Again, since the jargon originates from economics, precise economic definitions seem appropriate if clear debate is to be fostered. Strictly internalisation can only come about if property rights are allocated to the resources in question (for example, to road space in the context of congestion, or to the atmosphere in the case of air pollution). If this is done, the various affected parties can either trade these rights so that the optimal use is made of the resources -- the Coasian (Coase, 1960) solution -- or they may merge their activities so that they are forced to adjust their behaviour for their own mutual good.

The main practical problems limiting any extensive effort at pure internalisation stem from difficulties in monitoring the use of environmental resources and from transactions costs involved in administrating such regimes. Strict application of the "pure internalisation" approach to traffic congestion would, for instance, involve each motorist encountering another engaging in a bargaining process, to determine who passes whom.

In practice, these approaches are thus seldom applied in their pure form, but some crude approximations have been attempted. The use of marketable permits in the USA to reduce lead emissions from cars is an imperfect use of property rights (Hahn and Hester, 1989). The federal government allocated a predetermined amount of lead for use at refineries, and allowed market trading between the refineries to optimise the use of the lead. This is not "pure" internalisation because the overall quantity of lead involved in the trading process was determined by dictate and not by a market process.

While these options involve moves aimed at strict internalisation, a more common, although imprecise, employment of the term involves the use of such devices as Pigouvian taxes and subsidies (Pigou, 1920) or command–and-control instruments to reduce the level of the external cost. These are not *strict* measures of internalisation, but may be seen as resulting in *quasi-internalisation*. They do not create a market for the external effect, since it is only one party which bears the incidence of the change. What they represent are measures by government to induce behaviour which is thought to be consistent with optimal levels of external cost. Consequently, while there are either fiscal or physical incentives associated with such measures to reduce external costs, they are not strictly internalising these costs. It should perhaps be remembered that this distinction between internalisation and the use of Pigouvian taxes and similar measures is not a trite one -- indeed, the Nobel Prize Committee felt it significant enough to award their highest honour to Coase for highlighting it.

The difference between strict internalisation and the use by the authorities of other economic instruments (such as emissions charges) or command-and-control instruments can be seen by considering an example. If there are noisy cars, internalisation of this noise might be achieved by allocating rights to peace and quiet to residents. In turn, the residents could sell some of these permits to car users and a market would develop in "noise". The outcome would be some abatement of the noise, since car users will have to pay for disturbance rights, but there would also be actions taken on the part of residents to insulate themselves from the noise (such as fitting double-glazing). The residents would do this because they could gain more by selling some of their property rights to "peace and quiet" and installing insulation, rather than by forcing car owners to further limit their noise emissions. Trade in these property rights would produce the optimal response by all parties. The use of a noise emissions charge or the setting of a noise standard does not bring about this response because it is only aimed at one party, and because those suffering the noise will have no inducement to play their part. Of course, in theory, a package of measures designed, on the one hand, to bringing about the optimal reduction in emissions coupled with, on the other hand, optimal insulation by those affected by the externality is possible, but predicting exactly what that package should look like would be virtually impossible.

A further point to note is that internalisation is concerned with the efficient use of resources and is not concerned with normative matters such as who should pay or who should benefit within the market. If property rights to environmental resources are created, and trade for them takes place, it does not matter, from an efficiency perspective, who initially gets those property rights. This is equally true if devices such as pollution taxes or subsidies are introduced -- for example, one can reach the same target level of pollution damage by either taxing the generator of the pollution or by paying the generator a subsidy to modify its levels of emissions.

For practical purposes in discussing policy implementation, while one would ideally like to keep to the scientific exactitude of economic definitions, the widespread use of the term "internalisation" to imply any form of a number of possible policy measures which attempt to reduce the incidence of external costs (in terms of Figure 1.4, a move to a traffic level akin to F_4), means that a broader definition of the term is used in the rest of the discussion. In other words, internalisation effectively means, in this rather imprecise context, the use of policy to reduce the external costs of transport to a socially desirable level. It, therefore, embraces *strict internalisation* and, what one might term, *quasi-internalisation*. Further, it does not necessarily mean removing the effects of externalities entirely.

Monetary Valuations

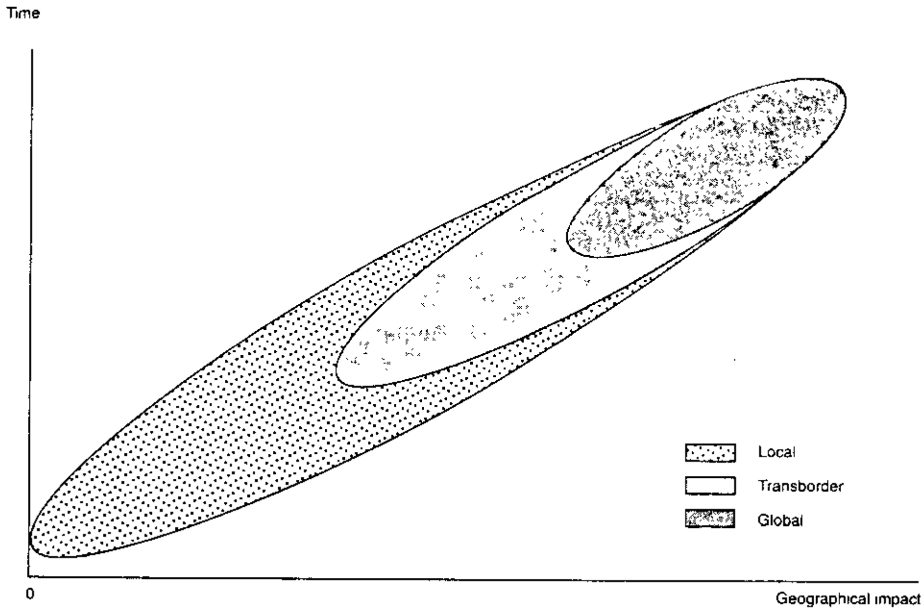
The placing of monetary values on the externalities associated with transport, although not a necessary condition for policy formulation, has a number of distinct benefits associated with it. Not the least of these is that it enables important trade-offs between internal and external effects to be made using a common numéraire. The practical issue is one of deciding on evaluation methods. While still not yet exact in their application, the science of placing appropriate monetary values on many of the major externalities associated with transport have clearly progressed a long way in recent years (see Chapter 2). Indeed, with regard to several aspects of environmental intrusion and congestion, relatively robust calculations of these costs are now available.

A major difficulty with evaluation of transport-induced externalities, and in particular those associated with environmental effects, is that their impacts can be quite diverse. For ease of understanding the evaluation problem it is helpful to separate the effects into three spatial/temporal categories; Figure 1.4 provides a broad indication of the relationships:

- There are *local effects* on residents and workers, and to property, in the area immediately adjacent to the transport activity. Noise nuisance is the most apparent problem, but there are also local air pollutants, such as lead and particulates, which can have adverse effects for health, while sulphur and other emissions can damage buildings. Vibration, community severance and danger can be added to this list; traffic congestion is also a local cost.
- There are *transboundary effects* which can impact on adjacent areas. These include low level ozone, which can spread across wide parts of urban areas, and "acid rain gases", such as nitrogen oxides, which can harm woodland and lakes some distance from the site of the emission. These transboundary effects by their nature, tend to impact in the medium term rather than immediately.
- There are *global effects* on the atmospheric composition. The main concerns here are "greenhouse gas" emissions, such as carbon dioxide, which, by preventing heat escaping from the planet, can bring about global climate change, and stratospheric ozone depleting gases, such as chlorofluorocarbons, which lead to increased risks of cancer. These are much longer term concerns.

This diversity complicates policy initiation, especially concerning the level of decision-making which should exercise the policy rights. But even before this stage is reached, it poses problems for evaluating the scale of the problem. For example, the longer term impacts of carbon dioxide (CO_2) are difficult to forecast (and hence, to cost), both because of simple prediction problems of foretelling ambient levels and because of lack of complete knowledge about the exact link between the original emission and the eventual global warming. Added to this, the diversity of implications of global warming on the ecology of the planet is so immense that evaluation is virtually impossible. Efforts at such evaluation to-date tend to be geographically very partial (for example, looking just at the USA), and only to be concerned with the impact of such costs on national income performance.

Figure 1.4



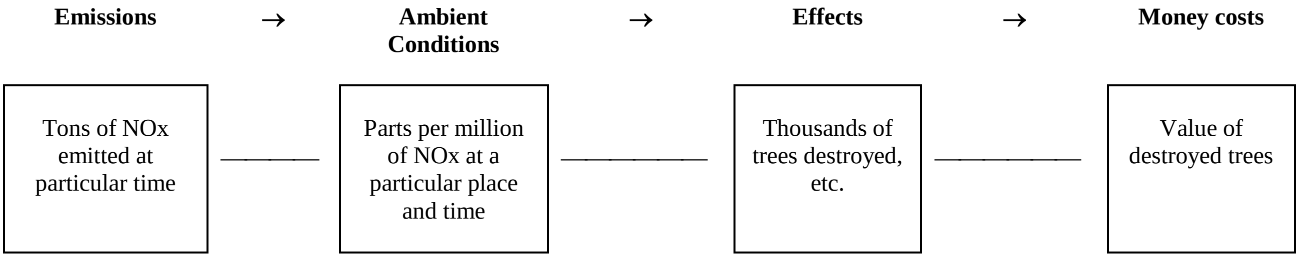
A further difficulty is that there are often important non-linearities inherent in many externalities. For example, the marginal impact of additional cars on the congestion inherent in the traffic stream is an increasing function of the existing traffic flow, with each additional car imposing more time and operating costs on other vehicles than preceding cars. This effect can become acute if congestion on one road leads to problems at junctions further back in the network and, in the extreme, can generate "gridlock". Equally, health effects are often non-linear and, in extreme cases, there are critical thresholds of atmospheric pollution, above which costs may become infinite (i.e. the pollution doses are lethal). In these latter instances, the policy question is not so much one of evaluation, but one of finding the most efficient way of ensuring that such critical levels are not reached.

It is because of these types of problems that most evaluations of the external costs of transport have tended to focus on local and, to a lesser extent, transboundary effects (Kanafani, 1983; Quinet, 1990). Before discussing the techniques available for evaluating even these local and transboundary items, several other points relevant to the methodology employed need clarifying:

- First, the tie between the physical external effect and its monetary evaluation is not normally a direct one, but involves a number of links which are often difficult to quantify -- Figure 1.5 offers an example in terms of NO_x emissions from cars on forestry. In many cases, our knowledge of the exact form of each link is still imprecise and cloudy. It is also extremely difficult in many instances to measure even the physical magnitude of an externality, let alone to evaluate the impacts of that externality (e.g. stress resulting from living in a congested environment).
- Second, the total valuation will depend on the breadth of the social impact under consideration. In simple terms, for example, excessive NO_x emission will increase the costs of forestry to the lumber industry but, if the breadth of impact is extended, other costs may emerge. Some sections of society may be concerned with the "bequest value" lost -- the fact that forests will not be there for future generations, while others look at the costs associated with the possible loss of bio-diversity. A full evaluation of costs would take these, and other, factors into account.
- Third, valuations tend to provide measures of the aggregate monetary cost of an externality to a population (often expressed as a percentage of national income). As seen below, however, in many cases policy decisions are determined as much by the distribution of costs and benefits

across society as by their overall magnitude. In most empirical studies, however, most attention for practical reasons is on the aggregate effect, which often hides these important distributional impacts.

Figure 1.5



The techniques of evaluating the local and transboundary environmental and congestion costs of economic activities have advanced considerably in recent years (Johansson, 1987). As Quinet points out in Chapter 2, there are now a variety of procedures available -- each with its own strengths and weaknesses. These methods can, in summary, be classified into several broad categories:

- *Precedents*. This method looks at such things as legal judgements on environmental damage from transport (such as compensation from oil spills) and at payments to workers for undertaking employment in environmentally-degraded conditions. The empirical evidence generated by these forms of analysis tends to be inconsistent, mainly due to the problem of isolating the exact justifications for the payments made.
- *Averting behaviour*. This method embraces such things as assessing the costs of insulation or altering behaviour to reduce adverse environmental effects. As Quinet indicates in Chapter 2, this is a legitimate element of the cost of the externality. Normally, however, it is difficult to determine exactly how much of the cost of averting behaviour is strictly determined by the imposition of the negative externality. Double glazing, for instance, not only reduces noise problems but also saves on heating costs. It also says little about the costs of the remaining emissions.
- *Revealed preference*. This procedure looks at actual trade-offs which people make when there are environmental costs involved. It uses a secondary market to gain insights into the implied market for externalities. Perhaps the most common method is to look at the housing market to seek differentials in property prices which reflect variations in the level of environmental intrusion. This frequently involves relatively sophisticated statistical analysis (e.g. hedonic price methods), since houses tend to exhibit a broad range of attributes of which variations in exposure, say to traffic fumes, may be but one. The main limitations of the procedure are, first, that it can only cope with evaluating existing levels of environmental intrusion and this is of little help if one is attempting to put a value on substantial changes in, for example, pollution levels; and, second, that it is very difficult to allow for all of the other reasons why property values differ, despite the trend toward the deployment of an army of sophisticated econometric tools.
- *Travel cost method*. This is a particular form of the "revealed preference" approach, which is designed to evaluate such things as parks and sites of natural importance. It essentially looks at the amount people pay in terms of travel costs (fuel, travel time and so on) to visit such sites. It shares many of the same problems as the hedonic house price approach, but there is an additional problem, inasmuch as the time input into the travel cost must itself be given a monetary value for it to be incorporated in the evaluation framework.
- *Stated preference (contingency valuation)*. By asking carefully couched, hypothetical questions -- in other words, a sort of market research methodology – it is possible to gain

insights into how much individuals value the environment. Essentially, people are given hypothetical options in pre-specified circumstances and asked to make choices. The outcome of these choices in turn provide guidance to the values they place on external factors. The technique has the particular advantage that it can gain information about the values put on the longer term implications of environmental intrusion (i.e. "bequest" values). The main methodological problems derive from difficulties in posing appropriate questions and in ensuring that respondents do not act strategically when answering them (respondents may offer answers which they think may ultimately benefit them, rather than ones which reflect their genuine preferences).

The body of information that we have indicates that the external costs of transport are significant. In particular, the costs of traffic congestion in terms of time wastage and fuel consumption are high, with important noise and safety concerns also emerging as substantial (Quinet, 1990). (Comfortingly, this ordering also seems to be broadly in line with opinion polls which have sought views on modern social problems -- see Chapter 6). There are also indications that, in some circumstances, there is a high correlation between the external costs borne by the transport system itself (namely congestion) and those imposed on third parties (namely noise, pollution, vibration and the like). This seems particularly so in urban areas -- see Table 1.1 for evidence from the USA. This latter feature seems especially relevant for policy deliberations, since it may point to important problems which would be the most cost-effective to tackle immediately. The argument for making traffic flows more efficient by reducing congestion may, for instance, be more attractive to the electorate if this also brought about environmental gains.

These quantitative conclusions produced by Quinet and others do, however, come from a diverse range of studies which employ all the estimation techniques outlined above. They are thus inevitably open to the criticism that they are "adding apples and oranges". This is inevitable if one uses a range of studies from a variety of countries for comparison. At the national level, it is possible to be more consistent and to employ a common methodology, but this does not generally seem to affect the overall conclusion (see Chapter 3).

Table 1.1. **The social costs of urban traffic congestion in the USA**

Social costs	**Cost per vehicle-mile (1982 prices)**
Travel time	$0.1152
Air pollution	$0.0256
Noise pollution	$0.0037
Excess fuel consumption	$0.1105
Traffic accidents	$0.1265
Total	$0.3815

Source: Khisty, C.J. and P.J. Kaftanski (1986). *The Social Costs of Traffic Congestion During Peak Periods*. Paper presented to the 66th Annual Meeting of the Transportation Research Board, Washington.

The use of a standard methodology to evaluate all external effects does, however, raise a rather important question. This involves the appropriateness of any single procedure to cover all the diverse effects of transport activities. In some cases, because the effects are short term (such as noise), matters relating to bequest values, for example, are of limited relevance; thus, hedonic price methods may be most appropriate. Equally, if one is concerned with the costs of building roads or high speed railways through scenic country-side, the "travel cost method" or the "stated preference approach"may be more appropriate. In other words, there may well be justification for using different evaluation proceeds for different external effects, rather than using a common methodology for them all. This is an issue which needs further analysis.

Policy Options

Evaluation of the external costs of transport allows an assessment of the degree to which they should be reduced (even if not strictly internalised). Initially, however, it is useful to know what the underlying causes of the problem are -- this will influence the appropriate policy response. The original externality may, for instance, stem from inherent imperfections in the market mechanism itself, or they may stem from the side-effects of actions by policy makers themselves (Barde and Button, 1990). If the problem is of the former kind, there is a need for market adjustments, either through the use of economic instruments, such as Pigouvian charges, or through regulations and standards. If the problem comes from inappropriate government interventions, there will also usually be a need for some form of institutional change (Button, 1992).

Since intervention failures are already considered in detail in Button (1992), the focus here is primarily on the problem of market failures and, given the potential administrative and enforcement problems of implementing strict internalisation, it assumes that quasi-internalisation is the primary approach. If one considers Table 1.2, it is clear that, although this is mainly concerned with road transport, there are a variety of ways of reducing the external costs of transport. These can be effected either at the level of the vehicle, the fuel used or, more generally, the traffic itself. The policy instruments also offer the possibility of cocktails of measures, although assessing the individual contributions to quasi-internalisation of each may prove difficult.

Table 1.2. **Policy options for control the external costs of road transport**

	Market-based incentives		**Command-and-control regulations**	
	Direct	**Indirect**	**Direct**	**Indirect**
Vehicle	• Emission fees	• Tradeable permits • Differential vehicle taxation • Tax allowances for new vehicles	• Emissions standards	• Compulsory inspection and maintenance of emissions control systems • Mandatory use of low polluting vehicles • Compulsory scrappage of old vehicles
Fuel		• Differential fuel taxation • High fuel taxes	• Fuel composition • Phasing our of high polluting fuels	• Fuel economy standards • Speed limits
Traffic		• Congestion charges • Parking charges • Subsidies for less polluting modes	• Physical restraint of traffic • Designated routes	• Restraints on vehicle use • Bus lanes and other priorities

Which of these instruments is the most suitable depends to a large extent on the particular circumstances, and on the form of the external cost under consideration. There are strong arguments, mainly associated with flexibility and the fact that they dovetail into market systems more naturally, for looking toward economic instruments such as charges or marketable permit systems whenever possible (OECD, 1991). Economic instruments also often provide valuable flows of revenue which in turn can be used to compensate those who have to adjust their behaviour as the result of the policy (Goodwin, 1990; Small, 1992). It is also true that there are several quite dramatic examples of where economic instruments have proved effective in reducing some of the external costs associated with transport. Perhaps the most obvious of these are:

- the marketable permit system used to phase lead from petrol in the USA (Hahn and Hester, 1989);
- the area licensing system used to contain congestion in Singapore (Behbehani *et al*., 1984); and
- the use of differential taxation to reduce the use of leaded petrol in many countries, especially in Europe.

Despite these successes, the use of economic instruments to contain external costs is generally low (Opschoor and Vos, 1989). There seem to be a number of reasons for this, some of which represent real obstacles, while others are more of a psychological nature (see Chapter 5).

First, recent history has witnessed a general withdrawal of state intervention, as increased deregulation and privatisation have taken place. There are a number of reasons for these liberalising trends, but since they are occurring in most democracies, it must be assumed that they reflect social preferences. In many eyes, the introduction of new charges or other forms of economic intervention would run counter to this pattern and is, thus, ideologically in conflict with it. (One could add here, however, that in some cases, such as the privatisation of transport infrastructure, the new market mechanisms which are emerging could have beneficial environmental consequences if they lead to charging regimes which reduce congestion levels and use.)

Second, and drawing upon the academic work of Frey *et al.* (1985), Common (1990) and others, there is evidence that policy makers are fearful of the possible adverse distributional implications of deploying economic instruments. In many cases, for example, the use of the price mechanism to limit the external costs of transport would appear to impose a particular financial burden on poorer sections of the community. There are also inevitable spatial and sectoral distribution issues to consider, which may have more to do with the relative consequences for specific regions and interest groups than with the absolute well-being of poorer sections of the community. In fact, the empirical evidence relating to the exact incidence of different policies is thin and most standard data sources offer few useful insights (see Chapter 6). Even if there are serious regressive implications (either in relative or absolute terms), however, the revenues generated by such policies could often provide an adequate basis for compensation. Indeed, several recent studies (Small, 1992) argue that, in the case of congestion charges, the main issue now being debated is effectively how the proceeds from such schemes should be dispersed.

Third, there are often *practical problems* involved in using economic instruments (see Chapter 5). There may be significant transaction costs involved in any form of effort at quasi-internalisation, and these may simply be higher in some instance with economic instruments than with other policies. Thus, overall such instruments are less efficient. In some cases, such as with certain forms of electronic road-pricing aimed at containing congestion, there are problems of designing systems which do not infringe on personal privacy.

Fourth, there is an *asymmetry* in the ways in which individuals perceive charges and the benefits that may flow from them. It has been estimated that an efficient road-price would, for instance, immediately increase the average household budget in London by about 60 pour cent -- the costs are therefore transparent. On the other hand, the benefits of a more efficient transport system and an improved environment are less immediately apparent -- they would take time to materialise and are difficult to visualise in advance.

Fifth, policies are generally carried into being by coalitions of interest groups and this can lead to the capture of the system by powerful lobby groups, who feel it is not in their direct interest to internalised external costs through the adoption of economic instruments. Such groups can include automobile clubs, transport operators and vehicle manufacturers (see Chapter 5). A particular case of capture can emerge through the "principal-agent" problem. This arises when there are differences in the interest of those setting the policy and those responsible for carrying it through. The outcome may be a reluctance on the latter's part to initiate environmental charging measures which are not in their direct interest, or to inadequately enforce measures which are already in place.

Where strict internalisation or the use of fiscal instruments is either practically difficult or politically impossible, regulations and other command-and-control instruments offer the prospect of containing the environmental damage. Regulations are already widely used and range from measures such as the need to drive on a specific side of a road and priority rules at junctions (which in the road transport context are often taken for granted), to restrictions on aircraft landings, design requirements for vehicles and regulations governing the use of land. Increasing advances in technology provide considerable scope for improving the environmental performance of transport regulations regarding, for example, the introduction of "best-available-technology". These changes can provide a useful way of reducing external environmental costs. In some instances, it may be effective to combine fiscal and command-and-control measures, as has been practised in Germany, by providing financial inducements for transport users to take up new technologies in advance of statutory requirements to do so. In other cases, as with the combination in the UK of the introduction of differentiated leaded/unleaded petrol taxation, along with the banning of low octane leaded fuel to release storage space for the unleaded fuel, combinations of economic and regulatory instruments can have positive synergy effects.

Policy Acceptance

A plethora of academic studies have examined the pros-and-cons of alternative policy options designed to internalise the external costs of transport (Button, 1993). Despite this, the policy response has been comparatively slow, and there remains a marked divergence between the policies which are often advocated and their acceptance into transport policy. Perhaps the most transparent example of the is that of road-pricing to help optimise urban traffic congestion where serious consideration has been given to schemes in the Netherlands (see Chapter 4), Sweden (see Chapter 3), the UK (see Chapter 6) and the USA in recent times, but to date, no OECD/ECMT country has moved beyond the exploratory stage.

Of course, this does not imply that no advances have been made. Indeed, in recent years, the policies pursued by many countries aimed at reducing lead in petrol (either through taxation differentials or marketable permit systems), and at containing growth in nitrogen oxide emissions (through regulations on the fitting of catalytic converters) have been notable successes. One must also add to this the reductions in fatal accidents which have taken place in many countries as a result of better design of infrastructure and vehicles, better operational laws and better education.

To take the situation forward, however, it is important that new policy initiatives gain public acceptance. Many would agree that the intellectual battle for increased use of measures designed to ensure that the external costs associated with transport are more fully brought into decision-making is already won, but the practical matter of translating this into actual policy initiatives still exists. It is not easy to reduce external costs because, by definition, it means reducing the consumption, either by economic or other instruments, of something which has previously been perceived as a free good.

An important step forward would be improved education concerning the issues involved. While individuals have general impressions about external costs, there is no incentive to seek more details, and there is still often far from a full appreciation of the nature of the problem or its magnitude. More education would serve two purposes:

- It could help to gain acceptance for actual policy measures, be they economic or regulatory in orientation, which would help improve the situation. In other words, it would reduce the asymmetry in perceptions that was outlined in the previous section.
- Second, it could lead to autonomous changes in behaviour as individuals, even without the stimuli of new charges or controls, adjust their transport patterns to enhance social welfare. (In terms of Figures 1.1, 1.2, and 1.3, this may influence people's perceptions of the marginal benefits of their trips, and shift *MB* to the left.)

A further problem with market adjustments, using either economic instruments or command-and-control measures, is that for these adjustments to be successful, they require high quality and objective information, not only about the current situation and underlying relationships, but also in terms of future trends and the impacts of the interventions themselves. Further, since people are being asked to reduce their consumption of resources previously perceived as being free, there must be public confidence in this information. The evidence available, however, is that frequently the information acquisition and development process is "captured" by the policy making mechanism.

Examples of this later problem can be seen in Pickrell's (1989) study of grant programmes funded by the federal Urban Mass Transportation Administration in the USA. These grants were given to cities partly to encourage trip-makers to switch from private to public transport, both to reduce congestion and to contain environmental degradation. Pickrell's study found that all ten urban public transport projects that were examined produced major underestimates of costs per passenger (for example, the costs for the Miami heavy rail transit were 872 per cent of those forecast; for Detroit's downtown people mover, they were 795 per cent; and for Buffalo's light rail transit project, they were 392 per cent). While inaccurate costing was one element of the problem, the forecast patronage in all cases was also over-optimistic (see Table 1.3). Indeed, only the Washington heavy-rail transit project experiences actual patronage that is more than half of that which was forecast.

Some of the differences can be explained by technical difficulties in predicting future values of explanatory variables such as demographic changes, automobile costs and the service levels which the public transport service would offer, but Pickrell argues that important questions must also be raised over the structure of the models employed, the ways in which they were used, and the interpretation of their output during the planning process. These and similar forecasting problems associated with the impacts of alternative policies clearly need to be addressed from a purely technical perspective, if measures aimed at the quasi-internalisation of external costs are to be successful.

Perhaps of equal importance is the loss of public confidence which can arise from excessively optimistic forecasts of the type outlined above. These reflect far higher costs than anticipated for far smaller social gains, and this is unlikely to instil confidence in the public's mind that any alternative measures will prove more successful at meeting environmental and other objectives.

Table 1.3. **Forecast and actual rail transit ridership in a number of US studies[1].**

	Heavy rail transit projects			Light rail transit projects				DPM[2] projects	
	Washing-ton	Balti-more	Miami	Buffalo	Pitts-burgh	Port-land	Sacra-mento	Miami	Detroit
Forecast	569.6	103.0	239.9	92.0	90.5	42.5	50.0	41.0	67.7
Actual	411.6	42.6	35.4	29.2	30.6	19.7	14.1	10.8	11.3
% difference	-28	-59	-85	-68	-66	-54	-71	-74	-84

Notes: 1. A heavy rail transit project for Atlanta was also examined, but no passenger forecasts were made.
2. Downtown people-mover.

Source: Pickrell, D.H. (1989). *Urban Rail Transit Projects: Forecast versus Actual Ridership and Costs*. Cambridge MA: US Department of Transportation.

There are also lessons which can be learned from those policies of quasi-internalisation which have been successful. In general, the experiences of area licensing, marketable permits for lead, the fitting of catalytic converters, speed limits and so forth suggest that public acceptance is eased if there is a definite and explicit link between objectives and instruments. The Singapore area licensing system was a congestion-reducing measure; catalytic converters reduce NO_x emissions; and speed limits reduce accidents. Where economic instruments have been used for other, less direct, internalisation policies (such as the toll rings in a number of Norwegian cities), a similar clear linkage is also apparent.

The need for such links is perhaps to be expected, since it leads to political accountability and (particularly in the case of fiscal measures) helps reduce fears that such policies would ultimately simply become mechanisms for enhancing sumptuary taxation revenues. [Ideally, as Banister argues in Chapter 6, it is desirable to avoid this latter problem by legislating for measures to be broadly fiscally-neutral in their overall impact.] What this linkage could mean in practice is that a diverse portfolio of instruments may need to be adopted (see Table 1.1). In some instances, however, the transaction costs associated with a complex portfolio may make this option difficult. Under these conditions, and given the high correlation between many external costs and energy use, there may be a case for putting an emphasis on additional fuel duties. Ideally, and to retain accountability, such charges should be broken down into their constituent elements, and their exact levels made clear.

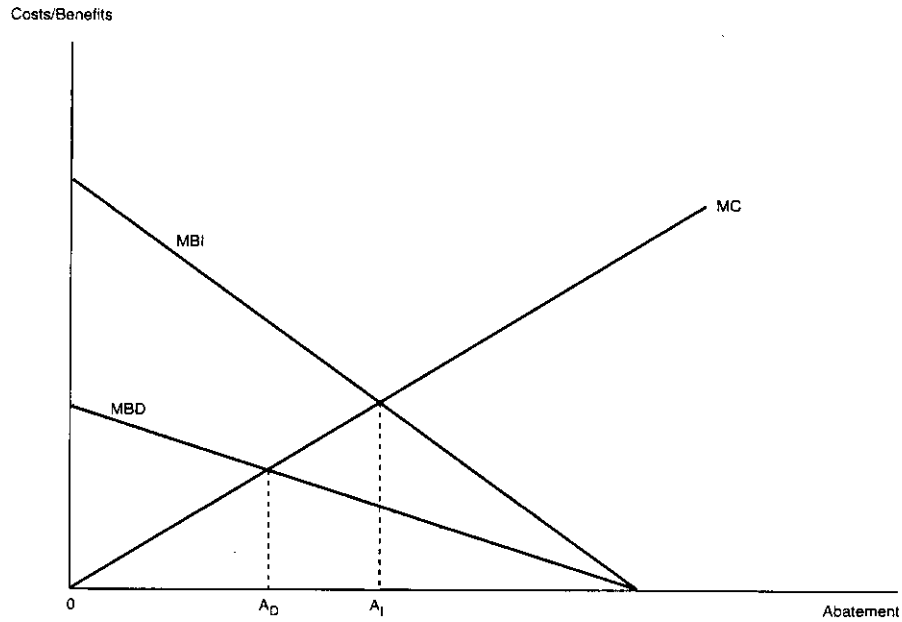
Tied to the notion of accountability and, in particular, to the idea that instruments such as charges could lead to governments collecting high levels of sumptuary revenues which are not used to maximum social effect, there may be instances where a degree of hypothecation and ear-marking is necessary to gain public acceptance of economic measures. Standard public finance theory argues for public revenues to be spent on activities yielding the highest social return rather than for individual income flows to be set aside for particular purposes. Alternatively, the Public Choice School favours ear-marking to ensure that revenues are not wasted and that the public can select the charging/expenditure packages that they prefer. While complete hypothecation is unlikely to be desirable, even in the Public Choice framework, some amount of ear-marking may be required to gain public confidence in the way economic instruments operate.

International co-operation

Establishing international co-operation in the quasi-internalisation of the environmental and congestion costs of transport is important from both the narrow perspective of traditional economic efficiency, and as part of a longer term strategy aimed at attaining sustainable development. To ensure maximum efficiency in conventional economic terms, international trade should be carried out on the basis of full-cost pricing, which should embrace all congestion and other costs. In the longer term, international co-operation is needed to ensure that transboundary pollution levels are optimised and that matters of a more global interest (such as ozone depletion) are resolved in an effective manner.

The problem is that, without co-operation, there is a tendency for individual countries to lack an incentive to fully internalise transport costs. Figure 1.6 provides a simple illustration of why this tends to be so. Many of the negative external costs of transport, and especially global and higher level ozone depleting emissions, are not only external to individual users of transport, but are also external to the country in which

Figure 1.6



they make their trips. There is a tendency for domestic governments, therefore, to ignore such effects, or at least not to take them entirely into account in their policy formulation. In consequence, the benefits for any country to reduce its transport-induced emissions are represented in Figure 1.6 by *MBD*. Reductions in such emissions as CO_2, CFCs and NO_x, however, have wider implications for the global community -- the full international benefits of abatement are, therefore, those represented by *MBI*. If the costs associated with various levels of abatement to our target country are *MC*, then abatement will only occur to the level A_D. Full allowance for the benefit of further reductions in emissions to the entire international community would indicate that abatement should ideally continue to A_I. Of course, if all other countries are confronted with similar cost and benefit curves, there is an incentive for the first country to advocate that others abate to the internationally-optimal level, while it remains at A_I. It can then *free-ride* on the improved global environment that results, without incurring high abatement costs itself. This is where international co-operation and notions of international harmonisation become important.

While national self-interest often makes international co-operation on environmental issues far from easy, a number of important advances have been made in recent years.

First, internalisation (or more often, quasi-internalisation through taxes or controls) is essentially concerned with efficiency, and not with the distributional incidence of policy. From a co-ordinated policy perspective, however, it is important that all countries pursue similar strategies regarding whether the polluted or the polluter is targeted for action. The 1975 Polluter-Pays-Principle (OECD, 1975) provided an important step forward in this respect, by putting the onus of the burden for correction on those actually responsible for the external costs. This approach reduces the problem of seeking the most effective way of ensuring that payment is made, either by having to conform to rules, or by paying a charge. In some instances, the long-term adoption of the Polluter-Pays Principle may require short term subsidies and other aid to help ease the transition from existing structures, which tend to be of a "victim pays" nature. For example, in both developing countries and the post-communist states, it may be necessary for the international community to help finance the up-take of new technologies and to provide new infrastructure, consistent with less environmentally-damaging transport systems.

Second, many of the negative external costs of transport are related to intervention failures in the transport market more generally. One way these can be reduced is by institutional change and by increased commonality in policy across countries. In terms of transport, there have been considerable developments in this respect. For brevity, it is useful just to look at the changes which have occurred in the European Union (EU) (see Chapter 7). The need for a "level playing field" as a pre-requisite for fair competition within the Union has led to moves designed to achieve greater harmonisation in charging regimes. One manifestation of this is that there is now support within the Union for full cost allocation within the transport sphere (CEC, 1992). In particular, the measures have been initiated for the establishment of minimum rates for infrastructure use. Common policies are also emerging to tackle the problems of "petrol tourism" (again, see Chapter 4) which deter small countries from establishing appropriate national environmental policies because of the ability of transport users to 'shop' elsewhere for such important inputs as fuel. Such measures help to reduce intervention failure.

In the longer term, there may be a case for more international co-ordination of policy, especially across adjacent blocks of countries. From a practical and intellectual perspective, for example, there are strong arguments for a common technical approach to electronic road user charges (see Chapter 4).

Conclusions

Transport is a major economic activity and good transport is a pre-requisite for economic prosperity. To achieve this goal, transport needs to be both internally efficient and cognisant of the full costs (including environmental ones) involved in its activities. Before appropriate policies leading to improvements in internal and external efficiency can be fully implemented, however, it is important that the grounds for the debate be clarified. There is often a tendency to misinterpret exactly what is meant by social benefits, and to assume that the definition of external costs and benefits embraces rather more than it actually does.

Equally, the notion of "pure" internalisation has a very specific meaning and, in any case, the strict internalisation of all of the external costs and benefits associated with transport is unlikely to prove to be either realistic or attainable. More important in practice is the quasi-internalisation of these external effects by the more widespread adoption of appropriate economic and command-and-control instruments.

An important pre-requisite to reducing negative externalities from transport is to gain a good impression of the actual cost. This enables calculations to be made of the exact adjustment required and provides guidelines as to the "cost-effectiveness" of alternative policy strategies. In many areas, information on these costs is emerging and the results are relatively robust. Not surprisingly, where there is less clarity is with the larger environmental externalities, such as the costs of global warming gas emissions. This is an area in need of further research.

The armoury of policy instruments available for tackling the externality problem is, at least in theory, quite extensive. There are often strong intellectual arguments in favour of using economic instruments, such as emissions charges, as the main weapon, but there may be circumstances where alternatives could prove more effective. Much depends upon the transaction costs involved.

The theory of how one can limit the adverse external consequences of transport is well-established. The main on-going problem is one of implementation. There are many aspects to gaining policy acceptance. Education and information is important in changing public attitudes. Equally, the public has to have confidence that the authorities will not manipulate policy to achieve ends others than those stated. While hypothecation of revenues from emissions charges may, for example, not conform to all theories of public finance, some degree of ear-marking may well be a necessary concomitant to the initiation of such measures. Transparency seems to be an important issue here.

While national governments have a central role to play in the processes of reducing external costs, there is also often a need for international co-operation. In the past, major developments such as the adoption of the Polluter-Pays-Principle have come about as the result of deliberate efforts at the international level to limit environmental damage. More recently, there has been the additional impetus of creating level environmental "playing field" in countries forming economic unions. The results of both these forces has been that progress has been achieved on a number of important fronts.

REFERENCES

BARDE, J-P. AND K.J. BUTTON (EDS.) (1990). *Transport Policy and the Environment: Six Case Studies*, London: Earthscan.

BEHBEHANI, R., V.S. PENDAKUR AND A.T. ARMSTRONG-WRIGHT (1984). *Singapore Area Licensing Scheme: A Review of the Impact*, Washington: World Bank Water Supply and Urban Development Department.

BUTTON, K.J. (1979). "An Historical Survey of the Early Debate on Consumer's Surplus Theory", *Journal of Economic Studies*, 16, 155–181.

-------- (1992). *Market and Government Failures in Environmental Management: The Case of Transport,* Paris, OECD.

-------- (1993). *Transport, the Environment and Economic Policy*, Aldershot: Edward Elgar.

COASE, R. (1960). "The Problem of Social Cost". *Journal of Law and Economics* 3, pp. 1-44.

COMMISSION OF THE EUROPEAN COMMUNITIES (1992). *The Future Development of the Common Transport Policy*, Brussels: EC.

COMMON, M.S. (1990). "The Choice of Pollution Control Instruments: Why is so Little Notice Taken of Economists' Recommendations?" *Environment and Planning*, 21A, 1297–1314.

EUROPEAN CONFERENCE OF MINISTERS OF TRANSPORT (1990). *Transport Policy and the Environment,* Paris, ECMT.

FREY, B.S., F. SCHNEIDER AND W.W. POMMEREHNE (1985). "Economists' Opinions on Environmental Policy Instruments: Analysis of a Survey", *Journal of Environmental Economics and Management*, 12, 62–71.

GOODWIN, P.B. (1990). "How to Make Road-pricing Popular". *Economic Affairs*, 10, 6–7.

HAHN, R. AND G. HESTER (1989). "Economic Perspectives for Environmental Problems: How the Patient Followed the Doctor's Orders", *Journal of Economic Perspectives* 3, 95–114.

JOHANSSON, P-O. (1987). *The Economic Theory and Measurement of Environmental Externalities*. Cambridge: Cambridge University Press.

KANAFANI, A. (1983). *The Social Costs of Road Transport*, Paris: OECD.

OPSCHOOR J.B. AND H.B. VOS (1989). *Economic Instruments for Environmental Protection,* Paris, OECD.

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (1975). *The Polluter-Pays-Principle,* Paris, OECD.

-------- (1988). *Transport and the Environment*, Paris, OECD.

-------- (1991). *Environmental Policy: How to Apply Economic Instruments*, Paris, OECD.

PIGOU, A. (1920). *The Economics of Welfare*, London: Macmillan.

QUINET, E. (1990). "The Social Costs of Land Transport", *Environmental Research Monographs*, 32, Paris: OECD.

SIMONS, J.G.W. (1992). *External Benefits of Transport*, Serie research Memoranda, Research Memorandum 1992-19, Amsterdam: Faculteit der Economische Wetenschappen en Econometrie, Vrije Universiteit.

SMALL, K.A. (1992). "Using the Revenues From Congestion Pricing", *Transportation*, 19, 359–82.

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INTERNALISING THE SOCIAL COSTS OF TRANSPORT

Chapter 2

The Social Costs of Transport: Evaluation and Links with Internalisation Policies

by Émile Quinet

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The Social Costs of Transport: Evaluation and Links with Internalisation Policies

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With the increasing concern for the environment, the rising demand for transport and the development of economic understanding in these fields, a great deal of research is now being done on evaluating the social costs of transport, a situation which justifies a general review. This is the purpose of the present report, which continues earlier work carried out at the initiative of the OECD by Bouladon (1979), Kanafani (1985), and Quinet (1990).

The following report is organised in two parts. The first part evaluates the social costs of transport, including summaries of the definitions of environmental costs and the methods of measuring them. This is followed by a literature review of results found in different countries by different authors. The second part examines how evaluations of social costs are used in formulating and implementing environmental policies, starting with a review of the various instruments for internalising social costs. Then, on the basis of an assessment of the policies followed, a judgement is made as to their success or failure, with a view toward making recommendations for future research and action.

Evaluation of social costs

Problems of method

If policy decisions are to be coherent, it is essential to translate the effects of transport activities on the environment into money terms. However, the precise way this is done would depend upon the type of decisions to be taken. Thus, for decisions on pricing, one is generally interested in marginal costs, while for decisions about investment, one will generally seek to assess the difference in costs "with and without" the investment[1].

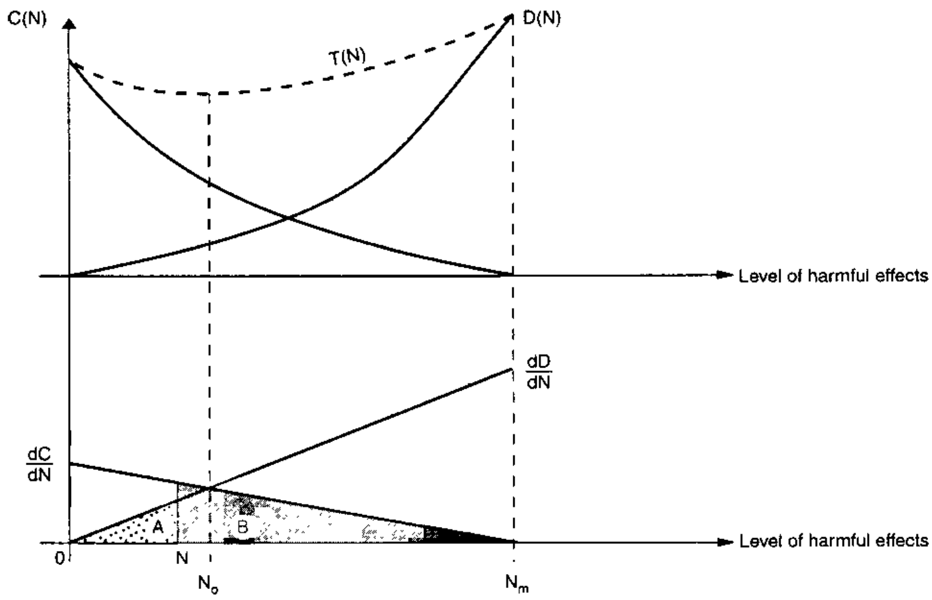
The evaluations of social cost that we are interested in here, and that may exist at either the city, region or country level, correspond to strategic decisions that determine the main lines of policy, and are comparable with national accounts data. This concept can be expanded using the orientations given below (Quinet, 1991), based upon the conventional approach which consists (for an environmental parameter) of measuring the willingness to pay and the cost of reducing the harmful effects (see Figure 2.1).

In Figure 2.1:

- $C(N)$ is the cost of moving from level N_m (the "natural" level) to level N;
- $D(N)$ is the amount the individual is willing to pay to move from level N to level 0;
- $T(N) = C(N)+D(N)$ is the total cost to the individual concerned, which is a minimum when $N = N_0$.

1. See the Appendix for more details on this subject.

Figure 2.1.



It is logical to call *T(N)* the social cost, which equals the sum of the hatched areas *A* and *B*, for a level of pollution, *N*:

A: represents the sum total of pollution control costs committed for this level, *N*;
B: represents the amount which those who do not benefit from the pollution control would be willing to pay (they do not benefit from it because it would not be viable to go beyond the optimum).

This concept of social cost involves a degree of uncertainty, related to the decision about what constitutes the "zero level" of harmful effects in certain cases, notably for noise and air pollution. This affects the social cost expressed in absolute terms or as a percentage of GNP, but does not reduce the value of the concept for decision-making. In fact, one characteristic of social cost is that it is a minimum at the optimum; the proposed definition may be compared with that of the surplus and other concepts used in national accounts (Quinet, 1990).

This definition must be extended to a number of situations. The first is that in which the harmful effects do not affect a final user directly, but instead affect a production activity by increasing its cost. Applying the above definition to this case suggests that social cost is equal to the difference between the existing production cost, and the one it would be possible to achieve if the harmful effects did not exist[2].

The second extension is where the community may decide to replace the values worked out by individuals with those provided by the authorities. In fact, with regard to environmental questions, economic agents may not properly appreciate the consequences of a disamenity (e.g. not fully understanding its effects on health). In this context, "willingness to pay" may not be a good criterion, needing to be corrected by an assessment of the true harmful effects.

2. If *C(q,n)* is the marginal cost, assumed constant, of producing the quantity, *q*, with the disamenity, *n*, and *D(q)* is the demand for the good concerned, the collective surplus, $S_{(n)}$, is:
$S_{(n)} = \int_0^{qo(n)} [D(q) - C(q,n)]\delta q$, q_0 being the amount which clears the market; and $S_{(0)} - S_{(n)}$ is the desired social cost, essentially equal, if $q_0(n) - q_0(0)$, at $\int_o^{qo} [C_{(q,n)} - C_{(q,0)}] = D(q_0(n)) - D(q_0(0))$.

The third extension concerns the permanent environmental effects, or at least where results will affect the next generation. An example is where landscape changes, or where CO_2 emissions lead to a lasting increase in global temperature. In this case, the total social costs in future years must be taken into account and discounted accordingly.

A final extension is the introduction of uncertainty. As regards disamenities whose effects are more than transient, the time dimension is accompanied by uncertainty (potentially leading to irreversibilities), and by a possible disparity between the mathematical expectation of the worth of different possible situations and the utility of their mathematical expectation (see Pearce and Markandya, 1989).

Having laid down this theoretical basis, one must then consider the current methods of evaluating environmental costs (Pearce and Markandya, 1989; Barde, 1992). Traditionally, three types of evaluation method have been used:

Replacement markets, a category which may be subdivided as follows:

- The cost of travel -- it is possible to deduce, from the cost to the users of a theme park (in money and in time), the value these users place on it.
- Hedonistic prices -- the price of certain merchantable goods (for example, housing) is influenced by qualitative factors, such as exposure to noise and pollution. By relating variations in price to variations in the quality of the environment, it is possible to deduce the value people place on the latter.
- Evaluation of expenditures on protective measures -- by statistically analysing the amount agents spend on protecting themselves against a certain level of disamenity, it is possible to deduce a willingness to pay to avoid that disamenity.

These methods suffer from a number of difficulties of implementation:

- How to separate out the effects of the different variables, which are often mutually correlated.
- The relationships found are not really demand-based: thus, the occupants of the most exposed dwellings may have chosen them in part because they are less sensitive to noise; the reduction in the values of the dwellings is less than it would be if the sensitivity to noise was the same, whatever the degree of exposure.
- The economic agents are not always fully aware of the damage caused by the disamenity concerned.

Contingent evaluations

This involves asking the economic agents how much they would be prepared to pay to eliminate the disamenity (or be paid to put up with it). The main implementation problems associated with this approach are:

- To elicit reliable answers, the questions must be formulated with great care.
- Owing to "cognitive dissonance", the willingness to pay for an improvement is generally less than what respondents would be willing to accept to put up with a deterioration.
- As with the previous methods, the results may be biased by incomplete knowledge of the damage caused.

Indirect methods

These generally involve two stages. The first is technical, and seeks to evaluate the consequences of the pollution in physical terms. For example, in the case of air pollution, this may relate to the frequency and seriousness of illnesses caused, damage to buildings, or destruction of plant life, etc. The second stage involves evaluating the corresponding damage, using market assessments for the goods that have been destroyed (if any), the cost of putting things right (care for the sick, repairing buildings), or through more subjective evaluations (such as the value placed on human life). This method sidesteps any lacunae in the knowledge possessed by those involved. However, the actual evaluation of damages in monetary terms will be a matter of much discussion. In particular, monetary evaluations based on the cost of cleaning up environmental problems will overestimate the willingness to pay, if that action is not actually taken. Finally, the process of solving the environmental problem requires a definition of the "zero pollution" level -- often an arbitrary quantity. The question arises as to how these methods of evaluation are to be assessed in view of the previous theoretical considerations regarding the definition of social cost.

Evaluations involving substitution markets provide the quantity *D(N)* in Figure 2.1, but raise operational problems. For example, how can the effects of the many qualitative variables that influence market price be separated out; what is "pure" demand, and so on? However, these evaluations disregard the term *C(N)*, relative to what is actually being spent on reducing the disamenity (or in countering its effects), as well as the effects on the cost of producing intermediate goods. Also, when the effects of the disamenity are spread over time, they can only be taken into account at the cost of (often risky) assumptions about the discount rate, future demands, and the cost of the risk. Finally, the data provided on willingness to pay are generally not authoritative, and can give a poor approximation of the true social cost, especially when the agents involved are poorly informed.

The same remarks can be made about the "contingent evaluation" approach. The practical difficulties are considerable: how can the agents be made to reveal their true value when their replies are subject to no sanctions? Also, as in the case of evaluations based on substitution markets, the additional costs of producing intermediate goods are disregarded, the money actually spent on controlling pollution is neglected, and the evaluations for future generations and the value of behaviour patterns can be wrong.

These difficulties can be overcome by the use of indirect methods, which attempt to take all these effects into account (even those which are not perceived), by incorporating the interest of future generations in a disinterested manner. With these indirect methods, the cost of the disamenity is worked out by estimating the level of expenditure needed to eliminate it (or to reduce it to a desired level). This is usually done by assuming a minimum acceptable level of disamenity, even though the expenditure is not actually paid out. Hence, the question arises as to whether the resulting overestimate of willingness to pay is a good approximate of the "true" value or a good anticipation of the values of future generations. The answer to this question varies from case to case, and is extremely difficult to provide. Considered from a different angle, indirect methods often disregard some or all of the term *C(N)*, representing the actual expenditure on pollution control. These considerations show how uncertain evaluations of social cost in the literature can be, and provide little guidance on how they may be assessed and compared.

The results

The results available in the existing literature for several of the conventional externalities associated with transport are discussed below. Externalities covered here include local and global pollution; accidents; noise; congestion; and altered land use.

Accidents

In all countries, the methods used for evaluating the cost of accidents generally involve multiplying the numbers of dead, injured and material accidents by the per unit cost of these deaths, injuries and material accidents. The evaluation of material accidents is usually assumed to be equivalent to the monetary costs of the damage. As regards deaths and injuries, the estimates typically cover the direct costs (medical care, transportation costs, etc.); the indirect costs (production losses) sometimes excluding consumption eliminated as a result of the death); and occasionally, an authoritative evaluation of the worth of the life to the community. Few evaluations are based upon individuals' willingness to pay.

Table 2.1. **"Official" figures for the value of human life**[1]

Country	**Cost in 1000 ECU (1989) ...**	**... of which market cost**	**Method**	**Source**
Belgium	300	300	Gross production costs and losses	Hansson and Marckham (1992)
Denmark	600	200	"	"
Germany	630	630	"	"
Finland	1 600	540	Willingness to pay	"
France	255	--	Life expectancy	"
United Kingdom	890	265	Willingness to pay	"
Luxembourg	330	330	Gross production costs and losses	"
Netherlands	85	85	Net production costs and losses	"
Norway	340	340	Gross production costs and losses	"
Austria	545	545	"	"
Portugal	12.5	12.5	"	"
Sweden	1 070	130	Willingness to pay	"
Switzerland	1 665	560	Social willingness to pay	"
Spain	145	97	Gross production losses	"
United States	2 350	495	Willingness to pay	"
United States	441	441	Gross production costs and losses	Le Net (1992)
France	344	315	"	"
Australia	407	407	"	"
New Zealand	155	122	"	"
	to	to		
	451	181		

Note: These percentages naturally also include the cost of material losses and injuries.

Most countries make some evaluation of the value of human life and the cost of accidents in their cost-benefit analysis of investments in the road system. However, these official values generally differ from estimates provided by researchers. Table 2.1 illustrates the "official" estimates of the value of human life used in cost-benefit analyses in several OECD countries, and Table 2.2 indicates the resulting costs of accidents based on these values, expressed as a percentage of GNP[3]. Table 2.1 shows a fairly wide scatter from one country to another. This scatter is primarily due to the use of different methods:

- evaluations based on "willingness to pay" are the highest;
- evaluations based on "gross losses" are, of course, higher than those based on "net losses".

3. These percentages naturally also include the cost of material losses and injuries.

However, the differences also seem to be related to the differences in per capita incomes in the various countries -- a result which is not entirely illogical. The data in Table 2.2 show the predominant contribution of road transport in the social cost of accidents. As to the relative weight of different types of traffic, the data will be examined by traffic unit.

Table 2.2. **Cost of accidents as a proportion of GNP, based on "official" values of human life**

Country	**Cost of accidents in million ECU**		**GNP in million ECU**	**% of GNP**	**Year**	**Source**
	Road	**Rail**				
Belgium	2 335	8	146 200	1.60	1989	Hansson and Marckham (1992)
Denmark	635	5	97 800	0.65	"	"
Germany	14 033	132	1 080 900	1.31	"	"
Finland	1 649	60	89 000	1.92	"	"
France	7 423	51	748 900	1.00	"	"
United Kingdom	11 879	86	760 000	1.57	"	"
Luxembourg	60	1	6 600	0.92	"	"
Netherlands	1 130	5	204 500	0.56	"	"
Norway	359	5	78 000	0.47	"	"
Austria	1 973	34	115 100	1.74	"	"
Portugal	152	2	40 000	0.39	"	"
Sweden	2 020	21	165 000	1.24	"	"
Switzerland	2 137	99	153 800	1.45	"	"
Spain	4 426	10	350 800	1.26	"	"
Mean of above countries	1.24%	0.01%		1.25	"	"
United States				1.24		Deakin (OECD) quoted by Bouladon (1991)
Switzerland	780[1]	31[1]	142 000	0.57	1988	Jeanrenaud (1993)
Switzerland	2 814[2]	50[2]	142 000	2.00	"	"

Notes: 1. *External* costs.
2. *Social* costs, including both *external* costs and *expenditures* made by users.

Table 2.3 shows evaluations of the research into cost of accidents, in terms of GNP, based on figures for the value of human life which have not had official sanction. As noted earlier, these figures are appreciably higher than those used in government reports.

The specific research on which this table is based is summarised in Table 2.4. The main result illustrated in this Table is that, in terms of distance travelled, the cost of accidents to cars in passenger-km is virtually the same as the cost of accidents in trucks in tonne-km, and about 10 times higher than that of buses. The cost of the railway is much lower.

Table 2.3. **Alternative assessments of the social cost of accidents**

Country	% of GNP	Year	Source
Australia	3		Test (1991) quoted by Hansson and Marckham
Austria	1.9		Marckham (1992)
Belgium	2.5	1983	CCFE (1991)
France	2.6	1979	Quinet (1989)
Germany	2.4	1977	"
Germany	2.54	1982	
United Kingdom	1.1		"
Italy	1.5		CCFE (1991)
Luxembourg	1.85	1978	"
Luxembourg	2.5		Quinet (1989)
Netherlands	1.67	1987	CCFE (1991)
Sweden	2.2		Quinet (1989)
United Kingdom	1.5	1986	CCFE (1991)
United Kingdom	1.45	1986	Quinet (1989)
United States	2.0	1975	"
United States	2.4	1975	Kanafani (1983)

Noise

The effects of transport noise are not very well understood. There is no fully satisfactory measurement of noise and the nuisance it causes. The most common unit -- the dbA -- is a relative measurement, since according to certain authors, there is a difference of 5 dbA between railway noise and road noise producing the same nuisance. The duration, frequency and regularity of noise all make contributions to the noise problem that are difficult to evaluate, and even more difficult to measure *in situ*.

Neither is the monetary evaluation of these effects is very far advanced. The most common methods of evaluation are:

- *Assessing the effects on the market value of buildings*. Unfortunately, these methods tend to disregard the effects of the noise on premises other than dwellings; they also imply that the economic agents are fully aware of the effects of noise, which is not entirely true.
- *Evaluation of actions which would have to be taken to eliminate or attenuate the noise*. Compared with the "market value" method mentioned above, this approach does, in fact, incorporate the poorly perceived effects of noise, but setting the standard to be achieved is a highly uncertain and arbitrary business.
- *Evaluating the damage caused by noise and the cost of corrective action*. This consists essentially of damage to health, which is itself difficult to assess.

Table 2.4. **Accidents costs of different forms of traffic**

Study	Year	Country	Passengers, in terms of passenger-km			Goods, in terms of tonne-km		
			Car	Bus	Railway	Road	Rail	Waterway
Planco	1990	Former FRG	(0.0328 DM) 0.016 ECU	(0.0056 DM) 0.0029 ECU	(0.0048 DM) 0.0025 ECU	0.0092 ECU (0.0178 DM)	0.0006 (0.0012 DM)	0.00005 ECU (0.0001 DM)
Tefra	1985	France Belgium				0.0059 ECU 0.0027 ECU	0.00002 ECU	
EcoPlan	1991	Switzerland	0.0238 ECU	0.0058 ECU	0.0032 ECU	0.0281 ECU	0.0011 ECU	
Hansson	1987	Sweden						
		-- Urban	0.051 ECU per veh-km (about 0.04 ECU per pass-km)	0.2 ECU per veh-km (about 0.01 ECU per pass-km)	0.2 ECU per train-km (about 0.001 ECU per pass-km)	0.62 ECU per veh-km (about 0.01 ECU per tonne-km)	0.2 ECU per train-km (about 0.0002 ECU per tonne-km)	
		-- Non-urban	0.015 ECU per veh-km (about 0.07 ECU per pass-km)	0.022 ECU per veh-km (about 0.001 ECU per pass-km)	"	0.022 ECU per veh-km (about 0.001 ECU per pass-km)	"	

Table 2.5. **Evaluating the cost of noise**

Country	Source	Year	% of GNP	Comments
Norway[1]	Ringheim	1983	0.06%	Fall in property values
France[1]	Lambert	1986	0.08%	"
Netherlands[1]	Opschoor	1986	0.02%	"
Former FRG[1]	Wicke	1987	2%	Fall in property values and losses of productivity
France	Bouladon (1991)		0.24%	
United Kingdom	Bouladon (1991)		0.50%	
Norway	Nielsen and Solberg	1987	0.3%	
Germany	Weinberger	1992	1.4%	Willingness to pay, plus health damage
France	OECD (1990)	1990	0.2% to 0.6%	Desirable expenditure
	Merlin (1992)	1989	1.5%	Covers all modes
Finland	Himanen *et al*. (1992)	1989	0.3%	Cost of protection
	Ministry estimate (1992)	1992	0.42%	
United States	The going rate (1992)	1992	0.2%	
United States	Bouladon (1991)	1990	0.10%	
Australia	NRTC (1992)	1992	0.15%	
Austria	Hansson and Marckham (1992)	?	0.1%	
Sweden	"	1992	0.4%	Fall in property values
Switzerland	"	?	0.1%	
Germany	Dickman (1990)		0.2%	Cost of protection
Germany	Planco (1990)	1985	0.15%	Cost of protecting to 55 dbA
			0.9%	Cost of protection at 45 dbA
Switzerland	Jeanrenaud (1993)	1988	0.3%	Decline in property values, of which 0.26% was for road, and 0.04% was for rail; estimates based on "cost of protection" yield similar results.

1. Data quoted in Quinet (1990).

Of course, valuing the effects of noise across a country in monetary terms will depend upon the degree of urbanisation and the geographical structure of the country. These considerations underlie the dispersion of the current evaluations shown in Table 2.5. This diversity of evaluation results is well illustrated by the recent comparison of research relating to the cost of noise from land transport carried out in Germany, and given in Planco 1992:

- Prevention cost at 55 dbA: 1.7 BDM
- Prevention cost at 45 dbA: 10.0 BDM
- Willingness to pay: 18.0 BDM.

Here, we see a phenomenon which will recur with regard to all forms of transport pollution: estimates related to "willingness to pay" are much higher than the indirect estimates, probably because those interviewed do not have to bear the financial consequences of their answers. These data are highly scattered around a median of the order of 0.2 per cent. The way the noise is distributed between the different modes can be seen from a number of projects for a whole country or per traffic unit.

According to Weinberger (1992), the breakdown of costs in Germany between the different modes is as follows (willingness to pay, plus health expenditure):

Road: 13.7
Rail: 5.3
Air: 0.6

According to Planco (1990), the distribution in Germany is:

Road: 0.8
Rail: 0.8
Total: 1.7

According to Merlin (1992), the breakdown in France is (in billions of francs):

Road: 42.0
Rail: 3.4
Air: 10.0

According to Dickman (1990), the distribution of noise is (in GDM):

Road: 1.4
Rail: 0.22
Air: 0.57
Total: 2.19

The Green Book of the Commission of the European Communities (1992) quotes the following breakdown of the social costs of noise (from the Karlsruhe Fraunhofer Institut):

Road: 64%
Rail: 10%
Air: 26%

A survey carried out in 1986 in the former Federal Republic of Germany, quoted by Rothengatter (1989), gives the percentages of households annoyed by different kinds of noise:

	Annoyed	Highly annoyed
Road	65	25.0
Rail	19	3.9
Air	47	16.5

Research into the cost of noise in terms of traffic units all assumes that one passenger-km (i.e. cars) is as noisy as 1 tonne-km (i.e. trucks). The following results have been obtained in previous studies:

Table 2.6. **Cost of noise per traffic unit**

Planco-Germany (1992), in ECU/100 passenger-km or ECU/100 tonne-km:			
Passengers	*Rail*	*Road*	*Bus*
	0.20	0.03	0.5
Goods	*Rail*	*Road*	*Waterways*
	0.13	0.19	0.00
Dickman (1990), in ECU per 100 passenger-km or tonne-km:			
	Rail	*Road*	*Air*
	0.12	0.11	2.3

Hansson and Markham (1992), using a standardised cost (50 ECU) for eliminating annoyance to people exposed to over 65 dbA, arrive at the following costs for rail and road per traffic unit (pass-km or tonne-km) for a sample of European countries (in ECU/100 km):

Road 0.222
Rail 0.173

Varying the assumptions for the standard service costs from one country to another, the respective values by traffic unit for rail and road are (in ECU/100 km):

	Assumption 1	Assumption 2	Assumption 3	Assumption 4
Road	0.222	0.213	0.512	0.175
Rail	0.173	0.228	0.995	0.096

Two other studies give values of the cost of noise from road goods vehicles in ECU/100 tonne-km:

Source	Country	Year	Cost per tonne-km	
			Road	**Rail**
TEFRA	France	1985	0.017 ECU	
	Netherlands	1985	0.032 ECU	
PEREZ	France	1990	0.050 ECU	

These studies give fairly scattered results. Nevertheless, a tentative conclusion can be drawn here (one which would obviously need to be verified by more far-reaching research) that passengers and goods traffic by road and rail generate specific noise costs (in terms of passenger- or tonne-km) that are equivalent in order of magnitude.

Local pollution

Local pollution is expressed in terms of several components: sulphides, nitric oxides, and particulate matter (neglecting pollution by CO_2, which is global in nature, and which is discussed below). The methods of evaluation used here are primarily of the indirect type, involving first of all a technical estimate of the damage done, and then an evaluation of the "cost of repairs or protection". "Substitution market" methods are less common here than for noise. As for "contingent valuation" methods, these are occasionally used, but they tend to produce very different results.

Damage refers to human health, material damage and effects on plant life. These have been separated out in a number of studies. They are summarised in Kågeson (1992*a*), from which most of the information in Table 2.7 is drawn. It should be noted that, as for noise, the estimates based on willingness to pay are generally much higher than those based on damage. For example, the Planco study indicates pollution costs higher by a factor of 1.5 to 2.

Apart from the UPI estimate, which is very high, the percentages obtained are relatively little dispersed around a mean value of the order of 0.4 per cent of GNP. The breakdowns by mode and by traffic unit can be examined either in terms of physical or monetary quantities. In terms of physical quantities, the following studies have been done:

- Befahy ("The Environment: Global and Local Effects", ECMT, Lisbon, 1992) shows the following specific emissions by mode for Belgium:

	CO	**CO_2**	**NO_X**	**C_XH_Y**	**SO_2**	**Aer.**
Passengers (en gr./pass-km)						
Conventional rail	0.008	48.7	0.120	0.003	0.209	0.074
High speed train (TGV)	0.005	28.9	0.071	0.002	0.124	0.044
Car with 1.7 passengers	1.038	126.4	1.367	0.168	0.084	0.046
Aircraft	1.266	210.0	0.588	0.198	0.078	0.028
Goods (in gr./T-km)						
Truck with payload >10T	2.10	--	1.85	0.92	--	0.04
Rail	0.6	--	0.40	0.02	--	0.08
Waterway	0.20	--	0.58	0.08	--	0.04

Table 2.7. **Costs of local pollution**

Study	Country	Year	Cost of pollution as % of GNP			
			Health	**Material damage**	**Vegetation**	**Total**
Grupp (1986)[2]	Germany	1986	0.11-0.42	0.05-0.06	0.03-0.15	0.19-0.63
Planco (1990)[2]	"	1990	0.07-0.18	0.05-0.09	0.13-0.21	0.25-0.48
UPI (1991)[2]	"	1991	0.59	0.07	0.26-0.41	0.92-1.05
Marburger[2]	"	1986	0.06-0.14			
Henz & Klassen-Mielke[2]	"	1990	0.05-0.25			
Iseeke[2]		1990		0.05-0.08		
Henz[2]		1986		0.06		
Ewers[2]		1986			0.13-0.21	
Pillet[2]	Switzerland	1988	0.02-0.06	0.21	0.18-0.41	0.41-0.68
Infras[2]	"	1992	0.01-0.03	0.07-0.16	0.16-0.45	0.24-0.64
EcoPlan (1992*a*)	Berne	1992	0.14	0.13	0.15	0.42
Gunnarson & Leeksell[2]	Sweden	1986	0.02-0.06	0.00-0.03	0.00-0.02	0.03-0.11
Hassund *et al.*[2]	"	1990			0.06-0.2	
VROM[2]	Netherlands	1985	0.16-0.29	0.08-0.13	0.14-0.18	0.38-0.6
NAPAP[2]	USA	1991			0.01-0.02	
Merlin (1992)	France	1989				
N.R.T.C. (1992)	Australia	1992				
Fin RA (1992)	Finland	1992				0.4
Mackenzie *et al*. (1992)	USA	1992	0.22			
Himanen *et al*. (1989)	Finland	1989				0.23-0.7
Mautynen	Finland	1988				0.2-1.2
	Norway	1992				
Bouladon (1991)	U.K.	1991				0.15-0.35
Deakin[1]	USA	1990				0.48

Notes:
1. Quoted by Bouladon (1991).
2. Quoted by Kågeson (1992*a*).
3. Quoted by Quinet (1992).

OECD (1991*a*) gives the following data for the same emissions, applying to the Federal Republic of Germany in 1986:

	CO	CO_2	NO_X	C_XH_Y	SO_2	Aer.
Passengers (in gr./pass-km)						
Gasoline car	14.4	180	2.4	2.5	0.03	0.01
Long-distance train	0.01	45	0.15	0.01	0.3	0.07
Aircraft	2.2	465	1.8	0.4	0.15	0.07
Goods (in gr./T-km)						
Truck (long haul)	0.25	140	3.0	0.32	0.18	0.17
Rail	0.15	48	0.4	0.07	0.18	0.07
Waterway	0.018	40	0.5	0.08	0.05	0.03

Prognos (1987) gives the following comparative specific consumption data for road and rail in grams per traffic unit:

	CO	NO_X	C_XH_X	Aer.
Passengers				
Road	9.3	1.7	1.1	0.03
Rail	0.06	0.43	0.43	0.08
Goods				
Road	3.7	3.3	1.6	0.07
Rail	0.03	0.2	0.01	0.04

IRU (1987) gives toxicity factors for the different emissions:

	CO	NO_X	C_XH_X	SO_2	Aer.
Toxicity factors	1	125	100	100	100

It also provides weighted equivalents for emissions for the different traffic modes in 1982 (in terms of CO equivalent), together with an estimate of the traffic concerned:

	Emissions	Trafic	By traffic unit
Route	250 000	535	478
Rail	8 600	40	215
Air	2 000	10	200

The following average ratios for a transport distance of 500 km, and an average occupancy rate are obtained from Ten Have (1992):

	CO	NO_X	C_XH_X	SO_2
Aircraft	12.5	25.65	0.60	0.41
High speed train (TGV)	1.15	6.70	0.25	3.50

Putting all these data together produces the following table, comparing the studies quoted for each mode by traffic unit:

	Befahy Unit gr/traffic unit	**OECD 91 Unit gr/TU**	**Prognos 87 Unité gr/U.T.**	**UIC 87 Unité ECU/100 U.T.**	**Ten Have équivalence**
Passengers					
Road	189	564	325	2.00	
(car)	15.4	58	104	4.78	
Rail					
(TGV)	(9.1)			2.15	(1)
Aircraft	95	267		2.00	2.27
Goods					
Road	323	442	579	4.78	
Rail	52	82	30	2.15	
Waterway	80	78		2.00	
Year	1987	1986	1987	1982	1992
Country	Belgium	F.R.G.	F.R.G.	F.R.G.	Netherlands

The first observation here is that there is considerable variation illustrated in the data, leading to the following average results as an order of magnitude:

- for passengers, in terms of passenger-km, road transport is 1 to 2 times more polluting than aircraft, and 10 times more polluting than railways;
- for goods (in tonne-km), road transport is about 10 times more polluting than rail; and
- one tonne-km is slightly more polluting than one passenger-km.

The studies also make monetary evaluations, which lead to similar conclusions (Table 2.8). Despite some variation in the data, Table 2.8 illustrates a few constants:

- the low value of pollution of railways and waterways, compared with roads and aircraft;
- roughly speaking, one passenger-km is as polluting by car as by aircraft; and
- one tonne-km is 1 to 2 times more polluting than a passenger-km, both by road and by rail[4].

Global pollution

Here, the main focus is on the greenhouse effect caused by atmospheric warming due to the increase in CO_2 concentrations. Neither the physical extent nor the economic effects of the greenhouse effect are yet very well understood.

Several figures are put forward as to future trends in the average temperature of the planet if no emission abatement action is taken. Estimates of the heating effect range from 0.1 to 0.5 degrees per ten-year period. The consequences of this warming are difficult to quantify and include such things as: certain species would disappear and others would develop; harmful effects on agriculture; increased exposure to sunlight; a rise in sea level; and possible feedbacks from the ecosystem, tending to accelerate the temperature rise even further.

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4. This result is compatible with the one found earlier (Quinet, 1990), where the ratio between a car and a truck was calculated in the range 2.5-3.8, assuming that a car carries an average of two passengers, and a truck of the order of 5 tonnes:
   car = 1 = 2 = 0.5;
   truck = 2.5 (or 3.8) = 5 = 0.5 to 0.8.

The OECD (1988) has calculated that transport is responsible for 21 per cent of CO_2 emissions in the OECD member countries. In general, there has been no direct assessment of the cost of the greenhouse effect[5], but estimates have been made of the rates of energy -- or carbon -- taxes which would have to be imposed to generate different levels of reduction of CO_2 emissions to, and concentrations in, the atmosphere. Assessments of the potential economic consequences of this taxation have also been made. These procedures would involve laying down targets for CO_2 concentrations, working out the tax which would allow these targets to be achieved, and measuring their economic consequences. The Academie des Sciences de France (1990), citing IPCC (1990), has provided Table 2.9, which indicates a range of temperatures, depending on various CO_2 emission scenarios.

According to the different research done, the reductions in CO_2 emissions which would either stabilise global warming, or hold it at an acceptable level are:

- An immediate reduction of 60 per cent according to Swedish researchers (quoted by Kågeson, 1992) for immediate temperature stabilisation. This target is clearly unrealistic.
- In order to stabilise CO_2 emissions by the year 2000 at their present level (i.e. the actual objective contained in the Framework Convention on Climate Change), the European Commission considers that the target should be a reduction of 12 per cent relative to baseline, which would require (among other things) a tax of $10 per barrel of oil[6].
- Barrett (see OECD, 1991) reviews the taxes needed to reduce emissions by 20 per cent, using various assumptions as to the elasticity in energy consumption and price; these taxes range from 19 to 140 ECU per tonne of carbon.
- The OECD GREEN Model (quoted in Kågeson, 1992) indicates that to reduce emissions by 20 per cent by the year 2010, the tax would have to be 5 ECU per tonne of carbon, increasing to 12 ECU by 2000 and 120 ECU by 2010.

The consequences of a carbon tax have been reviewed using different models, summarised by Hoeller *et al*. (1991), from which Tables 2.10 and 2.11 have been obtained. It should be noted that carbon taxes[7] would also have secondary effects on local pollution. Alfur and Glomsrϕd (1992) found that stabilising CO_2 emissions by means of an international tax would lead to a reduction in the social costs caused by local pollution, virtually equivalent to the direct reduction in GNP (2.4 million NOK-1990, compared with 3.1 million NOK-1990 for reducing pollution).

5. Cline (1992) is one of the exceptions to this rule.

6. Recall that 1 metric tonne of carbon = 7.6 barrels of petrol = 1.55 m^3 of gasoline.

7. Or on energy. The taxes being considered by the Commission of the European Union combine the two as follows:

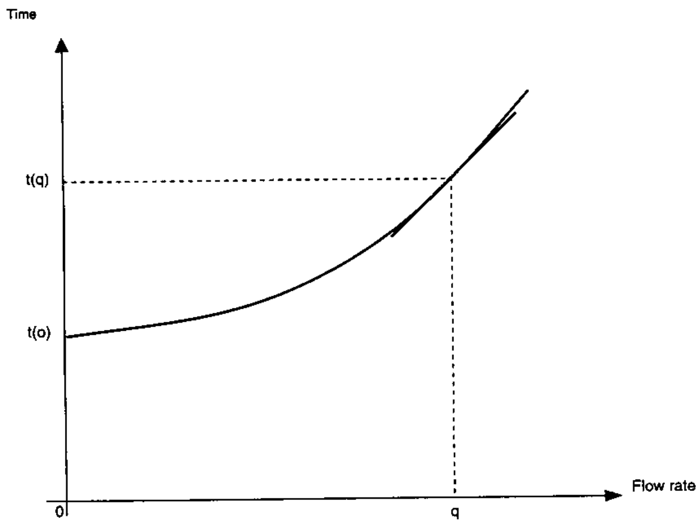
Tax in ECU	**Energy term**	**CO_2 term**	**(Tonne of carbon as toe)**	**Total**
Heavy oil/t	19.7	26.5	(1.12)	46.2
LNG/t	30.0	30.0	(0.83)	60.0
Liquid gas/t	35.0	31.5	(0.75)	66.5
Nuclear power/kWh	8.29		(0.00)	8.29

Congestion

When speaking of congestion, it is more important to define one's terms than for the other effects in the "social costs" category. For this purpose, it is worthwhile considering the time-flow curve, which has the shape shown on Figure 2.2. For a given flow, *q*, it is possible to define:

- the total time taken during a trip, *t(q)*;
- the marginal cost of the trip, defined by the tangent to the curve, *t(q)*;
- the extra time taken due to the presence of other users, or *t(q)-t(0)*. If comparisons are to be made between the monetary and non-monetary expenditures on transport, it is the term *t(q)* which must be used. It must also be used to set the price to be paid to reach the optimum. In order to measure the additional cost caused by the presence of the traffic, it is *t(q)-t(0)*.

Figure 2.2. **Time-flow curve**



Hence, for different reasons, each of the three quantities is entitled to be called the "cost of congestion", and in fact research calculations have been done for each. Of course, the term actually used is of little importance, so long as one knows what is being covered in each case.

In the United States, annual statistics are prepared for total congestion in major cities, calculated as the difference between the actual journey time and the journey time which would be possible in free-flowing traffic. Fifty urban areas are analyzed. In 1989, the cost of lost time was evaluated at $780 million (including additional fuel costs due to lower speeds) compared with $700 million in 1988. The provisional results for 1990, and a review of the period 1982-1990, show an increase in congestion of about 20 per cent over the period.

Bouladon (1991) reports the following costs of congestion (calculated as the difference between the actual time and a "normal" reference time):

- 2.10 per cent of GNP in France;
- 3.20 per cent in the United Kingdom;
- 1.30 per cent in the USA; and
- 2.0 per cent in Japan and the EEC.

Table 2.8. **Cost of local pollution by traffic unit (Unit: 0.01 ECU)**

Study	Country	Year	Road			Rail		Aircraft (pass-km)	Waterway (tonne-km)
			Pass-km per car	Pass-km per bus	Pass-km per truck	Pass-km	Tonne-km		
Grupp	Sweden	1986	0.15-0.68	0.05-0.21	0.18-0.82	0.04-0.15	0.05-0.20	0.16-0.72	0.06-0.25
Marbuger	Germany	1985	0.07-0.19	0.02-0.04	0.05-0.12	0.00-0.01	0.01-0.02	0.03-0.07	0.01-0.02
Planco	"	1986	0.11-0.27	0.02-0.05	0.07-0.17	0.01	0.01-0.02	0.04-0.10	0.01-0.02
Henz *et al.*	"	1984	0.06-0.31	0.01-0.06	0.04-0.2	0.00-0.01	0.01-0.03	0.02-0.12	0.01-0.03
Pillet	Switzerland	1985	0.52-0.85	0.26-0.53	0.78-1.25	0	0	0.26-0.54	0
Infras	"	1990	0.33-0.63	0.07-0.21	0.55-1.53	0	0	0.76-2.1	0
EcoPlan	"	1989	1.67	1.90	4.66				
Planco 92	Germany	mid-1985	1.94	0.40	1.33	0.10	0.06		0.16

Table 2.9. **Projections of key climate change variables in the literature**

	Forecast Period	Annual rate of increase							Levels at end of period	
		GDP	Energy efficiency	Final energy demand		Energy price		Emissions in CO_2 equivalent	Concentrations of GHGs[1]	Warming (°C)
				Total	Fossil sources	Total	Fossil sources			
Worldwide studies										
Manne/Richels (1990)	1990-2100							1.4		
USA		1.6	0.5	0.9				1.1		
Other OECD countries		1.6	0.5	0.9				1.1		
Eastern Europe (including USSR)		1.6	0.3	0.9				0.7		
China		3.5	2.0	2.6				2.1		
Rest of the World		3.0	0.0	2.3				2.0		
IEA (1990)	1987-2005			2.2			3.1	2.2		
Cline (1989)	1975-2075			1.0	0.9			0.8	>600	1.5-4.2[2]
Reilly *et al*. (1987)	1975-2075		1.0					0.5	430-590	3
Mintzer (1987)	1975-2075	2.0	0.8	1.3				1.5	825	
Nordhaus/Yohe (1983)	1975-2100	2.1		1.4	0.9	0.2	1.0	1.2	780	
Nordhaus (1990)		1.1						1.1	600	3[2]
Nordhaus (1977)	1980-2100			1.4				1.6		
Edmonds/Barns (1990)	1988-2025	3.0	1.0	2.0				1.2		
National studies										
SIMEN (1989) (Norway)	1988-2000	1.5		1.1				1.6		
Glomsrϕd *et al.* (1990) (Norway)	2000-2010	2.7					1.0	3.9		
Blitzer *et al*. (1990) (Egypt)	1987-2002	3.5						2.2		
Bergman (1989) (Sweden)	1985-2000	2.0		0.7				5.3		
Dixon *et al*. (1989) (Australia)	1989-2005	3.4		2.6[3]				2.7[3]		
CBO (1990) (USA)	1988-2000				1.1			1.1		

Notes: 1. Expressed in ppm CO_2 equivalent. 2. For a doubling of CO_2 emissions. 3. For electricity and road transport.

Table 2.10. **Effect of a reduction in CO_2 emissions on growth: worldwide models**

	(1) Reduction in emissions compared with their reference levels in the final year of the period considered	**(2)** Changes in the growth rate of GDP	**(3)** Percentage difference from reference level of GDP in final year	(4) Carbon tax (dollars per tonne of carbon)	
				Maximum value	Minimum value
Manne/Richels (1990)					
USA		-0.0	-2.5	400	
Other OECD countries		-0.0	-1.8	250	
Eastern Europe	-75	-0.0	-2.5	700	250
China	(2100)	-0.1	-10.5	250	
Rest of World		-0.0	-4.0	250	
Whalley/Wigle (1990)[1]					
National tax on production	-50	—	-4.4[2]	—	462.8
National tax on consumption	-50	—	-2.1[2]	—	463.1
Worldwide tax	-50	—	-4.2[2]	—	459.7
Per capita ceiling on emissions	-50	—	-8.5[2]	—	—
Cline (1989)	-65.5 (2075)	-0.1	-7.4	—	—
Mintzer (1987)	-88 (2100)	-0.0	-3.0	—	—
IEA (1990)[3]					
Scenario including a carbon tax	-12 (2005)	-0.2	—	—	72
Scenario with 70% nuclear power plus a carbon tax	-25 (2005)	-0.2	—	—	72
Nordhaus (1990) and (1990*b*)					48.5[4]
Small reduction	-30	-0.0	—	—	199.0[4]
Medium reduction	-50	-0.0	—	—	—
High reduction	-80	-0.1	—	—	—
Nordhaus (1990*b*)					—
Rapid implementation	-60	-0.3[5]	—	—	—
Rapid implementation involving regulations	-60	-0.5[5]	—	—	—
Edmonds/Barns (1990)	-75 (2025)	-0.2	-8.0	—	436.5

1. The objectives and results refer to mean values for the period 1990-2030.
2. Effect on well-being measured as changes according to Hicks.
3. The policies and results only concern OECD countries.
4. Assumption of a considerable reduction in CFCs. Without this reduction, the carbon tax expressed as equivalent CO_2 would be about 90 and 200 $ respectively.
5 For industrialised countries.

Table 2.11. **Effect of a reduction in CO_2 emissions on growth: results by country**

	(1) Reduction in emissions compared with their reference levels in the final year of the period considered	(2) Changes in the growth rate of GDP	(3) Percentage difference from reference level of GDP in final year	(4) Carbon tax (dollars per tonne of carbon)	
				Maximum value	Final year
Manne/Richels (1989, USA)					
Pessimistic technical scenario	-88 (2100)	-0.1	-4.0	600 (2020)	250 (2100)
Intermediate technical scenario	-77 (2100)	-0.0	-2.5	—	—
Optimistic technical scenario	-50 (2100)	-0.0	-0.8	—	—
CBO (1990, USA); DRI model	-16 (2000)	-0.2	-2.0	100	100
DGEM	-36 (2000)	-0.1	-0.6	100	100
Jorgenson/Wilcoxen (1990, USA)	-20 (2060)	-0.0	-0.5	17 (2020)	15 (2060)
	-36 (2060)	-0.0	-1.1	46 (2020)	42 (2060)
Blitzer *et al*. (1990, Egypt)					
Scenario 1	-15[1] (2002)	-0.1	-2.7	—	—
Scenario 3	-35[1] (2002)	-1.0	-15.0	—	—
Scenario 5	-40[1] (2002)	-1.5	-19.0	—	—
Glomsrød *et al*. (1990, Norway)[2]	-26 (2010)	-0.4	-2.7	—	—
SIMEN (1989, Norway)[2]	-16 (2000)	-0.1 - -0.2	-1 - -2	—	—
NEPP (1989, Netherlands)[2]					
Scenario including national measures	-25 (2010)	-0.2	4.2	—	—
Scenario including worldwide measures	-25 (2010)	0.0	0.6	—	—
Bergman (1990, Sweden)	-51 (2000)	-0.4	-5.6	—	—
Dixon *et al*. (1989, Australia)	-47[3] (2005)	-0.1	-2.4	—	—

1. For the emission target, the final year of the period considered is 2012, the reductions then reach -30 per cent, -35 per cent and -55 per cent, respectively.
2. The reductions in other pollutants is included.
3. The reductions apply to the sectors of electricity and road transport.

Matsuzawa (1989) devised a method for calculating the cost of congestion, still using the "actual time/free-flowing traffic time" definition, and applied it to the Osaka conurbation (2.6 million population, travelling 12,100,000 vehicle-km a day), leading to figures ranging from 250 to 1000 million yen (1985 value) a day, according to the assumptions, or from 20 to 80 yen per kilometre travelled.

Koshi (1991) calculated the cost of congestion in Tokyo as 2000 million yen a day or $3.6 million (the difference between the time actually spent and the notional time at a reasonable speed).

Darbeira (1992) calculated the cost of congestion per passenger-km, using the "total time spent" and gives the following results for urban areas in the Paris region: cars -- 2.16 F/km; buses -- 3.28 F/km.

Walter *et al*., in Frey and Longloh (1992) calculates the time lost in the Berne conurbation (difference between actual time and time in free-flowing traffic) as being worth 5 million ECU. The marginal cost of congestion varies considerably according to the time of day: 0.074 ECU per vehicle-km at the morning peak, and 0.115 ECU at the evening peak.

In Zurich (Mauch *et al*., in Frey and Langloh, 1992), the cost of congestion to the motor car is estimated at 0.20 SF per passenger-km, and to the bus at 0.25 SF per passenger-km.

Finally, the Environment Green Book of the Commission of the European Communities (1992) reports congestion costs at:

- £10 to 15 billion a year in the United Kingdom (or 12.5 to 19 billion ECU); and
- 1 billion florins in the Netherlands (0.5 billion ECU).

Congestion also exists for other modes of transport. Here, these costs are not expressed in terms of speed-rate curves, but in two other ways:

- The transport timetable can become saturated, making it impossible to add one additional train or one additional aircraft, without delaying or shifting the schedules of those already planned. The result is that the greater the number of users, the more the average journey time per user increases, and the greater the average difference between the desired timetable and the possible timetable[8].
- When the service frequency is high, delays become increasingly frequent.

Using these concepts, the costs of congestion in air traffic have been calculated at $1.5 billion in Europe, according to the Green Book of the Commission of the European Communities (1992). On the other hand, the cost of congestion at London's airports alone has been assessed at $10 billion or 1.5 billion ECU by the UK Department of Transport. Quinet (1993) also calculates the cost of air traffic congestion as 1.5 billion FF (0.2 billion ECU) in France, and the cost of rail congestion at 1 billion FF (0.15 billion ECU), again in France.

Land use

While it is true that transport uses land, it is not clear that this phenomenon should be regarded as a social cost in the same way that noise and pollution certainly are. This is because the land for transport projects is usually purchased from its former owners when the infrastructure is built. In principle, this transaction takes place at a price that is similar to the market value. Therefore, including the consumption of space in social costs would imply that the price of the land does not reflect its social scarcity, an assumption which would have to be demonstrated in each particular case.

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8. This last point applies only above a certain level of saturation. When traffic is light, its growth leads to higher frequency, and hence, to less waiting time.

For the oldest routes, which have been public for a very long time (sometimes for several centuries), the question of whether the land was originally bought at an appropriate price no longer has much meaning, but hardly less than that of the present value of old infrastructure: what is the value of a particular road, built along a route which already partly existed several centuries ago, whose earthworks, bridges, etc. date from the beginning of the century?

And if one considers only the land, should this be priced at the same level as the neighbouring land, which would probably be different if the infrastructure did not exist? It is interesting to examine the area of the different systems, but one must be careful not to draw too rapid conclusions and to avoid measuring the same data twice.

Subject to these reservations, the following are the figures given by the Commission of the European Communities Green Book (1992) on the impact of transport on the environment:

- Road system: 28,949 km², or 1.3 per cent of the total land area of the European Union (EU);
- Rail network: 706 km², or 0.03 per cent of the total land area of the Union;
- Air traffic routes: there are no statistics on this subject. However the area of a regional airport is calculated at 2 to 4 km², and that of a major airport at 15 to 20 km²;
- Finally, the idea of land use does not have much meaning for inland waterways, some rivers being navigable, others not. We may also point out the work done by SOFRETU (1992) and that of Marchand on the space taken up by different modes of urban transport in terms of m²/hour and per person, which takes account both of the area and of the time it is used, allowing the space needed for parking to be added to that necessary for traffic.

The corresponding figures, shown in Table 2.12, are an interesting illustration, but must be interpreted with care. For example, much more consideration would be needed in order to deduce pricing ratios between infrastructures for the different modes of transport.

Comparison of energy sources

Local pollution, like general pollution, depends on the type of engine involved, and on the particular energy source that is being used. However, there has been no quantitative study of the comparative social costs of different transport energy sources. A few emission rates can be given; otherwise, only qualitative comments can be made.

To begin with, there is a difference between energy sources for rail transport. Pollution from railways varies depending on whether the train is driven by electric or diesel power, the main difference being in the location of the pollution and in the emission rate. The emission rate is a little lower in thermal power stations than for on-board engines; it is appreciably lower -- virtually zero -- for nuclear power plants and hydro stations. This phenomenon may explain the difference between estimates of rail pollution for a country, and shows the care required when transposing results from one country to another.

As regards road transport, comparisons between the fuels and engines used (or usable) are more complex. The two fuels most frequently used are gasoline and gas oil. The relative environmental effects of the two fuels are uncertain. Gas oil engines produce more particulate matter and sulphur dioxide but their consumption is lower; in particular, their contribution to the greenhouse effect is less (it appears that the balance between the specific consumption -- in litres per 100 km -- which is 15 to 30 per cent less for diesel, is only partly compensated by the greater emission of CO_2 per litre burned, which is of the order of 13 per cent). Selected results are illustrated in Table 2.13. Other possible fuels, some of which are already in use, are:

- electricity;
- alcohol;
- liquefied or compressed petroleum gas; and
- hydrogen.

Table 2.12. **The cost of land use (SOFRETU-CETUR, 1992)**

	Use of land				
	Per person (m^2/h)			Per vehicle	
	Parking	**Traffic**	**Total**	**m^2/h**	**FF**
BICYCLES, MOTORCYCLES					
Work (duration 9 hrs)	13.5	7.5	21	21	3.78
Leisure (duration 3 hrs)	4.5	7.5	12	12	2.16
Shopping (duration 1.5 hrs)	2.5	7.5	10	10	1.80
CARS					
(1.33 person/vehicle)					
Work (duration 9 hrs)	68	17	85	113	20.34
Leisure (duration 3 hrs)	23	17	40	53	9.54
Shopping (duration 1.5 hrs)	11	17	28	37	6.66
BUS				**Price per passenger**	
Daily average					
(20 persons per bus)				1.35	
Normal roads	0	7.5		5.40	
Bus lane (30 buses/hr)	0	30			
Peak times (80 persons per bus)				0.36	
Normal roads	0	2		1.35	
Bus lane (30 buses/hr)	0	7.5			

Table 2.13. **Energy consumption and emissions for transport of 100 people over 500 km**

Vehicle	Energy use (Mj)	Total emissions (kg)					
		CO_2	CO	HC	NO_2	SO_2	H_2O
Car							
Low	45 000	3 240	85.5	15.3	63.0	0.9	---[1]
High	92 500	6 660	342.3	39.8	142.5	1.9	---[1]
Car + catalyst							
Low	45 000	3 240	9.0	1.4	9.0	---[1]	---[1]
High	92 500	6 660	55.5	3.7	112.9	---[1]	---[1]
Car diesel							
Low	45 000	3 375	4.5	1.8	18.5	4.5	---[1]
High	92 500	6 938	18.5	5.6	75.9	9.3	---[1]
Train							
Low	20 500	1 435	0.6	0.16	4.5	2.5	---[1]
High	23 000	1 610	0.7	0.23	5.1	2.8	---[1]
High speed train							
Low	27 550	1 929	0.8	0.19	6.1	3.3	---[1]
High	30 450	2 162	1.5	0.31	7.3	3.7	---[1]
Boeing 737-300							
Low (fl 350)	86 900	6 320	12.1	0.56	25.3	0.40	2.5[2]
High (fl 250)	91 500	6 655	12.9	0.63	26.0	0.42	2.6[2]

Notes: 1. Unknown.
2. At cruising level, consumption is about 45 per cent of this volume.

Source: H.B.G. TEN HAVE (1992). *Passenger Transport: Energy Use and Air Polluting Emissions*, NLR, Holland.

Hydrogen is the fuel of the distant future, and is less polluting. Alcohol has the advantage of lower pollution, compared with fuels based on petroleum, but its cost is high. Liquefied or compressed natural gases appear to be the most promising compromise between cost, environmental effects, the possibility of rapidly building up a distribution service, and compatibility with existing fuels. The electric vehicle is an ideal solution for eliminating pollution and reducing noise, particularly if the source of the power is non-thermal. On the other hand, the well-known problems with electric vehicles include those of costs, weight, and limited speed of the vehicles. These problems seem likely to limit their use to urban journeys in the near future.

Summary

An attempt can be made to summarise the above results, noting first of all that their considerable dispersion calls for great prudence and restraint in their interpretation. In particular, it is by no means certain that the differences shown between estimates for one country and another stem from actual differences between the two countries. Similarly, the various estimates show no significant trend over time, even though experience shows that (perhaps apart from congestion) the pollution and disamenities per traffic unit are steadily falling owing to vehicle improvements -- probably even more quickly than traffic volumes are growing.

Subject to these reservations, the following mean values can be given for the different social costs, expressed as percentages of GNP:

- Accidents: 1.5 per cent to 2 per cent;
- Noise: about 0.3 per cent;
- Local pollution: about 0.4 per cent;
- Congestion:
  - -- using the "total time" definition: about 8.5 per cent (of which 7 per cent is for roads);
  - -- using the definition of "additional time compared with free-flowing traffic": about 2 to 3 per cent.

No assessment will be made for overall pollution, but we shall simply note that most research on the cost of taxes for reducing it show an ultimate reduction in GNP of the order of a few per cent (between 1 and 15 per cent) for a carbon tax, which would affect all CO_2 emitters and not only transport (transport accounts for about 20 per cent of all greenhouse gases).

A few studies provide quantitative estimates of the social costs per unit of traffic (see Table 2.14). The range of variation for road transport -- the most common subject studied -- is relatively low, in the order of 1 to 2, including variations in costs according to the environment (rural or particularly urban), as well as uncertainties in the assessments themselves.

Environmental policies and the internalisation of social costs

In practice, one might expect environmental policies to be at least partially based on calculations of social costs. In a theoretical decision-making system, and using the definition of social costs provided earlier, environment policies should be formulated so as to minimise the social cost.

Table 2.14. **Social costs in 0.01 ECU per traffic unit (passenger-km or tonne-km)**

Source	Comments	Passengers				Goods		
		Car	Bus	Train	Plane	Truck	Train	Waterway
TEFRA (1881)	France					0.8 to 1.0 on motorway 0.3 to 0.4 on highway		
Sweden 1987	Stockholm	14.3 - 27						
Report quoted by Hansson & Marckham (1992)	Rural area	2.8						
Darbeira	Paris	3.5	0.15					
Auzannet & Bellaloum	Paris and region, without accident cost	1.6 - 4.3	0.15	0.15 - 0.30				
Planco	Germany	3.48	0.50	0.57		2.58	0.37	0.18
CCFE (1992)	Netherlands	1.66		0.2		1.66	0.2	
Replies to a questionnaire	Belgium	1.56				1.56		
(Assumption:	Denmark	1.51				1.51		
1 passenger = 1 tonne)	Switzerland	3.0		0.8		3.0	0.8	
	Austria	3.3		0.25		3.3	0.25	
	Sweden	5.0		0.7		5.0	0.7	
	Finland	3.1-4.3				3.1-4.3		
	Norway	2.1				2.1		
	Germany			0.006			0.006	
Directions (1992)	Canada	0.38-0.43	0.14-0.20	0.18-0.45				

In fact this is not so, for several reasons. The first is that calculations of social cost are too recent and are still infrequently used, with the result that they do not yet form part of the thought processes of decision-makers. The second reason is the probably not-unjustified feeling that calculations of social costs are vague and not very reliable. Indeed, this view is supported by the results summarised in the previous section. Also, most of the available quantitative research results do not take account of the expenditures actually committed to reducing or repairing environmental damage.

Nevertheless, policies for internalising social costs *have* developed, often based more upon intuition and common sense than on rational economic calculation. One may ask how these policies are expressed and to what extent they have led to the social costs of transport actually being internalised in the different OECD countries. In order to answer these questions, we shall begin by analysing the direct actions taken by the public authorities within their own sphere of influence -- that of infrastructure. The measures they have taken to influence the attitudes and decisions of particular actors are then reviewed.

Infrastructure

Transport infrastructure is in the hands of the public authorities. As such, it escapes market forces and the influence of particular decision-makers. Social costs are taken into account at two different levels: first, in the design of individual projects, and then in the definition of development plans.

Design of projects

In most countries, projects are chosen and defined on the basis of a cost-benefit or cost-advantage analysis, with public hearings being used to aid in this definition process. Cost-benefit analysis has long included both congestion and accident effects: the value placed on time and on life are already old concepts. Although this type of analysis has been done comprehensively and stringently for projects in rural areas, it is done less frequently in urban areas, even though it is here than congestion is highest.

Turning to the other major elements of transport social costs -- noise and pollution -- these are usually not incorporated into the cost-benefit analysis, and show up only as additional criteria in a multi-criterion analysis. They are then often evaluated by people whose own situation will be significantly improved by the corresponding investment. Nevertheless, there is now a growing tendency in many countries to allocate a monetary value to these elements and to incorporate them in the cost-benefit analyses. For example, this is already the case in Sweden, and Finland is looking into the possibility. Also, decisions relative to new infrastructure projects are increasingly the subject of an environmental impact study, which should, of course, include the social costs analyzed in this report, as well as to effects on the ecosystem at large, such as consequences for the life of species, aesthetic aspects, cut-off effects, and so on.

The impact study is usually the subject of a public hearing -- a very general procedure, whose content varies from one country to another. Important variables discussed during public hearings include the duration, the procedures used and, particularly, the capability of opponents to stop progress. This is an extremely worthwhile procedure which can help to avoid overly technocratic decisions. Unfortunately, however, public hearings more often result in the expression of individual interests than in the disclosure of the public interest, owing to the absence of any evaluation of consequences in financial terms, and because the quantitative estimates of environmental damages are usually imprecise. In order to help overcome this disadvantage, the quantification and monetary evaluation of environmental effects must be further developed. The question arises as to how the different types of social costs are assessed in these environmental impact studies.

The visible effects are the easiest to predict; the use of photo-montage and mock-ups can give an excellent idea of how the future infrastructure will appear and fit into the landscape. Of course the evaluation of the specific result will still be highly subjective. As regards noise and local pollution, the evaluation can be less subjective, but knowledge of the effects of environmental impacts is generally more difficult to obtain. Many impact studies merely list the number of people who will be affected (for example, those living within a certain distance from the infrastructure). This approach does perhaps provide a satisfactory image of the effects of the pollution moving through the space surrounding the infrastructure; however it is used primarily for noise, where the propagation of the noise is highly sensitive to the local geometry, and it is only through investigations at the construction stage that greater precision can be introduced and adequate measurements considered. This very often leads (in cities, at least) to infrastructures being placed underground, for reasons of noise and appearance, much more for than reasons of local pollution. One wonders whether this situation can be improved and the effects of noise integrated in some more precise manner. To do this, one would have to be capable of improving the prediction of the effects, which could involve significantly improving the modelling capacity in these fields.

As far as contributions to overall pollution are concerned, this is generally neglected at the level of a particular project. An important milestone is reached when an impact study is performed and a public hearing is held. When these procedures first began, the impact study was only when the project had already reached a fairly advanced stage, with the decision in principle to build it already essentially having been taken, and the transportation route already approximately fixed. The influence of the impact study was thereby reduced; it could result only in slight modifications to the technical characteristics or, at the limit (and then rarely), in postponement of the project. In a different form, the environmental impact assessment could have provided a valuable input to the decision-making process. However, in all countries, the impact study is now being done earlier in the life of the project. In France, for example, a recent circular from the Ministry of Supply provides for an impact analysis of projects at the outset of planning new projects, with appropriate consultation of the associations involved.

Development plans

Impact studies make it possible to improve the environmental consequences of projects, but have no direct effect on transport demand, i.e., on the total volume of traffic and the way in which this demand is broken down between different modes or routes. This direct effect takes place through the Development Plans in which, from the infrastructure standpoint, the equilibrium between modes of transport is defined, both generally and by route. It is here that the degree of internalisation of social costs as regards transport infrastructure is most deficient.

To begin with, the development plans occupy a place of varying importance in the different OECD countries. In some countries, they are approved by parliament (this is the case in Austria, Switzerland, the Netherlands and Germany). In other countries, they do not exist. Where they do exist, they do not always include effective mediation between the different transport modes, and often consist of a litany of what the different pressure groups wish to see. Even when there is some mediation of this type, the influence of environmental considerations is very uneven and is typically subject to criteria that are less well codified than in decisions concerning isolated projects. The concern for relieving congestion does of course appear, since it is now accepted that saving time is an essential factor in the advantages of transport infrastructure.

On the other hand, safety plays a lesser role. As regards pollution and noise, their appearance is typically qualitative and, at this stage, slight. Generally speaking, there is no evaluation of the corresponding social costs, so there is no certainty that an optimum can be obtained. Environmental considerations are usually accorded very low importance. There are few countries where the contrary is true: the Netherlands, Sweden, Canada, Austria, Switzerland and Germany are a few examples. Even here, however, the resulting discussions have been somewhat bitter, with the actual decisions that have been taken often falling far short of expectations.

Apart from these considerations of national planning, special attention must be given to urban infrastructure, the decisions for which, while depending partly on the national authorities, are largely a matter for local authorities. In this field, there is a wide variety of attitudes, not only between countries but also between communities, as a result of the autonomy of local authorities.

In conurbations that are concerned about the environment, there is usually a tendency to encourage the development of public transport. It must be noted, however, that the development of public transport is not in itself a guarantee that consumers will shift transport modes, but can lead instead to an increase in total mobility, with only a slight fall in road traffic. To produce a real modal shift, measures must also be taken to restrict road traffic, as we shall see in the next section.

Actions on behaviour: taxes and standards

As far as infrastructure is concerned, the public authorities are directly involved. However, when it comes to the *use* of that infrastructure, and generally speaking in matters of traffic, private initiatives predominate. Thus, the public authorities do not take the decisions directly, but can only influence the decisions of the private agents. This can take two forms: technical *regulations* (standards, bans, etc.) and financial *incentives* (taxes and grants). Both instruments have defects and virtues as regard the internalisation of social costs.

The defects of regulations are well known:

- They do not lead to optimal solutions at least cost.
- They require policing, which can be costly or difficult.
- The regulatory power can be perverted by those to whom it applies, and be made less strict or diverted to generate income to their benefit.
- As time passes, regulations become increasingly complex in order to cover all cases, or to counter-evasive actions.
- They generate side effects or unexpected consequences in other areas.
- They can be an obstacle to technical and organisational change.

On the other hand, regulations do result in the easy achievement of quantitative objectives. Taxation, when set at the correct level, does ensure that the best result is obtained at least cost, but also involves certain difficulties:

- The uncertainties in evaluating environmental effects are considerable, as the study of social costs in the first part of this paper has shown. If taxes are set is at the wrong level, the consequences on the level of pollution can be substantial[9].
- Taxes may often meet greater psychological opposition, particularly since they require cash payments.
- The redistributive effects can be undesirable.

Thus, the choice between the two potential instruments must be based upon several different criteria, and one or the other will be the more suitable according to circumstances. Bearing these considerations in mind, the degree to which the social costs reviewed in the first part of this paper are actually internalised in OECD countries is now examined.

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9. From this standpoint, the advantage is with standards or taxes according to whether it is the optimal quantified target or the optimal social cost which is best known.

Local pollution and noise are essentially controlled on the basis of technical emission standards. These standards are continually being made more stringent, especially in the United States and the Scandinavian countries. For example, the United States is now promoting standards which will ultimately require vehicles to produce zero pollution (apart from carbon dioxide). Progress is slower as regards trucks. As far as noise is concerned, taxation seems to be effective for noise from aircraft; it can also be combined with regulations. Taxation produces revenues that can be used, for example, to soundproof dwellings, or to provide an incentive for the replacement of older, noisier aircraft.

Safety has made considerable progress over the last twenty years, as nearly all countries have introduced speed limits, safety belts and alcohol checks. Improvement is now slower, being based upon more fundamental actions concerning vehicles, accident assistance and improvements to infrastructure. Comparing performance in the different countries is complicated, since it involves structural factors such as geography and the breakdown of traffic. However, it seems that differences in attitude can play an important part, and that programmes of information and increasing awareness would prove effective.

It is nevertheless unfortunate that these various regulations do not rely more on cost-efficiency studies. It is possible, in fact, through improved knowledge of social costs, to produce increasingly good evaluations of the effects of regulations in monetary terms, and it should be possible to place regulatory decisions on more rational bases, using this type of estimate. It is also to be regretted that, in certain countries, regulations are poorly policed. The technical inspection of vehicles in particular has fallen considerably behind standards in some of them. Financial instruments play only a slight role in the direct control of road noise, pollution or accidents. In fact, road transport tends to be taxed only through taxes on fuel, taxes on ownership (the annual road tax charge), or taxes paid on the original purchase.

Taxes on fuels in general use are universal: a substantial proportion of the tax on fuels has a macro-economic and revenue-raising basis, related to the fact that the motor car is excellent target for taxation. The rest covers not only the social costs but also the costs of infrastructure, both of which are poorly-understood. There are few countries (e.g. Netherlands, Sweden) for which the taxes on the different fuels do reflect some differences in their degree of pollution. Moreover, fuel consumption does not exactly reflect the social costs of traffic; local differentiations are impossible. Finally, the taxation of fuels affects the overall use of the particular mode of transport, and not its differentiation according to location and time.

Taxes or allowances on ownership and purchase have the same general effect; they can affect the purchase of a particular model. Thus, in France, the axle tax has virtually eliminated trucks with two axles, and tax allowances for vehicles with a catalytic converter have increased the number of vehicles so fitted. But this type of differentiation is rare; the annual charges are usually proportional to the vehicle power rating, and are relatively low. However, these taxes could play a more important part, by being differentiated according to the characteristics of the vehicle with regard to noise and pollution. This behaviour modification instrument is little-used, except as regards the introduction of catalytic converters. Vehicles which have converters benefit from tax allowances in certain countries in the form of reduced annual charges, albeit in amounts which still leave the motorist bearing some of the cost of depollution (Germany, Netherlands, Denmark and, temporarily, France).

Generally speaking, taxation affecting the transport of goods by road is proportionally lower than that on the transport of people by road, having regard to the difference in social costs and infrastructure costs. Taxation may also be a useful instrument in controlling the greenhouse effect. Economic studies have shown that uniform regulations would lead to much greater economic losses (because the efforts are poorly distributed) than uniform taxation. However the temperature of the planet is a public good for the preservation of which the so-called "free rider" attitudes come to the fore. So far, only some OECD countries have introduced a CO_2 emission element into their tax systems[10]. Adoption of a joint measure throughout the OECD would require better knowledge of the phenomenon in order to make the prediction of damage costs less uncertain. However, on a worldwide basis, the adoption of similar measures by the countries of the south would probably necessitate some efforts to redistribute wealth far beyond the transport sector.

The extent to which the greenhouse effect has so far been internalised is virtually zero, despite declarations of intent, and this does not result only from technical uncertainties. Taxation is also being considered -- and occasionally used -- to control the demand for transport, and to affect the modal breakdown. Road pricing exists in certain countries. Here, we are not referring to the motorway tolls in certain European countries such as France, Italy or Spain, the aim of which is essentially financial, and which have a negative effect from this point of view, but to the general road-pricing systems introduced in certain city states, such as Singapore and, a few years ago, in Hong Kong.

The road-pricing trials in the Netherlands have been temporarily abandoned. However, the question is still under discussion or planned in several European countries (Netherlands, United Kingdom, Switzerland). It may be raised again in line with future technical progress with electronic pricing systems. However, road pricing has been introduced in a few cities, in the form of an annual charge or of tolls on roads surrounding the town. Table 2.15 lists several cities which have introduced (or considered) urban road-pricing. The fact is that the main effects of road-pricing can also be obtained by simple means, such as an annual charge or by increasing the price of fuel, almost as effectively as with electronic tolls. The key to success lies much more in the political will and the acceptability of the measures being proposed, than in the technical difficulties involved. However, the net result is that congestion as a social cost is fairly poorly internalised in the taxation of road transport. The same situation is found in other modes (particularly in air transport), where congestion is high, with zero internalisation in existing tax systems.

A few countries have introduced coherent policies to influence the modal breakdown and the volume of demand. Thus, the Netherlands combines taxation, technical emission standards and investment policies. Transport policies in the Scandinavian countries are also motivated by the same concerns.

Switzerland has resolved the problem of disamenities from "North-South through-traffic" by a series of measures combining taxation, technical standards and the construction of infrastructure to develop combined forms of transport to replace through road traffic. Approaches of this type are also being examined by certain countries on particularly heavily-loaded routes (for example, the Lille-Paris-Marseille route in France). General policies of this kind are also being applied in certain cities. These policies include a number of co-ordinated actions [these cities include for example Berne, Lubeck and Visby (see "Ecology 90" Conference)]:

- control of parking places in the town centre;
- the arrangement of commuter car parks;
- priority being given to buses on reserved routes, with priority arrangements where there are traffic conflicts with automobile traffic; and
- a ban on automobile traffic over extensive areas, particularly in city centres.

California has taken more general and more drastic measures, with direct action on air pollution through the control of emissions. This approach is speeding up the development of motor vehicles with low

10. The Commission of the European Union has made proposals, and the Union seems to be moving towards a tax, based partly on energy consumption, and partly on CO_2 emissions.

or zero emissions. Oil refineries in California are also pushing in the same direction, and work is being done to expand the use of electric vehicles and public transport.

The United States has also implemented three general types of internalisation that are little-used in other countries:

Table 2.15. **Road pricing experiments**

City/Area	Type	Status	Main Purpose
Singapore.	Are licensing system (in addition to very high taxes on vehicle purchases and ownership).	Start-up 1975.	Traffic restraint.
Hongkong.	Electronic road-pricing.	1983-85 experiment abandoned (said to interfere with personal freedoms).	Traffic restraint.
Bergen (N).	Cordon toll.	Start-up January 1986.	Traffic restraint.
Oslo (N).	Cordon toll.	Start-up February 1990.	Road funding.
Trondheim (N).	Cordon toll.	Start-up October 1991.	Road funding.
Tromso.	Local fuel tax.	Start-up July 1990.	Road funding.
Stockholm.	Various financial incentives and deterrents.	"Dennis Agreement" between the main parties on their introduction.	Traffic restraint.
Cambridge (UK).	Electronic road-pricing.	Planned for 1993 (test) and 1995 (operation).	Traffic restraint.
London.	Various methods, including road-pricing, to restrain traffic.	Under study.	Still open.
Netherlands.	Road-pricing (cordon-based system).	Ministry of Transport proposal; not yet followed up.	Traffic restraint.
Southern California (South Coast Air Quality Management).	Agreement between State Government and commuters to increase vehicle occupancy rates.	Start-up July 1988.	Traffic restraint (by pooling cars and vans).

Source: Abstracted from Frey *et al*. (1992*a*).

- Price reductions (tolls and car parks) for vehicles with high occupancies.
- Contracts for pollution rights. Under these contracts, firms limited to specific pollution totals can distribute their pollution rights amongst their vehicle fleet and their other activities, and can even sell only unused rights. This procedure can be easily applied only to large firms, but has (to date) had only a marginal effect on transport.
- The "CAFE" procedures, whereby an average emission is set per vehicle for each constructor.

Barde and Button (1992) and Banister and Button (1992) have also analyzed the degree of internalisation that exists in the transport policies of different OECD countries. From the information that emerges, a few examples of the risks of regulatory measures that are poorly conceived or poorly managed can be observed. Thus, in Athens (see Giaoutzi, in Barde and Button, 1992), the apparently drastic step taken to ban the movement of one vehicle out of two has had only little effect on congestion and pollution. Similarly in Germany, the reimbursement of workers' car expenses (see Rothengatter, in Barde and Button, 1992) has been shown to have negative effects on the environment. Finally, the effects of the axle tax instituted in France in 1970 to make heavy goods vehicle pay their social cost, have been completely wiped out by the fact that the tax has not been revised since its creation (Lamune and Quinet, in Barde and Button, 1992).

Other general information can be obtained from these analyses. Thus, United States experience (Deakin in Barde and Button, 1992) indicates that the effectiveness of regulatory measures to reduce emissions, the opposition to control by taxation and, finally, the regulatory measures themselves often have unexpected consequences on other factors of which they modify the conditions of equilibrium in an unpredictable way; for example, the style of development or use of land.

However, apart from the few cases quoted, there are not many countries or cities where an integrated transport and environmental policy approach is followed. This is particularly regrettable, since improvements in these areas cannot possibly result from a single instrument, but only from the combination of a large number of tools, owing to the many conflicting objectives involved, and to the complexity of their interrelationships.

Conclusions: future ways forward

Knowledge of transport sector social costs, of prime importance in the definition of broader environmental policies, is gradually improving as more and better research is done. The uncertainties that remain have many causes, most of these being related to the difficulty of calculating monetary values in the absence of markets, and to our imperfect understanding of the harmful effects of transport in certain fields, such as noise or pollution.

Subject to these reservations, the social costs of transport seem to be in the neighbourhood of the following values, as a percentage of GNP:

- Accidents: 2 per cent;
- Noise: 0.3 per cent;
- Local pollution: 0.4 per cent;
- Congestion:
    - -- Total time: 8.5 per cent;
    - -- Supplement compared with free-flowing traffic: 2 per cent;
- Overall pollution: 1 to 10 per cent in the long term.

The greater part of these costs stem from road transport. Costs per traffic unit are highly variable, depending in particular on the extent of urbanisation concerned. The following ranges and orders of magnitude can be proposed: one passenger-km has a social cost about the same as one tonne-km; the cost by road (car or truck) is about 0.02 ECU per unit-km; the cost by rail is about 10 times less, and of the same order of magnitude as the cost by air. These values are too imprecise for it to be possible to distinguish any time trends or differences between countries.

Social costs carry very low weights in the overall internalisation of environmental effects, seemingly because of the resistance generated -- a confrontation in which intuition and guesswork tend to play a greater role than any economic calculation. In this context, it is possible to pick out certain aspects for which internalisation has made relatively little progress:

- The environment should be more fully integrated into investment decisions at the Development Plan stage.
- Improvements in safety require training and information programmes and greater use of cost-benefit studies.

- The taxation instrument is used little (or poorly) in controlling noise or road pollution; in fact, it can be a useful complement to a regulatory policy, and its introduction should be promoted. Research and information programmes will probably be necessary for this purpose.
- The control of global pollution will likely involve a tax on carbon or on energy, for which there is as yet neither consensus nor obvious political will.
- Regulations are unevenly -- and occasionally very poorly -- adhered to, and thus lose a large part of their effectiveness.
- Implementation of a general policy for controlling demand requires not one, but many instruments, the effects of which must be properly co-ordinated.
- A better understanding of the physical phenomena governing social costs, and of their evaluation in monetary terms is essential, in order to give guidance to these different approaches, to assist with choices and to generate the political will to take the necessary action.

ANNEX
Definition of externalities

The term "externalities" usually refers to the phenomenon whereby an individual's well-being, or the conditions of production of a firm, are affected by the action of an economic agent who does not bear the consequences of that action; more importantly, the action does not give rise to a monetary transfer. Transport noise, for instance, may disturb local residents and reduce productivity. Consequently, the cost of transport to the community as a whole, or "social cost", covers not only the private cost borne by the operator but also external costs, the sum of which can be written as follows:

Social costs = Private costs + External costs.

However, this does not tell us much about the type of costs involved. Private costs can be divided into *average* cost, *marginal* cost, and *incremental* cost. For the purposes of pricing, other methods of calculating costs, such as the Shapley value, can be used. Costs can be calculated using a cost function which relates overall expenditure to the volume of each class of traffic. But it is also necessary to determine whether expenditure is adequate to cover costs; when it is not (usually because of market failure) shadow prices may have to be set for some goods. This can arise in particular with capital costs.

The same complications arise when measuring externalities, since external costs can be defined precisely only with reference to a specific problem (the internalisation of costs through taxes, for instance; it can also be useful to measure external effects prior to making an investment or to taking action in many other areas). It is also important to specify the model that is being used (in the case of internalisation, prices can be calculated using a Ramsey-Boiteux budget equilibrium constraint model, or the Shapley value). Every problem and every policy response will place a different value on social cost.

Thus, external costs are not absolute values, but will vary according to the purpose of the calculations. This report defines social costs for the purposes of macroeconomic comparison, but they would have to be defined differently, and the figures would not be the same, if the aim were to calculate optimal taxes.

Lastly, externalities need to be distinguished from rent. Rent is the profit that the owner of an asset that is in fixed supply derives from a rise in its price. A property owner, for instance, makes a capital gain on a piece of land when its market value rises as a result of the construction of new infrastructure in the vicinity. Similarly, a hairdresser's income can rise not because his productivity has risen but because that of other workers has increased, thereby pushing up average wages. These examples are (sometimes wrongly) called *pecuniary externalities*.

It is also somewhat inaccurate to speak of externalities in respect of a good that can be purchased at a price that is not the "normal" price (i.e. the price that would be charged if the market was clearing normally). This is usually the case for goods whose prices are controlled to some degree (e.g. goods supplied by a subsidised government monopoly). Before concluding that the difference between the actual and the "normal" price should be corrected, the reasons for the difference should first be ascertained.

REFERENCES

ABAY, G. AND C. ZEHNDER (1992). *Road pricing für der agglomeration Bern*, National City and Transport Research Programme, Zurich.

ACADEMIE DES SCIENCES (1990). *L'effet de serre et ses conséquences climatiques*, Paris.

ALFSEN, K. AND S. GLOMSRØD (1992*a*). *Valuation of Environmental Benefits in Norway*, Central Bureau of Statistics, Oslo.

-------- (1992*b*). *Secondary Benefits of Climate Policies: Some Tentative Calculations,* Internal note, Central Bureau of Statistics, Oslo.

ANSEN, F. (1990). "Example City of Visby", Paper to the Conference on Ecology and Transport, Gothenburg.

AUZANNET, P. AND A. BELLALOUN (1992). *Le coût des transports pour les collectivités*, Internal note, Paris Regional Transport Board (RATP), Paris.

BANISTER, D. AND K. BUTTON (EDS.) (1992). *Transport, the Environment and Sustainable Development*, E. and F. Spon, London.

BARDE, J.Ph. (1992). *Economie et politique de l'environnement*, PUF, Paris.

BARDE, J.Ph. AND K. BUTTON (EDS.) (1992). *Transport Policy and Environment*, Earthscan Publications, London.

BARDE, J.Ph. AND D. PEARCE (EDS.) (1991). *Valuing the Environment*, Earthscan Publications, London.

BOULADON, G. (1979*a*). *Coût et avantage des véhicules à moteur*, OECD report, Paris.

-------- (1979*b*). *La mobilité en zone urbaine: apprendre l'économie des transports*, OECD report, Paris.

BRANDBERG, A. AND R. ANDERS (1990). "Fuel for cars, trucks and buses", paper to the Conference on Ecology and Transport, Gothenburg.

BUTTON, K. (1992). *Market and Government Failure in Environmental Management*, OECD report, Paris.

CERWENKA, P., G. MOTZ, H. KUHFELD AND U. KUNERT, U. (1989). "Kosten and Umvuelteffekte" Verkehrs-politiken, *Verkehr und Technik*, No. 12.

CLINE, R. (1992). *Global Warming: The Benefits of Emission Abatement*, OECD report, Paris.

COMMISSION OF THE EUROPEAN COMMUNITIES (1992). *Green Book on the Impact of Transport on the Environment*, Brussels.

COTTON, E. (1990). *Vehicles for the Future for Southern California*, paper to the Conference on Ecology and Transport, Gothenburg.

DARBEIRA (1992). *Le coût total de la V.P. et des T.C. dans une grande agglomération: le cas de Paris,* duplicated note, L'Oeil, Créteil.

DEISTLER, F. (1990). "Example City of Lubeck", Paper to the *Conference on Ecology and Transport,* Gothenburg.

DIEKMANN, A. (1990). "Nutzen und Kosten des Automobils", Internationales Verkehrswesen, November-December.

DELSEY, J. AND G. DOBIAS (1991). "Road Transport and the Greenhouse Effect", *Recherche Transport Sécurité*, No. 8, Paris.

DIRECTIONS (1992). Report of the Royal Canada Transport Commission, Ottawa.

DOGS, E., G. ELLWANGER AND H. PLATZ (1991). "Externe kosten des verkehrs", *Die Bundesbahn*, no. 1.

ECMT (1991), *Goods Transport and the Environment*, Paris.

-------- (1992*a*). *Questioning Transport Growth*, Proceedings of the Twelfth International Lisbon Symposium - Paris. (Reports by R. BEHAZY; J. SHORT; F. CROWLEY; K.H. LENZ; and J.P.BAUMGARTNER).

-------- (1992*b*). *International Conference on Reducing the Impact of Transport on Global Warming* -- Paris. (Reports by: A. ARANGUENA; A.N. BLEIJENBERG; K. GWILLIAM; U. HÖPFNER; L. MICHAELIS; J.-P. ORFEUIL; S. ROMMERSKIRCHEN; Z. SAMARAS; P. TANJA; J.M. VIEGAS; and M. WALSH).

ECMT AND OECD (1990). *Transport Policy and the Environment*, Paris.

ECOPLAN (1991). *Les coûts sociaux des accidents de transport en Suisse*, Report for the transport research department, Berne.

-------- (1992*a*). *Externe Kosten im agglomerationsverkehr in Bern*, National City and Transport Research Programme, Zurich.

-------- (1992*b*). *Damage Costs of Air Pollution*, Study for T and E, Brussels.

EUROPEAN RAILWAYS COMMUNITY (1992). *Les externalités du transport en Europe*, Brussels.

FINNISH NATIONAL ROAD ADMINISTRATION (FINNRA) (1992). *Pricing of Traffic Noise and Exhaust Gases in Road Planning*, Reprot No. 15, Helsinki.

FRENCH NATIONAL AUDIT AND BUDGET COMMISSION (1992). *Croissance et environnement*, Ministry of Finance, Paris.

FREY, R. AND P. LANGLOH (EDS.) (1992*a*). *The Use of Economic Instruments in Urban Travel Management*, WWZ Report, Bâle.

-------- (1992*b*). *Internalisierung externer Kosten im Agglomerations verkehr*, NWZ Studie, Bâle.

GRUPP, H. (1986.) "Die Sozialen Kosten des Verkehrs", *Verkehr und Technik*, nos 9 and 10.

HANSSON, L. (1991). "Air Pollution Fees and Taxes in Sweden", *Transportation Research Board*, 70th Annual meeting, Washington D.C.

HANSSON L. AND J. MARCKHAM (1992). *Internalization of External Effects in Transportation*, IRU Paris.

HIMANEN, V., K. MAKETLA, K. ALPPIIVUORI, P. AALTONEN AND J. LOUHELAINEN (1989). *The Monetary Value of Road Traffic's Environmental Hazards*, Technical Research Center of Finland, Espoo.

HOELLER, P., A. DEAN A. AND J. NICOLAISEN (1991). "Incidences macroéconomiques de la réduction des émissions de gaz à effet de serre", *OECD Economic Review* no. 16.

HOPPE, K. (1990). "Example City of Berne", Paper to the Conference on Ecology and Transport, Gothenburg.

HOURCADE, J.C. (1991). *Politique énergétique et effet de serre*, CIRED Report, Paris.

JEANRENAUD, D., P. GROSCLAUDE, N. SCHWAB, N. SOGUELN AND M.A. STRITT (1993). *Le coût social des transports en Suisse*, IRER, Université de Neucahtel.

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC) (1990). *Climate Change: The Scientific Assessment*. Cambridge University Press, Cambridge, UK.

IRU (1987). *Tarification de l'usage des infrastructures à imputer aux exploitants des transports terrestres*, Paris.

KAGESON, P. (1992*a*). *External Cost of Air Pollution. The Case of European Transport*, T. and E., Brussels.

-------- (1992*b*). *Marginal and Average Costs of Reducing Nitrogen Oxides and Sulfur Dioxide Emissions in Europe*, T. and E., Brussels.

-------- (1992*c*). *Internalising Social Cost of Transport*, T. and E., Brussels.

-------- (1992*d*). *Making Fuel Go Further*, T. and E., Brussels.

-------- (1992*e*). *External Cost of Air Pollution*, T. and E., Brussels.

KANAFANI, A. (1983). *The Social Cost of Road Transport*, OECD Report, Paris.

LAMURE Cl. (1991). *Les mesures applicables au secteur des transports pour améliorer leur bilan vis-à-vis de l'effet de serre*, Internal INRETS Report, Lyon.

LAMURE, Cl. AND J. LAMBERT (1993). *Impact des transports terrestres sur l'environnement*, INRETS Research Report, Paris.

LE NET, M. (1992). *Le prix de la vie humaine*, Report for the General Commission for the Plan, Paris.

MACKENZIE, J., R. DOWER AND D. CHEN (1992). *The Going Rate: What it Really Costs to Drive*, World Resource Institute, Washington D.C.

MAIBACH, M., R. ITEN, AND S. MAUCH (1992). *Internalisieren der externen kosten des verkehrs Zurich* National City and Transport Research Programme, Zurich.

MARCHAND, L. (1984). *Du bon usage de l'espace de voirie dans les centres urbains*, Internal RATP note.

MARTIN, Y. (1990). *Rapport du groupe interministériel de l'effet de serre*, Internal note.

MATSUZAWA, T. (1989). *A Method of Estimating Congestion Less in Urban Area*, TSU Ref. 472, Oxford.

MERLIN, P. (1992). *Choix de transport et environnement*, Paper to the WCTR Conference, Lyon.

MONZON de CACERES, A. (1992). *Analisis de Metodologias y dieño de un balance social del transporte publico en Madrid*, University of Madrid.

MONZON de CACERES, A. AND R. HAMILTON (EDS.) (1992), Proceedings of the 4th International Symposium on Highway Pollution, Madrid.

NATIONAL ROAD TRANSPORT COMMISSION (1992*a*). *Discussion Paper on Charges for Heavy Vehicles*, Melbourne

-------- (1992*b*). *Issues and Objectives Paper*, Melbourne.

NEWMAN, P. (1992). *Policies to Influence Urban Travel Demand*, OECD Report, Paris.

NIELSEN, G. AND S. SOLBERG, S. (1988). "Costs and Effects of Traffic Noise Abatement Measures: Basis for a National Programme", *Applied Acoustics*, No. 25.

NILSSON, (1990). "The Swedish View of the Los Angeles Environment", Paper to the Conference on Ecology and Transport, Gothenburg.

OECD (1988). *Transport and the Environment*, Paris

-------- (1989). *Economic instruments for Environmental Protection*, Paris.

-------- (1991*a*). *Environmental Policy: How to Apply Economic Instruments*.

-------- (1991*b*). *Fighting Noise Pollution in the 1990s*, Report, Paris.

-------- (1991*c*). *Environmental Indicators*, Paris.

-------- (1992). *Road Transport Research Programme*. Environmental Impact Assessment of Roads. (Contributions from Australia, Sweden, Finland, Austria, United States, United Kingdom and Japan.)

OHM, A. (1990). "Future Transport Demands and Effect of Measures to Reduce Environmental Problems", Paper to the Conference on Ecology and Transport, Gothenburg.

ORFEUIL, J.-P. (1990). "Transport, énergie, environnement: le scénario Prométhée", *Futuribles*, November, Paris.

PEARCE, D. AND A. MARKANDYIA (1989). *L'évaluation monétaire des avantages des politiques de l'environnement*, OECD Report, Paris.

PEREZ, M. (1992). *Coûts externes du transport de marchandises*, LET Lyon.

PLANCO (1990). *Externe Kosten des Verkehrs: Schierre, Strasse, Binnenschiffart*, Essen.

PRUD'HOMME, R. (1993). "Analyse économique de l'effet de serre", Analyses by SEDEIS, January.

QUINET, E. (1990). *Le coût social des transports terrestres*. OECD Monograph, Paris.

-------- (1992). "Pour une définition de la notion de coût social de l'environnement", *Économie Appliquée*, Paris.

-------- (1993). *Propositions pour la tarification des infrastructures routières, ferroviaires et aériennes*, Report for the Ministry of Transport, Paris.

RATP (1992*a*). *Le bruit des transports en Ile-de-France*, Paris.

-------- (1992*b*). *La pollution liée aux transports de voyageurs en Ile-de-France*, Paris.

RIGBY, J. (1990). "The York Approach", paper to the Conference on Ecology and Transport, Gothenburg, Sweden.

ROTHENGATTER, W. (1989). *Aspects économiques*. Report to the ECMT Committee of Deputies, Paris.

SAMUELSON, H. (1992). *Fuel Efficient Vehicles*, paper to the XXIII* IRU World Congress, Barcelona.

SOFRETU-CETUR (1992). *Le coût de la consommation d'espace*, Internal Note, Paris.

STP-RATP (1990). *Compte transport de voyageurs pour la région d'Ile-de-France*, Internal Note, Paris.

SVIDEN, O. (1991). *Clean Fuel and Engine Systems for 21st Century Road Vehicles,* Stencilled Note from ESF/NECTAR.

TEFRA, M. (1991). *Évaluation des coûts externes créés par les transports routiers et ferroviaires de marchandises,* Study for the EEC, Brussels.

TEN HAVE, H.B.G. (1992). *Passenger Transport: Energy Use and Air Polluting Emissions*, National Aerospace Laboratory, Department of Civil Aviation, The Hague.

TEXAS TRANSPORT INSTITUTE (1987*a*). *Roadway Congestion in Major Urban Areas (1982-1987).*

-------- (1987*b*). *Roadway Congestion: Estimates and Trends*.

UNIVERSITY OF NEUFCHATEL (1990). *Proceedings of the Conference on the Social Cost of Transport*, IRER, Neufchatel.

UPI (1991). Ökologische und soziale Kosten der Umweltbelastung in der Bundesrepublik Deutschland, Heidelberg.

U.S.D.O.T. (1992*a*). "Transportation and Air Quality", Searching for Solutions, Washington D.C.

-------- (1992*b*). *Exploring the Role of Pricing as a Congestion Management Tool*, Washington, DC.

-------- (1992c). *Examining Congestion Pricing: Implementation Issues*, Washington, DC.

WALSH, M. (1992) *Motor Vehicle Trends and their Implication for Global Warming*. Report to the ECMT Committee of Deputies, Paris.

WEINBERGER, M. (1992). "Gesamtwirtschaftliche Kosten des Lärms", *Zeitschrift für Lärmebekämpfung*, No.39.

Chapter 3

Effects of Internalisation on Transport Demand and Modal Split

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Present-day mobility gives rise to large costs in terms of accidents, noise, air pollution and climate change. The term "costs" refers here not only to financial costs, as expressed in market prices, but also to non-market costs in the form of death and human suffering, and damage to nature and the atmosphere. Transport users are, in most cases, not financially liable for these costs and there is no market for effects of this kind. Thus, they may be regarded as *external costs*. Such costs can be reduced by:

- better use of best available technology and continuing technological development;
- making more efficient use of existing capacity (higher load factors);
- shifting to other modes of transport; or
- reducing the volume of transport.

Different types of regulation can be employed for making better use of such opportunities. Even if society decides on the introduction of such things as more stringent emission limits and mandatory air bags, social costs of considerable magnitude may still remain. Such costs are external so long as they are not paid for by those who cause them.

As long as emissions of harmful substances and noise continue to exceed what nature and human beings can tolerate (critical loads and levels, air quality and noise standards), and as long as people continue to be killed or injured in significant numbers on our roads, transport will generate social costs which have to be *internalised*. The term "internalisation" is used here to mean that transport operations and modes of transport giving rise to damage and injuries must also be made financially liable for these effects. This can be done by making different types of transport pay taxes or charges commensurate with the damage they cause. By taxing transport for its harmful effects, we diminish distortions of trade and competition, and convey a correct signal of the social cost involved in carrying goods or passengers an additional kilometre. External costs can, in many cases, be internalised by means of charges and taxes, which provide an incentive to the users to reduce the negative impact of transport by employing better technologies, or by shifting to other modes of transport.

Other subsidies

Some modes of transport receive subsidies of very different kinds, including:

- company cars used by employees;
- tax deductions (in some countries) for journeys to and from work;
- tax-free shopping at international airports and on international ferries;
- poor surveillance of compliance with working hours regulations by drivers of heavy road vehicles; and
- access to free parking (tax-free benefit).

All of these direct or indirect subsidies entail some distortion of trade and competition. These distortions occur mainly as a result of one or more modes of transport being favoured at the expense of others. It is essential that such subsidies be removed.

Congestion

Congestion is another factor which may be regarded as an externality. Congestion in the air and on streets and roads is primarily a problem causing expense to the persons using the modes of transport. In this sense, congestion is an *internal* affair for the concerned users of the infrastructure, but the marginal cost caused to other users by one additional motorist entering a congested area is, in principle, "external".

Congestion gives rise to large costs to society, and there are good reasons to use congestion charges (e.g. tolls) during peak hours to reduce traffic loads and, indirectly, traffic emissions. The proceeds from road-pricing should be used where the benefit is greatest, and it might in many cases be a good idea to spend the money on expanding track-bound goods transport or mass transit. This will improve the opportunities for some travellers and goods transport customers to change their mode of transport -- something from which everybody will benefit. Every car or lorry leaving the roads makes them more accessible for other users.

The cost liability of transport

The cost liability of transport can be summarised as follows:

- Cost liability should be based on socio-economic costs.
- The same cost liability should apply to all types of transport.
- The short-term marginal cost should form the basis upon which (most) variable costs are charged.
- The structure of charges ought, as far as possible, to be designed so that the imposition of charges can be adapted in time and space.

Concerning infrastructure, the following should apply:

- The charges levied from the users as payment for their use of the infrastructure must cover the socio-economic costs.
- Cost liability must be exacted at as low a level as possible in the transport system, and in the form of fixed and variable traffic charges.
- Fixed charges must, in principle, correspond to the difference between revenue from traffic charges and the total socio-economic cost of the infrastructure.

Exemptions from cost liability

There can be situations in which it is reasonable to depart from strict implementation of the cost liability of transport. For example, where infrastructure is concerned, this exemption can apply to investments which are made principally for reasons of regional policy. However, investments exempted for this reason should be separately accounted for, and the exact reasons given for each individual exemption. The proportion of such investments should never be allowed to exceed more than a limited share of total investments for each type of transport.

Environmental considerations can also justify the exemption of certain railway investments from complete cost liability. This argument, however, only applies as long as the different types of transport are not made to bear their full environmental costs. If stipulations or charges are made high enough to correspond to the marginal costs, then there is generally no cause to go on subsidising any investments for environmental reasons. Two circumstances, however, suggest that, during a transitional period, it may be reasonable to make investments in railway infrastructure which are excluded from cost liability. First, it is probably difficult to introduce environmental charges high enough to truly correspond to the marginal costs of environmental destruction. Second, for decades now, road traffic has been favoured at the expense of the railways by the absence of full cost liability. The lag which this has caused in rail transport may need, for a transitional period, to be offset by a volume of investments which is not fully covered by railway cost liabilities.

Public service obligations

It is, however, important to distinguish between general subsidies (e.g. in the form of unspecified grants) and the purchase of transport services. In the latter case, the state, region or municipality pays a company for maintaining services on a certain stretch of line, often because it is judged necessary to maintain some form of public transport which can be used by children, the elderly, the disabled and people who cannot afford to run their own cars. Similar subsidies also exist for some bus routes and (in a number of countries) for special taxi services for the disabled and elderly. School buses too are a form of public transport service financed out of local taxation revenues.

It is quite clear that purchases of concrete transport services by national and local governments do not constitute a subsidisation of the mode of transport concerned. Instead, they are a subsidisation of certain passenger categories in special need (school children, the elderly, the disabled).

Grants making it possible to maintain services on a line (or a bus or shipping route) are more difficult to assess. In cases of this kind, the service desired (public transport between A and B) really ought to be put out to contract, so that different modes of transport can compete on equal terms.

Getting the prices right

The European Federation for Transport and Environment (T&E) has recently carried out a major study on the external costs of transport (Kågeson, 1993). The aim of T&E's project has been to identify the social costs of transport, and to investigate possible ways of internalising these costs. With some external factors - for example, the transnational problem of damage caused by noxious vehicle emissions -- there are good reasons for European harmonisation. For other factors, the internalisation should reflect *national* costs and conditions, rather than the average *European* level of costs. This would apply, for example, to the cost of medical treatment of injuries from traffic accidents, and to the value of lost production, both of which vary a great deal from country to country, depending on the number of accidents per million passenger kilometres, and on the specific costs of hospital treatment and value of production.

Kågeson (1993) studies the feasibility of internalising the following disturbances:

- carbon dioxide (CO_2);
- sulphur dioxide (SO_2);
- nitrogen oxides (NO_X);
- volatile organic compounds (VOCs);
- noise; and
- traffic accidents.

Air pollution and climate change

The social costs of air pollution have been calculated using the "avoidance cost" approach. This means defining the *marginal* costs of reducing the emissions below certain targets (-50 per cent for VOC and NO_X; between 0 and 25 per cent for CO_2; and between -60 and -80 per cent for sulphur). It should be emphasised that T&E's calculations are based on intermediate targets. After some years, these targets are likely to be replaced by what could be regarded as long-term objectives, based more closely on the concept of "critical loads and limits". Where climate change is concerned, T&E assumes that the cost liability of transport should include the present tax on light fuel oils, as well as the European Union's (EU) proposed energy/carbon tax. In a case of "high ambition", the latter is proposed to increase by 4 dollars per barrel per year.

The marginal use of electricity in the transport sector is assumed to be produced in coal-fired condensing power plants, but a correction factor of 0.5 is introduced for the emissions of nitrogen oxides and VOCs. The reasons are that emissions from power plants come from tall smoke-stacks, which are not generally located in the middle of housing areas. Another reason for a correction factor is that the marginal power production is not based on coal-fired condensing power in all countries throughout the year. This correction factor is, however, not applied to carbon dioxide.

For short-sea shipping, a correction factor of 0.75 is used. For aviation, however, high altitude emissions of NO_x cause more damage compared to equally large exhausts close to the ground. Thus, there is no justification for allowing aircraft a reduced charge.

Noise

For noise, the report assumes social costs to be equal to 0.2 per cent of GDP (based mainly on Swiss and German studies of people's willingness to pay). The level of the charge is a very tricky question. Noise differs in time, space, frequency and the number of people affected. It is also dependent on speed, road surface and traffic volume. From this perspective, it is clear that imposing an average cost per kilometre on users would not be very meaningful. To do so would mean over-charging road vehicles in sparsely populated areas. At the same time, heavy traffic in urban areas would pay much less than the cost to which it gives rise. A solution to this dilemma cold be to introduce a *basic charge* -- for example, calculated at half the level of the average cost -- and in addition, introduce a noise component in schemes for road-pricing in metropolitan areas. Thus, the report proposes that 50 per cent of the costs be levied on road fuels. The difference in noise between heavy and light road vehicles is such that it comes close to the difference in specific fuel consumption of the same types of vehicles. The noise charge on railways would also be split 50/50 on a basic charge, and a higher fee in urban areas.

Accidents

Where traffic casualties are concerned, calculations made in various countries are based on very different assumptions (values, growth rates, discount rates, etc.). While waiting for the members of the EU to take a joint decision on how to calculate lost production and human costs, the report uses the average costs of those countries which have provided figures for all cost items, and weights those figures according to number of inhabitants. In doing so, it arrives at figures which could be expected to correspond fairly well to the average loss of production and to the average human costs of a specific casualty. For a fatality, the average cost is 583 000 ECU, based on figures from eight countries (Belgium, Denmark, Finland, France, Spain, Sweden, Switzerland and the United Kingdom). The average cost has been re-calculated according to GDP per capita in all countries concerned, and the same values have been used for casualties of all modes of transport.

Infrastructure

The report suggests that all infrastructure costs should be paid for by transport users, since failure to achieve this goal would perpetuate distortions of competition. The only exceptions would be on grounds of clearly defined regional policy (see above). In addition, rail transport should be exempt from the cost liability of infrastructure investments in the short term, to correct the historic imbalance between governments' treatment of road and rail. Where road transport is concerned, half the total costs are presumed to be charged using taxes on diesel and petrol, and the other half to be covered by a vehicle tax. For dividing the infrastructure costs between light and heavy road vehicles, T&E uses the British model for cost allocation.

Gradual introduction

In order for the internalisation of external effects to proceed smoothly, it may be reasonable for the reform to be introduced in stages. In the case of the European energy/carbon tax, the European Commission chose to recommend that the target level for the tax be 30 per cent achieved in the first year, and that the annual increase thereafter should equal 10 per cent of the target level. A model like this for gradual implementation of cost liability also seems reasonable where the external costs of transport are concerned. T&E therefore recommends that the charge for NO_X, VOCs, noise and traffic accidents, like the carbon dioxide and energy tax, be pitched at 30 per cent of the target level for the first year, and then raised by 10 percentage units annually for the next seven years.

Instruments for internalisation

All variable costs should, as far as possible, be internalised through traffic charges rather than via annual charges, since the latter do not relate to mileage driven. This is generally possible to achieve for aircraft, trains and large short-sea vessels. For road transport the best solution would be a weight-distance tax which also takes exhausts, noise and the average risk of accidents into consideration. While waiting for such a tax to be introduced on a European level, the best choice would be to make the externalities part of existing taxes on petrol and diesel. The specific fuel consumption of different vehicles corresponds fairly well with most of these costs. In cases where there is a significant gap between specific fuel consumption and the amount of externalities, this could be corrected by increasing or decreasing the annual vehicle tax.

Results

Table 3.1 illustrates the cost of air pollution, carbon dioxide, noise and accidents per tonne and passenger kilometre for different modes of transport, as reported in Kågeson (1993). After 10 years, as shown in Table 3.2, the costs of air pollution are expected to be lower, thanks to improved exhaust purification, while the energy/carbon tax will be higher [in particular, in the case of a fast increase ($4 a barrel) in the level of the tax].

The social costs of road transport in Germany come to approximately 2.5 per cent of GDP, split between air pollution (0.74 per cent); energy/carbon (0.39 per cent); noise (0.17 per cent); and accidents (1.16 per cent). The tax on petrol and diesel needed to internalise the present level of social costs of road transport will differ between countries, the main reason being differences in infrastructure and accident costs. The range is 0.70-1.05 ECU per litre of fuel. Most countries would have to raise their petrol tax by more than 100 per cent to achieve this, while the corresponding increase in diesel tax would, in most cases, have to be between 200 and 300 per cent.

Table 3.1. **Social costs in Germany -- 1993**
(ECU per 1 000 tonne and passenger kilometres)

	Air	CO_2	Noise	Accidents	Total
Tonne					
Lorry[1]	5.6	2.5	0.6	3.5	12.2
Train[2]	0.8	1.9	0.3	1.4	4.4
Railroad	6.0	0.6	0.0	0.1	6.7
Passenger					
Car	14.6	4.5	1.2	13.7	34.0
Train[2]	0.9	2.2	0.3	1.4	4.7
Aircraft	7.3	9.2	1.6	0.2	18.3

Notes: 1. Long distance.
2. Electric only.

Table 3.2. **Social costs in Germany after 10 years**
(ECU per 1 000 tonne and passenger kilometres)

	Air	CO_2 (low tax)	CO_2 (high tax)	Noise	Accidents	Total (low tax)	Total (high tax)
Tonne							
Lorry[1]	3.9	3.6	6.6	0.7	4.2	12.4	15.4
Train[2]	0.6	2.9	5.6	0.4	1.7	5.8	8.5
Railroad	4.5	0.9	1.7	0.0	0.1	5.5	6.3
Passenger							
Car	3.7	5.6	11.0	1.2	16.4	26.9	32.3
Train[2]	0.6	3.4	6.7	0.4	1.7	6.1	9.4
Aircraft	5.5	11.9	23.1	1.9	0.2	19.5	30.7

Notes: 1. Long distance.
2. Electric only.

Consequences

In ten years, the fuel consumption among light vehicles would be reduced by between 18 and 32 per cent (low and high energy/carbon tax). Car passenger kilometres, however, would only be reduced by 1 and 18 per cent respectively, compared with an anticipated increase of 24 per cent in the reference scenario. Where heavy goods vehicles are concerned, demand would increase in both the internalisation scenario (7-9 per cent) and the reference scenario (24 per cent), while fuel consumption would rise by 7-9 and 18 per cent respectively. The reason for the difference is a lower price elasticity for goods transport, and the fact that fuel and other taxes make up only a minor part of existing overall costs. Industry's average cost for transport would only increase by half a percentage point.

Emissions of NO_X could be expected to fall by 63-70 per cent for light vehicles, and around 25 per cent for heavy vehicles. VOCs would decrease by 78-82 per cent for cars, but would increase somewhat for heavy vehicles. Road transport fatalities could be expected to stay at around 55 000 per year in the internalisation scenario (all else being equal), and to rise to 68 000 for all of the EU and the EFTA in the reference scenario. Where aviation is concerned, demand for scheduled flights would increase rapidly in both scenarios, the difference between them being around 10 percentage points.

Some additional calculations

The aim of this section is to provide additional data on how the costs of different modes of transport would be affected by an internalisation of transport externalities. Most figures concerning the costs of the various modes are from Swedish sources. The exchange rate used between the ECU and the Swedish krona is 9:1. There may, however, be considerable differences between countries, in particular with regard to taxation. All prices are exclusive of VAT.

This part of the paper is also intended to shed some light on how competition between different modes is affected by variations in the charges levied to internalise external costs. Finally, the paper discusses how transport might adjust to the new situation.

Long-distance freight transport

Freight over longer distances can be carried by train or lorry, and in some cases by ship or barge. High-value goods are, to some extent, carried by air. The following analysis, however, is limited to lorries and trains.

Table 3.3 illustrates the split of lorry costs on different cost items. Expenditures are dominated by capital costs, and by the cost of the driver. Assuming a net load capacity of 25 tonnes, and an average load factor of 0.6 (15 tonnes), the total cost per 1 000 tkm is 76 ECU. According to T&E's study, external costs per 1 000 tkm are 12-14 ECU (Germany, 1993) which, if internalised, would raise overall costs by 16-18 per cent. Part of this, however, is already "internal" in countries with high taxes. As a comparison, the price of the "Euro tax disc" will be 1 250 ECU for this type of road vehicle, raising costs by only 1.8 per cent.

Table 3.3. **The cost of long-distance freight by lorry with trailer based on the average costs of such a lorry in Belgium, Denmark, Germany and Sweden (ECU per 1 000 vehicle-km)**

Cost	ECU[1]	%
Capital	259	23
Fuel (excluding tax)	125	11
Tires, repairs, etc.	156	14
Wages and social security	350	31
Insurance	32	3
Administration and sundry items	110	10
Taxes (1990)	113	10
Total	1 145	102

Note : 1. Assumptions: fuel consumption = 375 litres per 100 km; fuel cost = 0.33 ECU per litre.

Source : Lindell (1991).

Long-distance freight by rail

The cost of long-distance freight by rail differs greatly, depending on the railway company and the type of goods being moved. A "normal" (but not necessarily "average") cost of 45 ECU per 1 000 tkm (not excluding infrastructure costs) is used here. The external costs per 1 000 tkm are calculated by T&E at 4-8 ECU after 10 years. This would raise costs by some 9-18 per cent.

Some variations in the taxation

Table 3.4 illustrates how the impact on competition between road and rail would be affected by differing the assumptions concerning the size of the different externalities. The table shows, for instance, what happens if traffic accidents (fatalities and injuries) are valued at twice the cost assumed in Kågeson (1993). Today's cost of the lorry is assumed to be 76 ECU/1 000 tkm, while the cost of the freight train is set at 45 ECU.

The external costs of the lorry above those of the train would, in these examples, vary between 7-14 ECU per 1 000 tkm, which is equal to 9-18 per cent of the present cost of the lorry, or 15-30 per cent of that of the train. The difference is smaller in countries where the present taxation of heavy-duty vehicles covers more than the costs of the infrastructure, and larger in countries where the taxes do not fully cover these costs.

Other factors influencing competition between long-distance rail and lorry include speed, frequency of connections, and the ability to deliver safely and "just-in-time". The speed of road transport is likely to be negatively affected by increased congestion, by the introduction of speed restrictors, and possibly also by improved surveillance of working hours. Improved roads and to removal of border controls will probably counterbalance most of this loss. As a result, no significant change in average speed is likely to take place.

Table 3.4. **Long-distance freight after 10 years -- social costs of lorries above those of trains (ECU per 1 000 tkm)**

	Energy/CO_2-tax

	low	high
Base case according to T&E study	6.6	6.9
Air pollution valued twice as high	9.7	10.2
Accidents valued twice as high	9.1	9.4
Energy/CO_2 valued twice as high	7.3	7.7
All costs valued twice as high	13.2	13.8

Rail will gain from improved tracks and faster trains, as well as from the removal of border controls and a gradual harmonisation of technical systems, and a closer co-operation between railway companies. Improved frequency will also help to cut the average time for deliveries. As a result, there is likely to be a significant increase in average speeds (25-50 km/h). Road transport will suffer from the internalisation of high external costs, but this additional cost might partly be compensated for by an improved load factor, thanks to the introduction of cabotage. Rail will also incur higher costs as a result of the internalisation of transport externalities. A higher utilisation of wagons and locomotives thanks to higher speeds will, however, counterbalance these additional costs. Deregulation and a stricter cost liability (e.g. fewer subsidies) might also influence the long-term competitiveness of rail.

Short-distance freight

In most cases, road transport is the only option for short-distance goods transport. Table 3.5 provides an example of the costs of short-distance transport. In this case the lorry has a net load capacity of 9 tonnes. With an assumed load factor of 0.33, the present cost per 1 000 tkm, comes to approximately 400 ECU, while the "external" costs after 10 years amount to 63-78 ECU per 1 000 tkm, as shown in Table 3.6. This is equivalent to an increase in price of 16-20 per cent.

With a price elasticity of -0.3, demand will be 5-6 per cent below a reference scenario based on "business as usual". With an income elasticity of 1.1 and an annual growth rate of 2 per cent, demand will increase in 10 years by 24 per cent, and by 18-19 per cent when externalities are internalised. A fuel tax of 2 ECU per litre (= + 1.65 ECU) would probably reduce demand by some 14 per cent, compared with the reference scenario, which means an increase of 10 per cent, compared with today.

Internalisation is likely to affect demand primarily by influencing logistic strategies, leading to higher load factors and shorter routes. Demand for consumer goods will be indirectly affected, as higher transport costs make commodities somewhat more expensive.

Road-pricing in metropolitan areas might add to the cost of short-distance goods transport. A daily charge of 20 ECU for the above lorry, paid 250 days a year, means an annual cost of 5 000 ECU, or 28 ECU per 1 000 travel kilometres (7 per cent of today's cost). Thus, it takes a very high daily fee to significantly increase the cost of local distribution. If a similar (but lower) charge were imposed on cars, congestion would likely be reduced to the extent that the costs of distributive services are cut considerably. In this particular example, the break-even point is reached when efficiency is improved by 10 per cent as a result of reduced congestion.

Table 3.5. **Short-distance freight by lorry (ECU per 1 000 vehicle-km)**

Cost item	ECU[1]	%
Capital	285	24
Fuel (excluding tax)	108	9
Tires, repair, etc.	122	10
Wages and social security	510	43
Insurance	13	1
Administration and sundry items	78	7
Taxes (1990)	80	7
Total	1 196	101
Cost per 1 000 travel kilometres	399	

Note: 1. Assumptions: Lorry with 9 tonnes net load capacity; load factor 0.33; fuel consumption: 325 l/100 km; fuel price (excluding tax) = ECU 0.33/l; annual distance = 60 000 km.

Source: Capital costs, repair, insurance and wages according to DAGAB (Swedish wholesale business).

Table 3.6. **Social costs of short-distance freight transport by lorry (ECU per 1 000 tkm)**

Air pollution	20
Energy/carbon dioxide	18-33
Noise	4
Accidents	21
Total	63-78

Long-distance passenger transport

The cost of the private car (excluding the driver) in Sweden is 220-330 ECU/1 000 vehicle kilometres. Based on an average occupancy of two people, this corresponds to 110-165 ECU per 1 000 passenger kilometres. Internalising social costs would, according to T&E's study, raise the price of petrol by 0.40-0.50 ECU/litre (+ VAT) in most countries. This implies an additional cost of 14-18 ECU/1 000 passenger kilometres in a small car, or an increase in overall costs of 13-16 per cent. For a big car, the additional cost would be 20-25 ECU/1 000 passenger kilometres. This corresponds to only 12-15 per cent of the total cost, the reason being that the fuel makes up a smaller share of the overall cost in the large-car case.

The short-term price elasticity for petrol is generally calculated at -0.2/-0.3 for private cars (Dahl and Sterner, 1991, and Nederlands Economisch Instituut, 1991), while the long-term price elasticity is regarded as -0.6/-1.0. The elasticity is most probably a great deal lower for company cars.

T&E's study shows that internalising the social costs of the car, in the "average" country, would raise the cost of fuel by around 60 per cent. As a result, car use would level out during the next 10 years. With a "high" energy/carbon tax (+ 4 $/bbl per year), the demand for passenger kilometres by car would decrease by some 18 per cent. A large part of the adjustment to the higher price, however, would be in the form of improved fuel efficiency.

The average cost of passenger transport by rail in Sweden is approximately 130 ECU per 1 000 passenger kilometres (including overheads). Externalities are between 5-10 ECU per 1 000 passenger kilometres in most European countries, according to T&E's estimates. This wide range is partly a result of differing accident rates. In the case of Sweden, which has a rather low accident rate, the external costs after 10 years would be 5.2 and 8.5 ECU respectively, for the cases of low and high energy/carbon taxes. This corresponds to 4 and 7 per cent of the total existing costs.

For aviation, the cost per 1 000 passenger kilometres is around 165 ECU in Sweden, assuming a cabin occupancy factor of 0.6. Fuel accounts for only 13 per cent of the total cost. The rest is capital cost, crew, landing fees, administration and insurance. The external costs after 10 years would, according to T&E's study, be 20-31 ECU/1 000 passenger kilometres, which corresponds to about 12-19 per cent of the present cost.

The estimated price elasticity for scheduled flights is -0.5 [Nederlands Economisch Instituut (1990)], based on the average elasticity among business travellers and tourists. Price elasticity for charter flights is much higher -- believed to be around -1.0. Internalising the external costs would reduce demand for scheduled flights by 6-10 per cent below the reference scenario.

Table 3.7 illustrates the potential impact on competition resulting from changing the charges on different externalities. It illustrates the external costs of the car, relative to those of aircraft and trains after 10 years. Today's cost of cars amounts to 110-165 ECU/1 000 travel kilometres. "Externalities" in Germany are, according to T&E's study, 26.9-32.3 ECU, of which approximately 11 ECU is covered by the existing fuel tax (Germany). Only the social costs not covered by the present taxation regime are included in the "base case" of Table 3.7.

Table 3.7. **Long-distance passenger transport after 10 years -- some variations -- External costs of cars above those of aircraft and trains**

(ECU per 1 000 travel kilometres)

		Relative to train	**Relative to aircraft**
Base case:	low	9.8	-3.6
	high	11.9	-9.4
2 x air:	low	12.9	-5.4
	high	15.0	-11.2
2 x accident:	low	23.6	12.6
	high	26.6	6.8
2 x E/CO_2:	low	12.1	-9.9
	high	16.1	-21.6
2 x all costs:	low	30.6	3.8
	high	34.8	-7.8

The external costs of cars, relative to those of rail, is only 9.8-11.9 ECU/1 000 passenger kilometres. This is equivalent to 9-11 per cent of the present cost of small cars, and 6-7 per cent of large cars. Note that the outcome will be different in a case where rail is at present not paying the full costs of either the trains or the variable costs of the track. Doubling all charges results in a difference of 30.6-34.8 ECU/1 000 passenger kilometres, or 28-32 per cent for small cars, and 19-21 per cent for large cars. Thus, internalising social costs is *not* likely to result in any significant shift in demand from cars to trains. Adjustment to the new prices is more likely to result in the down-sizing of new cars, in more fuel-efficient cars, and in fewer vehicle kilometres travelled. Aviation will, in most cases, have to internalise costs slightly more than do automobiles. When the social costs of accidents are valued highly, cars will have to pay more than aircraft.

Table 3.8 illustrates long-distance passenger transport after 10 years, and shows the external costs of aviation, relative to those of trains. Today's cost of aviation is 165 ECU/1 000 travel kilometres. The assumptions are that rail already pays all costs, apart from investments in infrastructure, and that aviation is not subsidized.

Table 3.8. **The external costs of aviation above those of trains after 10 years -- some variations (ECU per 1 000 travel kilometres)**

Base case:	low	13.4
	high	21.3
2 x air:	low	18.3
	high	26.2
2 x accident:	low	11.0
	high	19.8
2 x E/CO_2:	low	22.0
	high	37.7
2 x all costs:	low	26.8
	high	42.6

In the base-case, the cost of aviation is increased by 13.4-21.3 ECU per 1 000 passenger kilometres, which corresponds to 8-13 per cent of present costs. Doubling all charges increases the difference to 16-26 per cent. Aviation is particularly vulnerable to a high tax on energy and carbon, less so on accidents. Overall, internalising social costs may help rail to gain market shares on short and medium distances, at the expense of aviation.

Short-distance passenger transport

Over short distances, cars are competing with rail, underground trains, trams and buses. Cycling and walking are also obvious alternatives over very short distances.

The cost of commuter trains in metropolitan areas is probably somewhat below that of long-distance trains, the main reasons being high passenger load factors and less expensive equipment. The cost of the car is also slightly higher in the city compared to the average (mix of urban and highway), because fuel consumption is higher. The difference in total cost, however, is almost negligible.

The costs of buses are shown in Table 3.9. It should be noted that actual costs may differ greatly, due to local conditions and to the passenger factor. The calculation here is based on a "normal-size" bus in Sweden, carrying an average of 15 passengers. The bus is assumed to be travelling 100 000 kilometres per year, at an average fuel consumption of 35 per 100 km. The total cost in this case is around 75 ECU per 1 000 passenger kilometres, and the externalities are 11-14 ECU after 10 years, which corresponds to 15-19 per cent of the present average cost.

Table 3.9. **The costs of short-distance bus transport -- An example from Sweden (ECU per 1 000 passenger kilometres)**

	ECU	%
Capital and other fixed costs	19	25
Wages	36	48
Tires, repairs, service	9	12
Fuel (excluding tax)	5	7
Taxes on vehicle and fuel	6	8
Total	75	100

A conclusion is that, in many circumstances, buses are a cheaper alternative than trains; this is also true in the case where the risk of climate change and the damage from air pollutants are valued twice as high as in the T&E's study. It should also be noted that, in some countries, buses already pay their infrastructure costs. For the mass transit of large numbers of people in congested areas, however, the train or the underground train is the best option.

Road-pricing in metropolitan areas might add to the cost of short-distance bus transport, if buses were made to pay a daily fee equal to that of lorries. A daily charge of 20 ECU paid 250 days a year implies an annual cost of 5 000 ECU, or 28 ECU per 1 000 passenger kilometres (assuming an average of 15 passengers).

The main impact on competitiveness from internalising social costs would, in the case of short-distance passenger transport, be a shift of commuters from cars to buses and trains. How this increase would be divided between trains, metro and buses would depend more on political decisions and available alternatives than on the actual costs of the different options. In many cases, people pay a monthly ticket which allows them to take *any* of these modes.

Private cars in most countries are used more for leisure trips and shopping, than for travelling to and from work. The price elasticity for petrol is likely to differ greatly, depending on how the car is used, and could be expected to be a great deal lower in cases where the car is the only reasonable choice for travelling to work. Adjustment to higher prices will, in the short term, include travelling less and/or using the bicycle (or walking) more. A large share of all journeys by car are short trips (< 5 km). In the long term, adjustment will include choosing more energy-efficient cars and will also influence housing choices.

The Nederlands Economisch Instituut (1991) divides long-term elasticity between various adjustment mechanisms, saying that improved specific fuel efficiency will account for most of the change, or -0.6/-0.7 (out of -0.8/-1.0); while the distance driven accounts for only -0.1/-0.3. A breakdown of this kind, however, may also be affected by the share of company cars among new vehicles. In some countries (e.g. Sweden and the UK), company cars make up more than half of all new cars, which, of course, will also have a significant impact on the second-hand automobile market.

Shift to other modes of transport

The shift from aviation and cars to different forms of land-based public transport will depend (among other things) on how the supply of public transport services develops. Mass transit presently accounts for some 15-20 per cent of the number of land-based passenger kilometres in most European countries, while cars account for 80-85 per cent (cycling and walking not included). Since cross-price elasticities are very sensitive to specific market situations, as well as to the degree of aggregation in the data, it is not very meaningful to make assumptions about what the cross-elasticities between different modes of transport might be. The T&E study assumes, just to show the potential magnitude of the change, that the shift from car to train and bus travel by the end of the first 10-year period is 25 per cent of the difference in car passenger kilometres between the two scenarios (internalisation and business-as-usual). This would imply a 45-60 per cent increase (depending on whether a "low" or "high" energy/carbon tax were assumed) in land-based public transport, compared with the situation in the reference scenario. Compared to the base year (year 0), the increase would be 50 to 70 per cent. This example is, however, more likely to be on the high -- than the low-side.

Conclusions

Internalising the social costs of transport will:

- only result in a small reduction of demand for long- and short-distance freight, compared to a "business-as-usual" reference scenario;
- give long-distance rail and combined transport a competitive edge over lorries;
- influence logistic strategies and improve (somewhat) the load factor in short-distance goods transport;
- result in a considerable shift from medium-distance aviation to trains, in cases where rail is an option;
- reduce car travelling (in some cases, even in real numbers);
- improve the fuel efficiency of new cars and other vehicles;
- reduce exhaust emissions, in particular from aviation, shipping, diesel locomotives and heavy road vehicles (if a km-tax is used);
- increase demand for public transport, in particular in metropolitan areas (it is difficult, however, to predict the *rate* of this increase); and
- increase the use of telecommunications.

It should, however, be noted that many other factors besides taxation will influence the size of demand, or the modal split.

REFERENCES

DAHL, C., AND T. STERNER (1991). "Analysing Gasoline Demand Elasticities; A Survey in Energy", *Economics*, July.

KÅGESON, P. (1993). *Getting the Prices Right, A European Scheme for Making Transport Pay its True Costs*, European Federation for Transport and Environment, Stockholm and Brussels.

LINDELL, Å. (1991). *Transportkostnader, en uppskattning av total-kostnaden per mil för en svensk, en dansk, en tysk och en belgisk åkare*, Bilspedition AB, Göteborg.

NEDERLANDS ECONOMISCH INSTITUUT (1991). *De prijselasticiteit van het energie per bruik in het wegverkeehr.*

Chapter 4

The Art of Internalising

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Introduction

There is broad support for the idea that road users should pay the full share of their costs, including environmental costs. This is not only the view of economists keen to ensure proper functioning of the market mechanism; at the political level, too, this is considered a desirable goal. It was confirmed, for example, by the European Conference of Ministers of Transport (see ECMT, 1989). In its White Paper on the Common Transport Policy, the European Union (EU) also supports the idea of full cost allocation (CEC, 1992). Among others, the Dutch government has also made pricing a key element of its traffic policy (SVV, 1988).

However, between this general aspiration and concrete policy measures there is a yawning gap. The Dutch government's main recommendations for increasing the price of road traffic (road pricing and toll collection) were voted down in parliament. Real fuel taxes in Europe (inflation-corrected) have probably decreased, rather than increased over the years. Even the recent EU agreement on the minimum vehicle tax level for trucks and the so-called "Euro-vignette" will mean only a slight improvement in cost allocation.

What is behind this gap between general aspirations and concrete policy? This is the key question addressed in this paper, which, after setting out a largely economic analysis, provides suggestions for achieving true internalisation of all traffic costs.

The problem of cost internalisation is virtually congruent to that of abolishing or reducing subsidies. Compare, for example, the complex and lengthy decision-making process surrounding potential cuts in the EU's agricultural subsidies. Those most directly affected protect their interests vigorously, frequently claiming that it is not only their interests that are threatened, but the public interest as well. Whether the assumption is right or wrong, this presumed negative impact on the national economy subsequently weighs relatively heavily in the processes of public opinion-forming and political decision-making. For this reason, an essential step towards reducing subsidies -- or allocating costs -- is an independent analysis of the major consequences involved. Such an analysis should not be coloured by sectoral economic interests. Provided it is prudently conducted, this kind of analysis can serve as the foundation for the required public and political support.

This paper first reviews the main background and impact of internalising transport costs. This is not intended as a comprehensive analysis; rather, it is intended to serve as an outline summary of current knowledge. Topics covered include economic and social effects, and the need for international harmonisation. Based in part on this analysis, the policy instruments available for internalising traffic costs are then discussed. The paper concludes by considering the elements of process to be followed to arrive at true internalisation: the Art of Internalising.

Analysis

This section provides a brief review of the main background and impact of internalising traffic costs, covering the following topics:

- road traffic costs;
- historical price trends;
- tax considerations;
- economic consequences;
- social consequences; and
- the international dimension.

Table 4.1. **Road-traffic-related expenditure by the Netherlands government (1987)**

Type of cost	Costs	
	Billion DFL	Share (%)
Infrastructure	5.8	51
Policing	1.0	9
Government personnel	2.3 - 4.3	29
Tax expenditure and subsidies	1.3	11
TOTAL	10.4 - 12.4	100
Share of GDP (%)	2.9	
Average per vehicle kilometre	0.14 Fl./km	0.58 ECU/Km
Average per litre of fuel	1.21 Fl./l	0.58 ECU/l

Source: Calculated using data from Van der Kolk (1989) and Dutch CBS statistics.

Road traffic costs

The following three kinds of road traffic costs can be distinguished:

- direct costs: depreciation, maintenance, insurance and fuel;
- government expenditure on infrastructure, policing and the like; and
- external costs resulting from traffic accidents and environmental pollution[11].

For the situation in the Netherlands, a detailed review has been made of all government expenditure relating to road traffic (Van der Kolk, 1989). This expenditure is not only for the construction and maintenance of infrastructure, but also includes policing and the cost of government road transport-related personnel. Tax benefits and subsidies are also included. Table 4.1 shows the main results of the study. This

11. It is sometimes claimed that traffic also has external benefits. However, a study of the scientific literature on the subject gives no indication that these are of any significant magnitude (Van Gent and Vleugel, 1991; Walter *et al.*, 1993). The existence of such benefits would constitute an argument for continued subsidization of traffic.

review indicates that infrastructure expenditures account for only half of overall road-traffic-related expenditures by the various echelons of government. To permit international comparison, government expenditure is also expressed in terms of GDP, traffic volume, and fuel consumption.

The other side of the government balance sheet shows substantial tax revenue from fuel excise duties ("fuel tax"), vehicle taxes and sales taxes. In 1987, this vehicle-related tax revenue totalled 10.3 billion guilders. The government books are thus approximately balanced.

The third cost category includes external costs -- the consequences of traffic accidents and environmental pollution, to the extent that these are not yet passed on to the motorist (e.g. via car insurance). Over the past ten years, many studies have been devoted to assessing the magnitude of these external costs. Several of these are discussed in detail elsewhere in this volume. In this paper, reference is made only to a review study (Neuenschwander and Walter, 1992). Based on the results of 11 studies, these researchers conclude that external traffic costs probably lie between 1.5 and 2.5 per cent of GDP. Table 4.2 specifies the various types of external cost.

On the basis of these figures for government expenditure and external costs, fuel taxes should stand at a level of at least 0.90 to 1.10 ECU/litre, if all of these costs are to be allocated to users in fuel prices. Proceeding from the assumption that one half of government expenditure should be passed on via standing taxes (see Kågeson, 1993), fuel taxes should stand at approximately 0.60 to 0.80 ECU/l. Kågeson (1993) in fact gives a slightly higher figure: a minimum fuel tax of 0.70 - 1.05 ECU/l. All these figures are clearly higher than present European fuel tax rates, which, at a rough estimate, are 0.40 ECU/l for unleaded petrol and less than 0.30 ECU/l for diesel fuel.

Table 4.2. **Probable values of external traffic costs**

Air pollution	0.4 - 0.7% GDP
Noise	0.1 - 0.6% GDP
Other environmental effects	0.1 - 0.5 GDP
Accidents	0.3 - 0.9% GDP
Congestion	0.1 - 0.5% GDP
TOTAL	1.5 - 2.5 % GDP
Average per vehicle kilometre	0.03 - 0.06 ECU/km
Average per litre of fuel	0.31 - 0.52 ECU/l

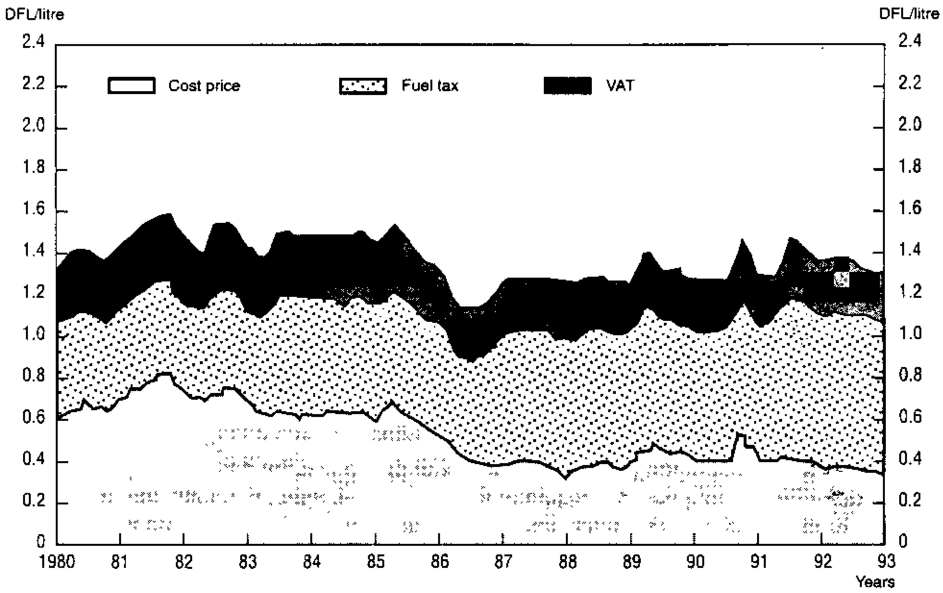
Source: Neuenschwander and Walter (1992) and Dutch CBS statistics (1990).

The aim of the foregoing discussion is not to give a precise picture of aggregate road traffic costs. This is an issue that is addressed in far greater detail elsewhere. The purpose of this cost review is merely to demonstrate that road traffic does *not* pay for all the costs that it incurs. Based on even cautious assumptions, fuel tax rates should at least be doubled, for example.

Historical price trends

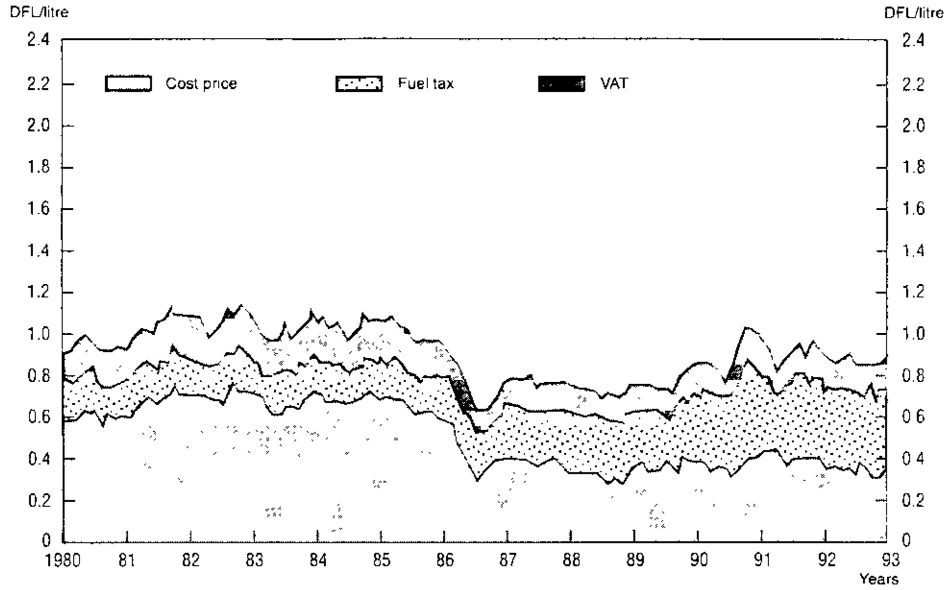
If pricing changes are to be implemented, it is prudent to introduce them gradually, making at least partial allowances for historical price trends. In the present context, it is not feasible to analyze trends in all relevant taxes and costs and I shall restrict myself to reviewing the price trend of regular petrol and diesel fuel in the Netherlands. Figure 4.1 shows that, in real terms, the price of petrol in the Netherlands actually *decreased* by 1.5 per cent between 1980 and 1993. Over the same period, the real price of diesel fuel increased by almost 6 per cent (Figure 4.2); this was because European harmonization of diesel fuel tax meant that the Netherlands was obliged to increase the national tax rate to the "European" level. For both types of fuel, the drop in real oil prices in the period under consideration was compensated by an increase in real tax rates.

Figure 4.1. **Real price of regular petrol in the Netherlands**
In 1980 guilders



Real price trends in the Netherlands probably do not differ significantly from the average for the rest of Europe. All in all, real pump prices will not have changed much in recent years.

Figure 4.2. **Real price of diesel fuel in the Netherlands**
In 1980 guilders



Tax considerations

A major point to be considered in the context of traffic cost internalisation is the use to which the extra tax revenue is to be put. It can be argued that those who suffer the damage or nuisance should receive due financial compensation. Frequently, however, the "victims" cannot readily be identified, since every inhabitant is in a certain sense a victim. In addition, most governments have already developed mechanisms for (re-)distributing the costs and benefits of many societal activities. It would seem prudent to adhere to current practice, and not to create new institutions. This implies that the government would receive additional tax revenue, which could, in principle, be used for a multitude of ends. Certain specific groups of "victims" might conceivably receive financial compensation. However, the lion's share should be used to benefit all citizens and businesses, by reducing other tax rates. After all, the aim of internalisation is not to generate extra tax revenue, for reducing the budget deficit, for example, or for financing extra government expenditure.

The government may, of course, wish to increase taxes, or perhaps to pay for new investments in public transport, but this should not be confused with internalisation. Any such confusion will form a substantial barrier to creating a public basis for accepting the idea of internalisation.

The above implies that internalisation of traffic costs will lead to a shift in taxes. From the fiscal point of view, there are also good reasons to make such a shift. Today, taxes are levied largely on the *production* factor, labour, and only marginally on the *consumption* of raw materials and on environmental pollution. The current tax regime thus acts as a brake on employment, and is not in line with the aims of environmental policy. This is not surprising, since current tax systems have their roots in an era when environmental pollution was not yet generally considered to be a problem. In general, it would be desirable to adapt the tax regime to modern circumstances.

To illustrate the merits of such a tax shift, Table 4.3 illustrates the tax mix for the Netherlands over the past few decades, as well as the situation following internalisation of traffic costs on the basis of the minimum estimate (i.e. 1.5 per cent of GDP).

Table 4.3. **Tax mix in the Netherlands (national taxes and part of social security payments)**

Type of tax	1950	1960	1970	1980	1987	1987[5]
Labour[1]	48%	60%	69%	73%	69%	66%
Raw materials and environment[2]	12%	9%	12%	8%	9%	12%
Other[3]	40%	31%	20%	19%	22%	22%
Overall tax burden[4]	31%	30%	36%	42%	44%	44%

Notes:
1. Taxes on wages and income, and social security contributions to the extent that benefits are not specifically for employees.
2. Excise duties, financing charges, vehicle tax and land tax.
3. VAT divided proportionally over the categories "labour" and "other", according to their respective shares in added value.
4. These national taxes and social security contributions as a percentage of Gross Domestic Product (at factor cost).
5. After "minimum internalisation" of traffic costs.

Source: CBS, based on CBS National Accounts.

Economic consequences

Internalising all traffic costs will result in more expensive transport. In turn, this will mean a certain decrease in the turnover of some branches of industry, instead of growth in turnover under an unchanged policy regime. It is impossible to state unequivocally whether this will lead to a shrinking of these sectors in absolute terms, or whether there will be a slackening of growth. These negative effects may be felt in the transport sector, the automotive industry, the road construction industry, refineries, garages, or petrol stations. Relative loss of turnover will then mean a reduction in employment levels in these sectors and a smaller share in GDP (added value).

Nevertheless, this does not *necessarily* mean that internalisation will have a negative impact on economic growth and overall employment. Offsetting the sectors confronted with unfavourable effects, there may also be "winning" sectors. Which these are depends on how the extra tax revenue is recycled to citizens and businesses (see above). If the currently high level of taxation on labour were reduced, it would be mainly labour-intensive sectors that would benefit. Across the board, then, there may even be a net *positive* effect on employment.

Alongside these -- probably minor -- shifts in the structure of production, there may also be slight changes in consumption patterns. Consumers will buy cheaper cars and drive less. On the other hand, there will be greater expenditures on recreation, home furnishings, and public transport (for example, see Bleijenberg *et al.*, 1990).

This set of shifts in the economy has been studied using a computer model of the Dutch economy (Bleijenberg *et al*., 1990). In this study, the effects of seven policy packages to restrict (auto)mobility were considered. In Table 4.4, the results are summarised for three of these packages:

- Package 2: raising fuel taxes by Dfl. 1.00/l (0.45 ECU/l), with full restitution of the ensuing tax revenue through a lowering of income tax rates;
- Package 6: raising fuel taxes by Dfl. 1.50/l (0.68 ECU/l) and abolishing vehicle tax, with restitution of the remaining tax revenue through a lowering of income tax rates; and
- Package 7: non-financial policy instruments, such as car-pooling, physical planning measures and public education.

The first two of these policy packages entail a tax shift as described in the previous section. The main conclusion to be drawn from this modelling exercise is that even a substantial increase in fuel tax would have only a minor macro-economic impact. The calculated effects are well within the margins of uncertainty inherent in existing economic forecasts.

In addition to this major conclusion, several other trends can be derived from the modelling calculations. Following a tax shift (packages 2 and 6), there is indeed a slight growth in employment. This is due mainly to the decrease in wage costs. Although jobs are lost in the (road) construction and automotive industries, there is a greater growth in employment in other branches of industry, as well as in the services sector. Overall production volume also falls slightly. However, it is above all government expenditure that decreases, as reflected in the lower overall tax burden, and in the unchanged volume of private consumption. The calculations do, however, indicate a shift in consumption patterns from car ownership and use, towards more recreation, home furnishing and public transport.

Table 4.4. **Macro-economic consequences ten years after implementation of given policy measures (modelling calculations for the Netherlands)**

	Unit[1]	**Package 2** **- Dfl. 1.00/l** **- Lower income tax**	**Package 6** **- Dfl. 1.50/l** **- No vehicle tax** **- Lower income tax**	**Package 7** **Non-financial measures**
Budget balance	*c)*	O.1	0.0	0.0
Tax burden (taxes + social security payments)	*c)*	-1.3	-1.5	0.0
Employment	*a)*	0.2	0.5	0.0
Private consumption (volume)	*a)*	-0.4	-0.4	0.0
Inflation	*b)*	1.9	1.8	-0.1
Labour costs per job	*a)*	-0.8	-1.9	-0.1
Balance of payments	*c)*	0.5	0.5	0.0

Notes: 1. Units are expressed as a difference relative to continuation of present policy:
a) in %;
b) in % points; and
c) in % points of Dutch national income.

Source: Bleijenberg *et al*. (1990).

The calculations also indicate a single extra 1-2 per cent leg of inflation, following introduction of the packages which involve a tax shift. Viewed in the long term, though, this represents only minor additional inflation. There is also a measurement problem involved in determining this extra inflation, however, since it is calculated on the basis of a fixed set of goods and services, while the envisaged tax shift is aimed precisely at changing consumption patterns. If this is duly accounted for, the extra inflation will be even less than indicated in Table 4.4. Moreover, the effect on inflation depends on the tax cuts that are assumed. If the increase in fuel tax is compensated entirely by a decrease in VAT, or by lower social security contributions by employers, a first-order approximation indicates no extra inflation whatsoever.

Obviously, these modelling calculations for the Netherlands cannot automatically be transposed to other countries, which may, after all, have a different economic structure. The Netherlands has a relatively small automotive industry and a relatively large refinery sector. Nonetheless, even in other European countries, it appears likely that there will be only a minor impact on economic growth and a small positive effect on employment. There are three arguments pointing in this direction:

- On theoretical grounds, it is to be expected that a tax shift will lead to shifts in the economy, rather than to an increase or decrease in growth;
- This is reflected in the modelling calculations for the Netherlands; and
- Macro-economic calculations of the consequences of an energy/CO_2 tax ("carbon tax") in the EU show the same trend (for a review study, see Bakker, 1992, and for a more recent study, see DRI, 1993).

To conclude this section, let us return to the branches of industry most likely to be affected by an internalisation of traffic costs. Their share in GDP and employment will decrease, without this being anticipated to have an adverse impact on the economy as a whole. This said, however, the tempo of this economic transition should be such as to avoid loss of capital and social hardship. If this transformation proceeds too rapidly, additional expenses will arise. This argues in favour of gradual, step-by-step introduction of full cost allocation.

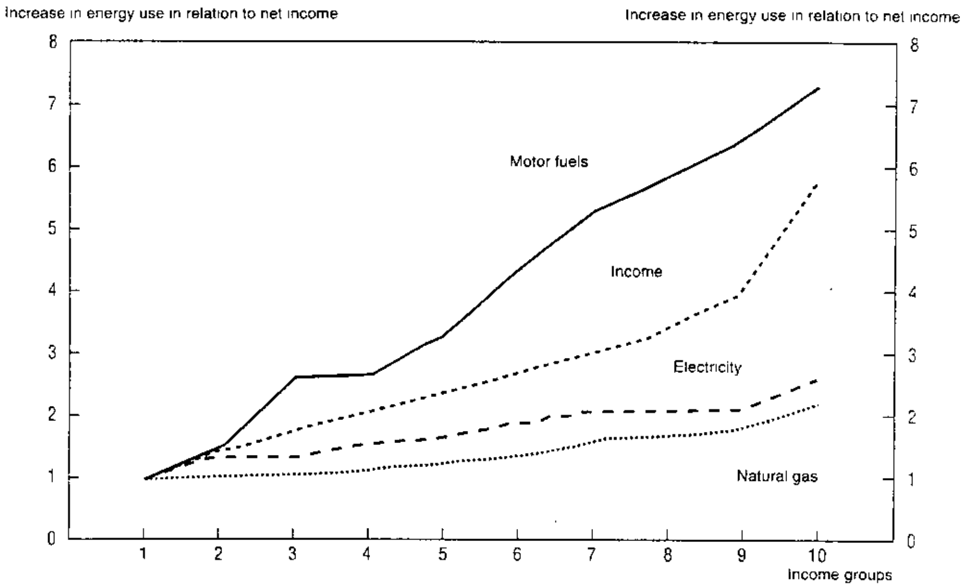
Social consequences

The internalisation of traffic costs may affect income distribution. This should be considered an unintentional side-effect, however, and additional income policy measures will therefore be required to correct for unwanted shifts in income distribution. Research has shown that this is feasible in practice, by careful design of tax cuts, and possibly by modifying income tax rates (Bakker and Bleijenberg, 1991).

In essence, cost internalisation is completely unrelated to income distribution. These two policy areas each have their own aims and instruments. The argument sometimes heard against internalisation -- that "the rich" will still be able to drive their car, while "the poor" will not -- does not stand up to scrutiny. In the present situation, "the rich" already have far more options than "the poor", and cost internalisation will not in itself change things one way or another. Those with objections to the present distribution of incomes should debate *that* issue, rather than using it improperly as an argument against certain pricing measures.

By way of conclusion, Figure 4.3 shows the relation between income and car fuel consumption. In the Netherlands fuel consumption is found to increase more rapidly (in percentage terms) than income. Measured as a percentage of net income, any increase in fuel tax will therefore constitute a greater burden on those with a higher income. Without supplementary income policy measures, then, there will be a slight levelling out of income differences.

Figure 4.3. **Relation between energy consumption and income**



Source: CBS Budget Study (1987).

The international dimension

Internalisation should be achieved in such a way that international competition is not affected. Individual countries will not readily be willing to take measures that damage their competitiveness. At the moment, if anything, we are seeing the opposite trend. Governments take a lenient stance towards the internationally-operating businesses in their country, with the aim of improving their competitiveness so that more employment and added value can stay within the domestic economy. This mechanism is sometimes termed "policy competition". Since this is the case in every country, the net effect is small, and the main consequence is that the internationally-operating businesses are usually "let off lightly" under government policy. Such is generally the case in the areas of taxation and environmental policy, for example.

Internalisation of traffic costs should therefore be seen in the light of considerations of international competitiveness. Three topics are discussed in this section:

- petrol tourism;
- the road haulage sector; and
- international businesses.

Petrol tourism

For small countries in particular, "petrol tourism" is a major consideration in setting the excise duty on fuel. In the Netherlands, for example, this issue plays a major role in the political decision-making process and there is a fairly strong petrol station lobby in the border regions working to ensure that there is no further increase in the difference in the price of fuel relative to the neighbouring countries. In the

Netherlands, various studies have been conducted into this form of tourism. With a price difference of 0.30 to 0.35 Dfl./l (0.14 to 0.16 ECU/l) relative to Belgium and Germany, 2.8 per cent of petrol sales take place across the border (Blok and Muizer, 1990). In addition, 10 million extra car-kilometres are driven to refuel across the border and an estimated 615 jobs are lost. Based on these considerations, the Dutch government feels a price difference of 0.35 Dfl./l (0.16 ECU/l) to be the maximum acceptable. The policy scope in the Netherlands is thus clearly delimited by excise duty rates in neighbouring countries.

Petrol tourism will be less significant in larger countries such as France and Germany, and in countries with a sparsely populated or inaccessible border region -- Denmark, for instance. These countries consequently have greater policy leeway for setting their own fuel tax rates and thus for internalising traffic costs. They could take such an initiative when the European excise duty rate is raised. A situation would then arise in which smaller countries with a low rate would benefit from their neighbours' policy. At the moment, this holds true for Luxembourg and Switzerland. Energy statistics indicate that average per capita motor fuel consumption in Luxembourg is about three times that in France or Germany. Roughly two-thirds of motor fuel sales in Luxembourg are therefore to foreigners and come under the category of petrol tourism. The extra excise revenue constitutes an estimated 2-3 per cent of Luxembourg's GDP, equivalent to about 500 ECU per capita. These calculations indicate that Luxembourg will not readily be willing to give up its revenue from petrol tourism.

To set limits on such "free rider" behaviour, the minimum fuel tax rate set by the EU should be increased. A major problem here is that such a move requires a unanimous decision by the Council of Ministers. It would also be desirable for Switzerland and Austria to conform to the EU's minimum rates.

If internalisation is achieved by means of road-pricing or toll collection, these problems of petrol tourism can be avoided (see also below). A major drawback of these options, however, is that they do nothing to encourage introduction of more fuel-efficient vehicles or a more fuel-efficient driving style -- two trends that could make a major contribution to reducing the environmental impact of transport (e.g. Rutten *et al*., 1990 and IEA, 1993). In addition, a high fuel tax is the most straightforward and effective instrument for achieving these environmental benefits. Even if road-pricing schemes were introduced, it would be desirable for traffic costs to be at least partly internalized via the excise duty on fuels.

Road haulage companies

Increasing the cost of transport must obviously be carried out without discriminating between domestic and foreign haulage companies. This will be closely supervised by the EU. Assuming that haulage firms of every nationality will have to pay the same duties and taxes, the competitive configuration among these firms will remain unchanged, even if one country introduces internalisation, while another does not. All haulage firms will endeavour to minimize their costs, by optimizing their refuelling strategy on every route, for example. Fuel tax increases, road-pricing and toll collection will therefore not upset international competitiveness among these companies. National differences in vehicle tax rates, on the other hand, may benefit one firm to the detriment of another. In this connection, it is important that the EU set a minimum vehicle tax for trucks. However, this tax is so low as to encourage a trend to lower the vehicle tax in some countries, because of competition considerations with other member states (in Germany and the Netherlands, for instance, as compensation for a higher tax on diesel fuel and/or the cost of the Euro tax disk). It is desirable to raise the EU minimum, and to give countries with substantially lower rates the time to gradually raise their vehicle tax. The other European countries might also conform to these EU arrangements.

This said, it should also be stated that increasing the diesel fuel tax would have several drawbacks with regard to arriving at correct cost allocation. In the first place, a truck with a full fuel tank is able to traverse such large distances that a major proportion of the fuel tax can be paid in a different country from that where the infrastructure is used. For this reason, no great discrepancies will arise between fuel tax rates in different countries and, in practice, the trend will be set by the EU minimum rate. The scope for increases in this minimum will therefore also be governed by the fuel taxes in neighbouring, non-EU countries (Switzerland, Austria, Poland, Czech Republic, etc.).

Second, fuel consumption is not directly related to the cost of damage to the road grid. If costs are internalized in the diesel fuel tax, heavy trucks will probably pay too little, given their relatively high loading of the road track. For these two reasons, it is desirable to introduce a form of road-pricing, with tax being paid on the basis of vehicle weight, and increased according to the mileage driven in the country in question. This system should of course be harmonized throughout Europe and might serve as a forerunner for the general introduction of road-pricing. Until the actual realization of such a system, fuel tax, vehicle tax, toll collection and the Euro tax disk offer sufficient scope for internalising traffic costs.

International companies

The final point to be considered is whether a given country might become less attractive to international business after the internalisation of traffic costs. In the Netherlands, for example, this argument is often heard in the traffic policy debate. As remarked earlier, a kind of "policy competition" has developed among countries, to vie for the favours of international business. Together with other factors, the level of various taxes and the quality of transport systems determine a country's appeal. However, it is by no means clear that a higher price for transport will result in a decrease in a country's competitiveness. In the first place, apart from the transport sector, there will be only small increases in product prices for other branches of industry (Bleijenberg *et al*., 1990). Second, the higher cost of transport will be offset by lower rates for other taxes, which will in fact give the country greater appeal for international business. The choices made in lowering tax rates are obviously of influence in this respect. Third, internalisation of traffic costs will lead to less congestion, which is favourable for the business climate.

To my knowledge, no studies have been conducted into the ultimate effect of these contradictory influences on a country's appeal to international business. It seems likely that traffic cost internalisation will have little impact on business climate. It is even possible there will in fact be a net *positive* effect.

Policy instruments

Having analyzed the effects of transport cost internalisation, this section reviews the main policy instruments available for achieving that internalisation. In selecting appropriate instruments, besides the aim of avoiding undesirable effects wherever possible, considerations of practicality and technical implementation also play a role. In addition, no attempt is made here to deviate from current policy practice. In considering policy options, a distinction can be made between the possibilities offered at the national and European level (see above).

National level

The scope for raising fuel tax rates at the national level may differ widely from country to country. Countries with a relatively low tax on petrol at the moment can increase this excise duty substantially without any significant economic consequences. To limit the economic impact, a gradual increase, and a prudent choice of associated tax cuts are required.

In smaller countries, "petrol tourism" may be of considerable influence, motivating governments to maintain a lower fuel tax (Luxembourg, for example), or to set a limit on the maximum price difference with neighbouring countries (the Netherlands, for example). Larger countries have greater policy leeway to raise the petrol tax at the national level. Irritation at the financial profit made in neighbouring countries may also imply limits to how far the petrol tax can be raised unilaterally by the larger countries. In the case of diesel fuel tax, there is probably less scope for deviation from the "European" level than with petrol. Otherwise, the same considerations hold.

In summary, national policy leeway for a unilateral increase in fuel taxes depends on the price a country is prepared to accept in terms of lost fuel sales and accompanying excise duty revenues. For smaller countries and for diesel fuel, there is less policy leeway than for larger countries, and for petrol.

Other pricing measures are relatively easy to implement at the national level. This is the case for toll collection, road-pricing, tax disks (for national trunk roads and trucks, and perhaps only during rush hours) and parking rates. Here, too, introduction should be gradual and accompanied by a prudent choice of tax cuts. Internalisation of traffic costs can probably be largely achieved by these means, without requiring agreement at the international level. Nonetheless, it can be queried whether this national approach is preferable, for it may give rise to a wide variety of schemes (e.g. tax disks and electronic road-pricing equipment), which may then form a barrier to international trade. It seems sensible to strike a balance, with sufficient measures being taken at the European level to keep the number of national schemes within acceptable bounds (see below).

International level

The minimum rates set by the EU for fuel tax and for the vehicle tax on trucks can be raised in the short term. For these policy instruments, an international approach is preferable because there is only limited policy leeway at the national level (with the exception of petrol taxes in the larger countries). It is above all the possible shifts in fuel sales that will restrict the scope for raising excise duties at the national level. A European increase in these taxes will also constrain the introduction of different national systems of cost allocation. It is also desirable that non-EU countries conform to the higher minimum rates for fuel tax and vehicle tax for trucks. Otherwise, they stand to profit financially from EU policy, reducing the social acceptance of such measures in EU countries. In this context, the position of Switzerland and Austria is particularly important, because of their central location in Europe.

In the longer term, the introduction of a single, harmonized system of electronic road-pricing throughout Europe would constitute an attractive proposition. However, to avoid introduction of a variety of different schemes, agreement on technical harmonization should not be delayed for too long.

For achieving proper cost internalisation, electronic road-pricing has several important advantages:

- payment takes place in the country (or region) where the infrastructure is used, and where the environment polluted;
- a supplementary tariff can be introduced for congested areas, as well as for rush hours;
- the emission characteristics of the vehicle can be incorporated into the price;
- vehicle weight can also be used as a parameter for assessing tariffs, permitting a better indication to be made of infrastructure costs; and
- it can take the place of existing toll collection, tax disk and vehicle tax systems.

When designing electronic road-pricing systems, due attention should be devoted to user-friendliness, fraud vulnerability and protection of privacy, matters that have come up during the Dutch political debate on this issue. Analogously to the present EU minimum rates for fuel taxes, minimum road-pricing rates should also be set. Ultimately, a methodology for obligatory allocation of all transport costs can be established within a European framework. In this way, existing national differences in such matters as infrastructure costs and the public cost of traffic accidents can be duly accommodated (see Kågeson, 1993).

So, in the longer term, it is feasible to achieve full, and economically correct, internalisation of traffic costs through a combination of fuel taxes and electronic road-pricing.

The art of internalising

In the preceding sections, the effects and perspectives of internalising traffic costs have been discussed and, overall, the picture is seen to be fairly favourable. Although there may be negative economic consequences for certain branches of industry directly concerned with transport, these are offset by positive consequences in other branches. On balance, economic growth is scarcely affected, and there may even be a slight increase in employment. With regard to technical implementation, there are also fairly simple and effective policy instruments available for achieving proper cost allocation. Alongside the scope for decision-making on the part of national governments, however, action must also be taken at the European level. It is well known that national interests may result in lengthy delays in effective European policy-making. This represents an obvious risk factor in achieving full traffic cost internalisation.

Figure 4.4 **The art of internalising**

Analysis
- background
- effects → supposed → actual → avoidable → unavoidable

↓

Public education
on background and effects of internalisation

↓

Policy plan design
- gradual implementation
- prudent choice of tax cuts

↓

Policy plan presentation
- background and effects

↓

Decision-making

To my mind, however, the major obstacle to internalisation is the almost total lack of public and political support for increasing the price of traffic -- both at the national and the European level. This is clearly reflected in the decision-making processes at these two levels. It is sometimes only after prolonged public opposition that minor increases in excise duty rates are passed by national parliaments or by the EU Council of Ministers. These "increases" are scarcely sufficient to keep pace with inflation. In many cases, there is even a taboo on researching the true cost of traffic. A recent opinion survey held in the Netherlands showed that 66 per cent of those questioned were of the opinion that car drivers were being exploited by the government. Although this is untrue (see earlier discussion), it means that there is insufficient public support for any form of internalisation. It is therefore absolutely crucial that adequate public support be created for traffic cost internalisation.

The first step towards achieving this goal is independent research, particularly research into the present cost structure and the major effects of internalisation. These topics have been covered briefly earlier in this paper. It is unavoidable in such research that some of the attitudes and opinions held by certain branches of industry have to be subjected to a critical analysis, and sometimes contested. For this reason, it is a prerequisite that this research be independent. In addition, such research should distinguish between "real" and "reputed" objections to internalisation.

The second step would be to organize good public education programmes on the main research results, for instance:

- government expenditure on traffic and government revenue from traffic-related taxes;
- information on traffic accidents and environmental pollution, and the financial valuation of these external effects;
- historic trends in real (i.e. inflation-corrected) traffic-related taxes;
- the fact that traffic cost internalisation represents a *shift* in the tax structure, rather than an *additional* tax; and
- the main economic and social effects of traffic cost internalisation.

This step would be aimed at increasing public understanding, and thereby at improving public support for cost internalisation. The third and last step would be to design and present a carefully balanced policy plan. This step should comprise:

- gradual, step-by-step introduction of internalisation of all traffic costs, creating a clear long-term picture and also avoiding, as far as possible, social problems and loss of capital;
- tax cuts to accompany internalisation, designed to avoid undesired side-effects; and
- an analysis of the main economic and social effects of the policy plan.

This policy plan would then obviously have to run the normal course of political decision-making. Figure 4.4 summarises the Art of Internalising.

REFERENCES

BAKKER, L. AND A.N. BLEIJENBERG (1991). *Brandstofheffing en inkomensverdeling* (Fuel tax and Income Distribution), Centrum voor Energiebesparing en Schone Technologie, Delft, January.

BAKKER, L. (1992). *Een EG energie/CO_2 heffing -- effecten voor economie en milieu* (An EC Energy/CO_2 Tax -- Effects on the Economy and Environment), Centrum voor energiebesparing en schone technologie Delft, December.

BLEIJENBERG A.N., J.W. VELTHUYSEN AND T. OEGEMA (1990). *Economische gevolgen van mobiliteitsbeheersing* [Economic Consequences of (auto)Mobility Control], Centrum voor Energiebesparing en Schone Technologie/Stichting voor Economisch Onderzoek, Delft/Amsterdam, April.

BLOK, P.M. AND A.P. MUIZER (1990). "Grenseffecten van de accijnsverhoging op benzineprijzen per 1-11-1990" (Border Effects of Petrol Tax Increase on 1-11-1990), *Nederlands Economisch Instituut, TK 1990-1991, 21.665, No. 3,* Rotterdam, August.

COMMISSION OF THE EUROPEAN COMMUNITIES (1992). *The Future Development of the Common Transport Policy*.

DRI (1993). *The Economic Consequences of the Proposed Energy/Carbon Tax*, Final Report, Paris/Wimbledon, February 1993, ECMT, 1989.

EUROPEAN CONFERENCE OF MINISTERS OF TRANSPORT (1989). *Resolution on Transport and the Environment*, Paris, November.

GENT, H.A. VAN AND J.M. VLEUGEL (1991). "Autoverkeer en -vervoer: externe baten??" (Car Traffic and Transport: External Benefits??) in: *Colloquium Vervoersplanologisch Speurwerk 1991,* Delft.

INTERNATIONAL ENERGY AGENCY (1993). *Cars and Climate Change*, OECD, Paris.

KÅGESON, P. (1993). *Getting the Prices Right*, T and E 93/6, Stockholm, May.

VAN DER KOLK, H. (1989). *Auto in balans* (Car in the Balance), Instituut voor Onderzoek van Overheidsuitgaven, The Hague, June.

NEUENSCHANDER, R. AND F. WALTER (1992). *External Costs of Transport -- An Overview*, Ecoplan, Bern.

RUTTEN, B., M. ELDERMAN, B. VAN DEN HASPEL AND A.N. BLEIJENBERG (1990). *Reductie van de CO_2-uitstoot van de personenauto door voertuigtechnische maatregelen beschikbaar op korte termijn* (Reducing CO_2-emissions from private cars by on-board technical means available in the short term), Centrum voor Energiebesparing en Schone Technologie, Delft, May.

SVV (1988). *Tweede Structuurschema Verkeer en Vervoer: Deel a* (Second Structural Traffic and Transport Plan: Part *a),* Ministers of Transport and Public Works and Housing, Physical Planning and Environment, The Hague, November.

WALTER, F., H. SOMMER AND R. NEUENSCHWANDER (1993). *External Benefits of Transport?* Ecoplan and T and E, Brussels, March.

Obstacles to the Use of Economic Instruments in Transport Policy

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Introduction

In most countries, the transport market is more or less controlled by the public sector. The reason is that the private market is expected to fail in providing the best allocation of transportation resources because of the sub-additivity characteristics of transport infrastructure, and because of the external effects caused by transport activities. But market control by the public sector may itself induce government failures, if it is performed by the wrong measures and induces false incentives (see OECD, 1992). Therefore, the issue arises of finding an optimal mix of public and private control. In general this means that public leadership should continue, but that the instruments of public management should gradually be replaced by private market instruments.

Economic instruments

Market economies are often considered to be superior to centrally-planned systems because of:

- spontaneous signalling of economic scarcity through flexible prices;
- decentralised decision-making and instantaneous adjustment;
- direct feedbacks by profits or losses; and
- stimulation of dynamic efficiency by competition.

In other reports of the OECD, market instruments are identified with pricing policies such as user charges, tradeable emission permits, deposit refund systems, etc. (see OECD, 1991). But pricing policy is only a part of the instruments which are applied in market economies and which contribute to efficient use of resources. And pricing policy *per se* is not sufficient to provide efficiency, as has been shown in the former socialist countries. It is crucially important that prices reflect the real costs or scarcity of resources. Furthermore, pricing policy should be embedded in the context of investment, operation management and finance policies. Therefore, attempts to bring more market principles into the transport sector by institutional changes should not be neglected.

Focusing the view

There are two basic ways to introduce economic instruments into the transport sector:

- assignment of market segments to private companies (i.e. the institutional solution); and
- application of the private enterprise instruments of planning, pricing and management by public enterprises or agencies (i.e. the operational solution).

In the first case, the public delegates management of a segment of the transport market to private decision-makers. In consequence, incentives, regulations and monitoring schemes have to be defined to make sure that private agents behave according to public objectives or requirements. It is not necessary for the public to know all the details of the technology, or everything about the optimal strategies for the market.

The only requirements are that the public agent find the most efficient private agent and develop an effective control scheme to prevent that agent from violating the regulations.

A special case of the institutional solution is the establishment of a "pseudo market" by the emission of pollution permits. While the public sector would fix the total emission volume, the private market could solve the problems of allocating the pollution rights to the users, setting prices and finding the most efficient ways of providing information and services for the trade of pollution rights.

In the second case, the public enterprise or agency would have to know everything about the technology and the demand situation which a private agent would have to know in order to be efficient. Furthermore, the public enterprise would also have to combine elements of profit-maximizing behaviour with elements of social welfare, including both merit goods and equity considerations. The instruments applied for decision-making and business activities can be absolutely private (such as rentability calculations, pricing rules or management techniques), even if the underlying objectives are not specifically oriented to profit maximisation.

Clearly, the management task in the second case is much more complicated, since managers are expected to be as well-versed in private business affairs as in dealing with public bodies and lobby groups. In France, there is a long tradition in the training of management science to public sector managers (beginning with Colbert, the Secretary of Finance of Louis XIV). The Anglo-Saxon tradition is completely different from the French. Its roots contain an intrinsic scepticism of the management capabilities of the public sector, because of insufficient incentive mechanisms ("X-inefficiency" -- Leibenstein, 1966). Therefore, in the Anglo-Saxon scientific literature, the notion of economic instruments in transport is closely linked with the notion of privatisation.

Sequence of the analysis

On the basis of these preliminary remarks, the analysis in this paper is organised as follows: the next section summarises the reasons favouring introduction of market instruments in the transport sector. This is followed by a review of the *psychological* barriers which may stimulate people to refuse market instruments, as well as the *real* obstacles which stem from the technology of production in the transport sector, or from equity or fairness problems. Possibilities for removing these psychological and real obstacles are then reviewed. The paper concludes with several policy recommendations.

In this paper, the institutional aspects of employing economic instruments play a dominant role. The reasons for this are twofold: first, it seems improbable that the public sector will be able to implement market strategies, because: i) public agencies tend to suffer from "X-inefficiencies"; and ii) the public is permanently under the pressure of lobby groups and of the press such that the incentive system facing those responsible for managing public agencies work against the market. Second, an institutional change in the responsibility for infrastructure management opens up the possibilities for a flexible demand management approach, which is absolutely consistent with the needs of environmental policy. Flexible pricing strategies according to the elasticities of demand, for instance, help to divert traffic to less congested time periods, routes or modes, and can be enforced by private or mixed private/public infrastructure operators much more easily than by public ones.

To underline this reasoning, it is useful to recall the fact that all the pricing instruments which are discussed in this volume have a long history and have been described in the literature since Pigou (1920), Knight (1924), Hotelling (1936), Smeed (1964), or Walters (1966). Therefore, the problem is not so much one of generating new theoretical approaches as it is of developing an institutional framework for the introduction of these market instruments.

Why transport economists call for economic instruments?

Transport infrastructure as a "club good"

Transport infrastructure is used predominantly for private purposes. Private consumers maximise their utility by performing consumption activities over space and time, and by using the transport infrastructure as a bridge between different locations in space. Private producers apply spatial logistic schemes to reduce their costs through specialisation and work-sharing, or to increase the radius of input demand and output supply. The additional benefits to society at large by providing basic accessibility and communication potentials are comparatively small in developed industrialised countries. Existing cost allocation studies for the transport sector suggest that the share of the public in the benefits of infrastructure are only between 15 and 25 per cent of the *total* (DIW, 1987; Aberle and Holocher, 1984). Therefore, transport infrastructure is basically a "club good", which provides most of its benefits to clubs of private users.

Abstracting from distributional problems for the moment, there is little reason for treating this club good like a public good and for producing or allocating transport services according to public rules. On the other hand, the transport infrastructure is characterised by a sub-additivy of costs, and its use leads to external diseconomies. Therefore, a high level of public control is needed to prevent the transport market from natural monopoly and from distortions by externalities. The conclusion is that public control is necessary, but that economic market instruments directed at the private sector are often feasible.

Externalities

External effects occur if a resource is used commonly, the property rights of which are not defined. In this case, the utility or production functions of agents are influenced by factors outside the market, and upon which they have no control. The decisions which are taken on the basis of such utility or production functions are consequently inefficient from the social point of view, and overall resource allocation could be improved if these externalities were internalised.

This could be simply done by a clear definition of property rights. Under the ideal assumption that there are no transaction costs, no problems of income redistribution, nor of unbalanced political power, it is not important to whom the property right is assigned to (Coase, 1960). But there are major cases where these assumptions do *not* hold (see Rothengatter, 1992):

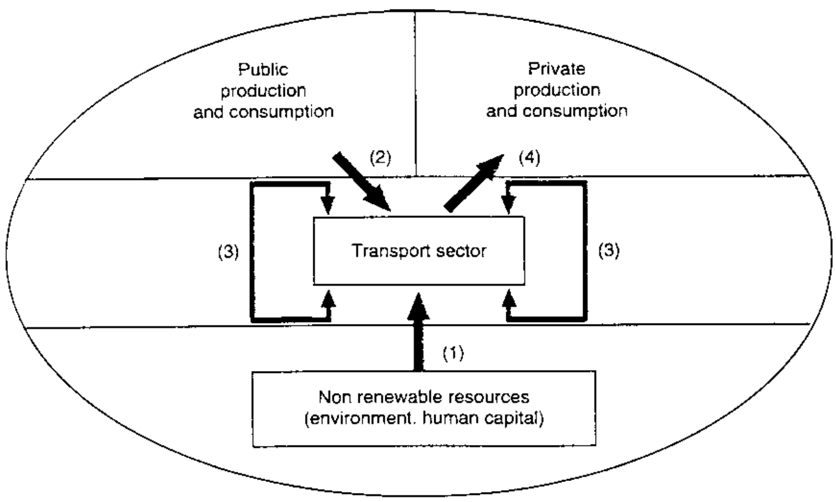
- *Adding unprofitable links to the network.* This can happen in less dense areas or in hilly regions, where the costs of additional infrastructure are very high. Improving accessibility to remote regions may foster regional development and produce interregional multiplier effects. Therefore, overall benefits can exceed the costs of investments if the (regionally) underpriced use of the infrastructure produces interregional spillovers. This is an example for positive external effects of the transport infrastructure which can be generated by an integrated network planning of the public.
- *Noise emissions and pollution by the use of the transport infrastructure.* Defining property rights for the environment can be one element of a solution strategy (*e.g.* pollution emission certificates, which could be traded on a special market). But as there are many different sorts of environmental disturbances caused by transport activities (and many polluters and affected parties), high transaction costs would be associated with the introduction of any complete market mechanism for controlling pollution tradeable certificates. Therefore, other forms of market mechanisms or direct regulations would also have to be discussed to supplement the "pure property rights" strategy.
- *Congestion externalities.* In the context of externalities, the congestion problem is often mentioned as a prototype example, following Pigou (1962). Contrasting the first two examples, these external effects are exchanged between the users of the transportation system only. They are typical interaction effects which occur in overcrowded systems, not only on roads but also in supermarkets or on beaches. A large step towards reduction of such interaction effects consists in introducing simple private rules of pricing and allocation -- for instance, on the basis of average infrastructure costing. But in highly congested areas, this might be insufficient, and

special congestion policies would become necessary. In this case, if a congestion charge is introduced, the income from this charge should be used for the benefit of users (redistribution of income or investment in the infrastructure capacity).

Figure 5.1 demonstrates that the external effects which occur in the transportation system are of four basic types:

- depletion of natural and human resources without paying the costs, because these are not transmitted to the polluter by market prices. These effects occur by interactions between the transport sector and the level of nonrenewable resources;
- providing synergy effects by adding links to the transport infrastructure which would not be profitable, if they were evaluated as isolated projects. If the public does not charge the private sector the full costs of such investments, there remain uncompensated external diseconomies. The affected parties in this case are the public sector, the transport sector and the sectors of private production and consumption;
- congestion effects stemming from the simultaneous use of the infrastructure. All parties involved in these interactions are inside the transport sector;
- positive effects of transport on consumption and production patterns. These effects are exchanged between the transport sector and the sectors of private production and consumption.

Figure 5.1. **Interactions causing externalities in the transport sector**



The fourth category of externalities is especially emphasised by the road lobby groups. The scientific positions here are highly divergent. Some scientists argue that it can be shown from theoretical reasoning that such positive externalities do not exist at all (Rothengatter, 1992); others demonstrate that some positive externalities exist, but that they are negligible (ECOPLAN, 1992); and a third group tries to show that these effects are significant and might offset the negative externalities of transport (Willeke, 1992; Aberle and Engel, 1992).

Pricing versus regulation

In a world of sustainable economic development, transport prices should reflect the true scarcity of resources. The problem which has to be solved by transport policy is that actual transport prices do not comprise the true depletion of environmental and human resources. As a result, transport prices are set too low and induce high excess demands for transport activities. A first solution has traditionally consisted of rationing transport demand by regulatory policies.

Examples are:

- zonal entry prohibitions for cars and trucks;
- enforcement of rail transport by regulation dependent on good categories and transport distances;
- control of market entry by concessions (trucks, buses, taxis, etc.);
- assignment of slots at the airport according to non-economic principles (e.g. "grandfathering of rights");
- introduction of technical environmental standards and control of vehicle licensing; or
- assignment of parking rights to residents in congested areas.

The problems of a purely regulatory policy have been discussed at length in the literature. For example, the transport policy of the European Union (EU) is oriented to reducing regulations because:

- Regulations impose rigid barriers to the behaviour of people, such that they cannot react flexibly according to their preferences.
- Regulation encourages people to find ways of circumventing the rules and directs private intelligence into the wrong directions.
- Regulation can be used as a national policy to protect the home markets from foreign competition.
- Regulation does not create enough incentives to promote innovation and dynamic efficiency.

The reasoning of economists is that prices are best suited to transmit the scarcity of resources into the decision planning of individuals and as such, prices regulate the market through so-called "soft constraints". "Soft constraining" individual decisions means that individuals are not prevented from certain transport activities, but that budget constraints operate to ensure that people decide according to their marginal utility per monetary unit. Contrasted with a "pure" regulation policy, individuals are therefore free to respond to higher transport prices by :

- choosing other spatial patterns for production, consumption and housing;
- changing logistics for input supply, distribution and sales of intermediary and final products;
- changing vehicles categories;
- adjusting the number and spatial distribution of trips;
- changing the choice of mode; and
- changing the route.

The striking advantages of price versus regulation policies are:

- All elements of the decision hierarchy of users can be influenced.
- The form of the response is left to the user. The individual can decide on the change of behaviour such that the de-central intelligence of millions of decision units is stimulated to find best solutions to save energy or pollution.

In short, pricing policies can introduce market-conforming reactions into the transport sector, which help to reduce external diseconomies without jeopardising the working efficiency of the market economy. In theory, the environmental side could also be internalised into the market economy as has been done with the social side in order to establish a socially sustainable market economy -- note that this does not mean that the social problems of the industrialised countries have been solved satisfactorily up to date, but it means that the solution of social problems is much more advanced than the solution of environmental problems. This is partly due to the fact that voters react much more sensitively to changes in their social situation than to changes of the global environmental quality (e.g. warming of the atmosphere, increases in the size of the ozone hole, etc.).

Private organisation, management and finance

The institutional side plays a key role in discussions about introducing economic instruments. Even in countries which show a high degree of confidence in public economic performance, it has been realised that it is necessary to change the form of organisation and to assign transport management from purely public bodies to institutions outside the normal public sector budget (such as funds or public enterprises. The essential properties of such institutions are:

- independence from short term political business (the public acting as a *principal*, not as an *agent*);
- organisation according to private business principles;
- "ear-marking" of revenues to combine investment planning and costing schemes;
- incentive-compatible rules for paying salaries and for promoting managerial careers; and
- clear rules for the payment of public or merit public services (Commissioner-Pays Principle).

Against the background of these principles, it is also necessary to define the range of acceptable activities of these private or mixed public/private institutions. In the context of private financing of transport infrastructure, the "build-operate-transfer" model has been developed to orient to the question to the single objective of finance and operation. Such an object can relate to a tunnel (Channel Tunnel), a bridge, a highway link, or a single asset (such as a new airport). But usually such objects are also integral parts of a broader network. Consequently, the cost, market, and political risks will be highly influenced by activities outside the object.

Take, for example, the case of private financing and operation of a MAGLEV-link between Berlin and Hamburg (IWW, 1992). The cost risks depend on the behaviour of regional public transit companies and the Deutsche Bundesbahn (which will provide interface between the systems). The market risk is dependent on the reaction of the Deutsche Bundesbahn (complementary or competitive behaviour, which leads to different time tables and production schedules by the Deutsche Bundesbahn). The political risk is influenced by government policy towards competing transport modes, such as car or air travel. The time span for approval and the legislative processes is also an uncertain factor. In any case, a private or mixed private/public company running a transport facility separately from complementary network elements cannot make use of the associated synergy effects, and will therefore probably respond in a sub-optimal manner.

The essential challenge of institutional policy in transport management is therefore not so much to decide on privatisation *per se*, but on the scope of activities which a private or public enterprise is allowed to perform and on the interface between that firm and neighbouring economic sectors. For example, if strong interrelationships between different companies remain, it will be necessary to develop agreements on sharing joint costs or common revenues, and the implementation of transfer schemes between high- and low-income companies, if the latter have contributed to the profits of the former.

Technical possibilities

The Smeed Report (1964) on road-pricing and its economic and technical feasibilities has already come out with the conclusion that technology is not a major obstacle for economic instruments in the transport sector. In the meantime, the technical instruments have been developed even further, although one should add that this is not the result of intensive research for implementing user charges, but a side outcome of the DRIVE-project of the EU. When developing a system for traffic guidance and control, it was discovered that the technology can also be applied to implement a pricing system. Thus the road-pricing technology became a (very small) part of DRIVE.

The results of DRIVE and other research activities (e.g. on road-pricing for London or Edinburgh) confirm the Smeed Committee's view that the technical problems are solvable. A first technological option would use automatic vehicle identification (AVI), which centrally records the charges for each vehicle. A second technology would not identify individual vehicles, but would deduct the cost of using roads from a stored value medium (similar to the current use of telephone cards), where the proprietor of the system is not able to establish who is actually using the facility (see Button, 1993). This latter approach can be extended to the use of smart cards, similar to those of credit cards, which automatically debit the costs of trips directly from bank accounts or charges them into a credit card account. Because of practical difficulties which occurred with the AVI-system in Hong Kong (essentially problems with privacy and with the perception of car drivers), the smart card system is now favoured for most applications.

While very simple toll systems have already been installed in some European countries to collect user charges (expressways in Italy, France, Spain; tunnels and expressways in Austria), a breakthrough on road-pricing is only conceivable with the use of sophisticated electronic systems. In Germany, the Autobahnen system is so densely interconnected with primary and state roads that simple turnpike toll systems cannot work. This is the main reason why a vignette system for trucks and cars on German Autobahnen has been discussed by the Ministry of Transport. The EU Council of Ministers of Transport has also decided (June 1993) to introduce a "Euro-Vignette" system in some countries of the EU (Benelux-countries, Denmark and Germany). This charging system is restricted to trucks and to motorways. It is obvious that such systems suffer from many deficiencies, such as independence from mileage and congestion (wrong incentive effects), or high transaction costs, and little efficiency of control. Nevertheless, it is probable that the vignette system will eventually be completely substituted by electronic road-pricing. (According to the decision of EU Transport Ministers in June 1993, an electronic road pricing system can be introduced in 1998.)

Why people refuse economic instruments -- psychological obstacles

Free rider problems

Public opinion is generally biased against higher user charges. "It is never popular to increase petrol taxes, etc. Trade and industry are opposing air pollution charges, as well as area licensing for urban road traffic." (Hansson, 1992). The reason for the heavy resistance of people against flexible pricing systems is often assumed to lie in the unfair distributional effects generated by such instruments. In the case of road-pricing, this argument is very popular and can be transformed easily to influence political decision makers. The case of the poor commuter who has to travel 100 kms per day for the journey to work, and cannot afford the user charges because he has to feed a large family on a low-income, is the standard paradigm of anti-road pricing campaigns.

However, it is easy to show that this argument does not hold on the average. The rich run a higher mileage than the poor, so they will have to pay more if user charges are introduced, based on mileage travelled. Therefore, it is not surprising that higher-income groups expect negative redistributive effects (in terms of direct losses of income), and therefore tend to reject flexible user charges (Staehelin-Witt *et al.*, 1992). In the empirical study of Small (1983, cited in Sims, 1992), the progressive income taxation effects of congestion tolls have been confirmed. Therefore, when pressure groups complain about the negative distributive effects of pricing policies to the poor, they are often trying to preserve their own high-income positions. Thus, the main reason for this resistance is the fear that perceived gains from free-ridership will be lost to the higher-income classes. This free-ridership can occur on two levels:

- insufficient payments to recover the costs of transport infrastructure; and
- using environmental and human resources without any charge.

On the first level, allocation problems occur:

- between the group of users and the group of non-users; and
- totally within the group of users, but among the different user classes.

In the "high transport tax" countries, (e.g. U.K. or Germany), there is no global free-ridership, in the sense that road users as a whole cover the total monetary costs of transport. But in Germany, for instance, there is a heavy internal cross-subsidisation between groups of users because:

- the fixed vehicle taxes disadvantage users with low mileage;
- the heavy loads only pay about 70% of their real infrastructure costs; and

- foreign users contribute little to the costs for which they are responsible (in the case of heavy loads, only about 10 per cent).

Furthermore, free-rider advantages occur to infrastructure users because they do not pay for the external costs of accidents, for environmental damages, and for the over-exploitation of human resources. As long as individuals profit from inefficient social cost allocations, there will be no incentives to change this allocation. In democracies, this leads to the dilemma of political truth-telling. Since people are concerned about environmental conditions, a politician cannot win an election without an environmental program. But, since people respond negatively to higher financial burdens to their budget, a politician might lose the next election if he/she actually tries to implement the environmental program. Therefore, price systems in transport tend to be incomplete, if they are decided upon by political bodies.

Private misunderstanding about public infrastructure

Although transport infrastructure is supplied by the public sector, it is actually a "club good" (see earlier discussion). If the public sector allocates this good according to public rules, it stimulates agents to seek additional rents by free-riding. As a consequence, excess demands for infrastructure capacity are generated. *Private* agents (based on their view that infrastructure is a public good) will respond according to the *public* good pattern. In other words, they will call for more capacity and put pressure on politicians to react, without revealing their true willingness to pay for the good.

This institutional "game" has established fixed behavioural patterns in many societies, so that agents stress traditional rent-seeking activities, instead of accepting more efficient alternatives. One result is that the private sector loses billions of ECU per year through congestion costs. Even though it is obvious that the public sector is not able to invest at will in transport infrastructure extensions to meet these demands (because of their empty treasuries and the resistance of people against investment plans), the acceptance of market instruments has not increased. This is somewhat surprising, since road-pricing has been proven to provide higher private benefits than costs, even at the individual level. Remember, a business traveller who pays 25 ECU to save 1 hour gains an expected profit of 25 ECU if his value of his time is 50 ECU/hour.

Unfortunately, misunderstandings about the character of transport infrastructure lead to inefficient responses by private agents, because they do not realise the potential improvements stemming from private forms of management and finance.

Public misunderstanding about private transport

The transport system generates many production and consumption benefits overall in the economy. These benefits are complementary inputs or outputs of many activities. Some of these benefits are external in the sense that the advantaged party does not pay the full costs of the transport system. Willeke (1992), for instance, mentions such external benefits as:

- development of remote regions;
- creation of new consumption patterns;
- new patterns of industrial and residential location;
- growth and structural effects; and
- industrial innovations linked to services of the transport system.

Based on this reasoning, the conclusion could be drawn that transport activities produce significant external benefits. This seems to be general thinking in transport policy and is supported by some scientists (e.g. Willeke, 1992; Simons, 1992; Aberle and Engel, 1992). The policy consequence which follows from the existence of positive externalities is that these externalities should be compensated for in the design of tax reliefs or subsidies. The Deutsche Straßenliga (1992), for instance, has concluded that the positive externalities almost equal the external costs, so that it is not justified to increase the total tax burden on road transport. This result was derived from interim reports of a study for the IRU on the European scale.

However, this conclusion is wrong. As has been shown in both theoretical and empirical studies (ECOPLAN, 1992; Rothengatter, 1992), the supposed positive externalities stem from infrastructure supply, but not from its use. There are no relevant external benefits of road transport which could justify monetary compensation in the form of reduced road user charges or fees to cover environmental costs. In most cases, the source of the misunderstanding is that the externality generated by the public sector through the building of infrastructure (see Figure 5.1) is assumed to be produced by the users of this infrastructure. Although the correct result can be derived by simple theoretical deductions, it does not correspond to the intuitive thinking of some transport experts and many politicians. Many of them falsely believe that transport is a inherently special sector of the economy, and should to be treated differently from other sectors with respect to subsidisation. This misconception seems to be an important reason for public and private business resistance against the internalisation of external costs.

Historical experience

Turnpikes and tolls on roads, bridges or tunnels are not inventions of modern transport management. They have a long history. These instruments were applied in ancient Rome to tax foreign traders, and were absolutely normal in the Middle Ages to charge the users of trade paths. In the U.K. in the 18th century, about 90 per cent of long distance trunk roads were toll roads. On the continent, very different experiences with toll systems have occurred. Some were legally-based and implemented according to common principles (such as the bridge tolls introduced under Karl I in the 11th century). But in countries with weak central governments and strong territorial principalities, un-coordinated toll systems developed which became, in extreme cases, similar to street robberies.

It is this bad historical experience which makes people distrust both pricing systems and the decentralisation of responsibilities for transport infrastructure. In particular, in the case of private infrastructure companies, people are afraid of adverse mechanisms because private profit maximisation could destroy synergy in and between the networks such that the efficiency gains of privatisation would be overcompensated by losses of synergy. Cross-subsidisation (which is usual in public networks, since expensive roads in hilly regions are not priced higher than in flat regions) would have to be reduced in a world of decentralised private network organisation and management. Furthermore, there is not much confidence in the advices of transport economists, because most of their results are derived from abstract or partial models, and there is a strong feeling among both practitioners and politicians that the concept of rational economic management in the transport sector is good for nice theoretical games, but is not an appropriate strategy for the real world. There is a clear signal here not to jeopardise the overall working efficacy of the transport system by implementing immature theoretical ideas (especially, those of transport economists!)

Enforcement of psychological barriers by lobbyists

Changes in the allocation of costs are always associated with a different pattern of payments by the groups concerned. As previously discussed, road-pricing and the internalisation of social costs affect high-income groups more than those with low incomes. Naturally, higher-income groups are quite capable of forming lobby groups to put pressure on the decision-makers.The most powerful of these lobbies are:

- automobilists clubs; in Germany, about 12 million car owners are organised in a general club of automobilists (ADAC). All German club members are voters;
- national and international road unions; although small with respect to membership and economic power, they are very influential because of their professional attitudes and the political over-rating of the importance of transport companies; and
- lobby groups of industrialists; these groups become very active if the public sector plans to increase tax burdens for industry as a whole, or for individual components of industry.

Summing up, there is a powerful political bias of lobby groups against economic instruments. Because of their solid financial basis, lobby groups can afford to hire highly qualified specialists to analyze the weaknesses of economically-based concepts and to develop populistic counter-arguments and media campaigns. A striking example of this process was provided in the journal "Motorwelt" of the ADAC in

Germany, where the club responded to an estimation of the external diseconomics of car traffic, with the calculation that external benefits of car travel exceed external costs by 5-10 times (ADAC-Motorwelt, 1992).

Real obstacles to implementing economic instruments

The reasons for objecting to economic instruments are not only psychological. There are several hard problems associated with the technology in the transport sector and with fairness/equity concepts, which will have to be solved before introducing the market into the transport sector to any great extent.

At this stage, we should recall that economic instruments concern investment and production planning, price-setting, organisation and management, as well as finance. In principle, each of these parts has to be analyzed separately for individual modes of passengers and goods transport. Since it is not intended to discuss all segments in detail here, emphasis is given to some general problems which are shown using examples from different transport modes, without being complete.

Synergy in networks

Physical networks are natural monopolies, both because their cost functions are sub-additive and because capacity decisions are not reversible, in the sense that fixed costs are "sunk". An incumbent of a given network component is able to protect his domain against entry by competitors, such that any effort to privatise would result in general in a technological monopoly. Whether or not this technological monopoly leads to a complete market monopoly depends on the degree of control by the private monopolist of the market for substitutes (Baumol, Panzar and Willig, 1982). Therefore, privatisation of wide parts of a network generates problems of monopoly power, while the privatisation of small parts (e.g. a link, a tunnel or a bridge might destroy the synergy in the network). Some possibilities include:

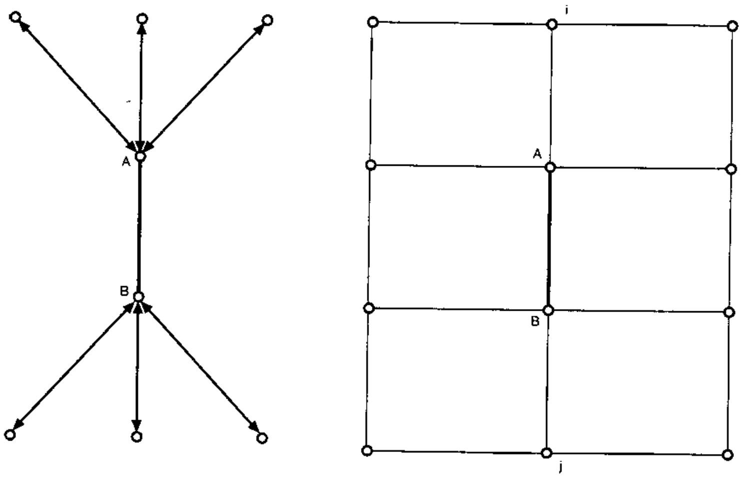
- *a)* privatisation of a link, organisation as a build-operate-transfer scheme;
- *b)* road-pricing on a regional expressway network;
- *c)* zonal road-pricing; or
- *d)* privatisation of regional public transit.

In case *a*, two situations are possible: In the left-hand illustration of Figure 5.2, the considered link is combining two distinct parts I and II of the network. In this case, the private operator is able to generate viable estimates of his expected income, because he is able to control the demand, assuming he has a reliable forecast of the demand side. This situation is promising for the private operator, but not as much for society as a whole, because it is probable that the private firm will be able to apply monopolistic pricing. Prototypes for this situation are the Channel Tunnel and the Alpe tunnels.

In the right-hand illustration, the considered link is part of a closely-knit network. Now, the firm operating the link is influenced by the behaviour of the (public) firms which are operating the rest of the network. We see here that these relationships can be either complementary or substitutional. If the other firms act competitively, the private firm has no control on prices and cannot behave monopolistically. This situation seems advantageous for society, but only from the aspect of pricing on competing routes. The load pattern on the network can only be optimised if the firms cooperate, which means that the other firms do not apply strategic prices to prevent travellers from *i* to *j* from choosing the route via AB. Formulating this situation as a cooperative game, we would real that a compensation scheme is necessary to form a grand coalition which can provide maximal cost efficiency.

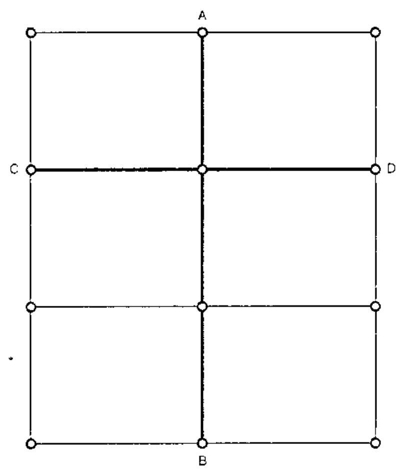
A prototype for this situation is the MAGLEV-link between Hamburg and Berlin. A private operator of the MAGLEV could (under extremely positive assumptions) make a profit, if the railway company (Deutsche Bundesbahn) does not react, even though it will be losing a major part of its market in the corridor. If the Deutsche Bundesbahn reacts by lowering prices for the Inter-City-train, it can improve its own cash balances, but the MAGLEV operator will run a loss. This shows that it is very difficult -- sometimes impossible -- to construct a market according to the classical ideal, because the market structure is in most cases monopolistic or oligopolistic.

Figure 5.2. **Privatisation of links in a network**



Case *b* represents a road-pricing scheme which is applied only on roads of the highest quality category (*AB* and *CD* in Figure 5.2). This measure could be introduced using the argument that expressways are very expensive and that the income is needed to extend the high level network. Such an argument will probably be accepted by the users, because they are used to the "good service -- high price" argument from their experiences in other markets. But what will happen with the load pattern on the network after introducing the tolls? Inevitably, the price-sensitive part of the demand will partly shift to the (lower quality) rest of the network and will produce more accidents, air pollution and noise than before. This means that a partial analysis of the shifts in demand is not sufficient to determine the probable outcome. A complete analysis and assessment of the network-wide effects may show that partial applications of road-pricing schemes are counterproductive. One prototype is the French LASER-project (a plan for an orbital tunnel around Paris), where the planned underground tunnel is regarded as a "first class service" which justifies the

Figure 5.3. **Road pricing on an urban expressway network**

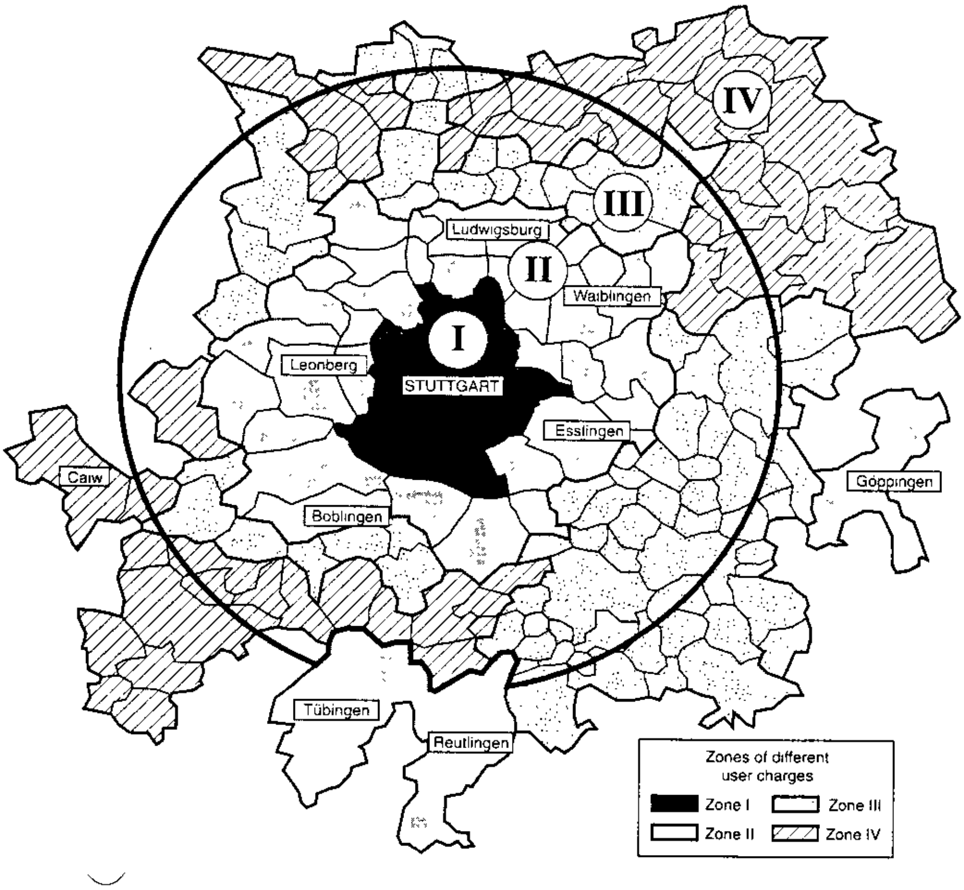


"first class price" (Papon, 1991). A second example is the German Autobahn system, for which an electronic road-pricing is being considered. Early studies of this possibility support the hypothesis that some traffic will be diverted to roads of lower grades, for which accident rates and congestion problems are likely to be higher.

This holds, in particular, for agglomeration areas, where a major part of traffic on Autobahnen is short distance travel.

Case *c* denotes a situation where the road manager tries to control traffic in congested areas by differentiated zonal user charges (Figure 5.3). The problem which arises from sharp differentiation of zonal prices is again that traffic can shift to other routes, therefore circumventing high density areas, on roads of lower quality, which once more produces higher accident rates and pollution externalities. Second, such a scheme would create incentives to change travel patterns such that short trips to the centre would be substituted by longer trips to sub-centres (Steierwald *et al.*, 1992).

Figure 5.4 Zonal road pricing system for Stuttgart



Finally, case *d* is related to the often-discussed issue of privatising public transit. The British example has shown that privatisation of single lines by tender cannot provide a satisfactory solution. The attractiveness of public transit is highly dependent on coordinated services, time-tables and tariffs. To preserve synergy effects in the public transit network after privatisation, it is necessary either to form larger units or to control the private firms by using "coordination authorities". What can be learned from the British lesson is that line concessions should be substituted by network concessions, and that the interface between the private networks needs strict coordination and monitoring by public authorities.

Transaction costs

The introduction of economic instruments may be associated with high transaction costs such as:

- preparation, planning and legal foundations;
- physical equipment needed for charging systems;

- information and advertisement;
- information failure and other activities designed to evade the charges; and
- monitoring and control of private operators.

Preparation and planning of a private infrastructure project can be more expensive than for a public project. For instance, a public road project can be separated into single sections and the construction in the first section can be started today, even though the property rights for section *n* are not yet owned by the public. In the case of privatisation, the property right of the whole link has to be assigned to the private consortium, and the project cannot be started unless the property rights for *all* sections are transferred. Furthermore, the privatisation of individual links is only possible if there is agreement on all problems concerning interfaces, common costs (or benefits) and risk sharing (i.e. cost, market, and political risks). Preparing the contracts for private infrastructure facilities can be extremely costly for both private agents and for the public. After a initial period of euphoria about private financing for transport infrastructure projects, banks eventually begin to react reluctantly and insist on major public involvement in the project, in order to control this type of a risk.

The costs of implementing charging systems depend strongly on the technology used. Although most turnpike systems on freeways indicate cost figures which are about 20-30 per cent of income, modern electronic-pricing by smart card systems is said to be much more cost-efficient, so that only 15 per cent of the income needs to be spent for equipment control and administration (Janson, Nemoto and Patterson, 1990). Nevertheless, this is still a significant cost compared with an increase in fuel taxes, which can be achieved at almost zero incremental cost. But the big disadvantage of a fuel tax is that it cannot be differentiated according to economic or environmental characteristics in specific regions, because people would avoid filling their tanks at gas stations located in high-price regions.

Incurring information costs is a necessary element of increasing rational economic behaviour, which is the main reason for using market instruments in the first place. This information should help travellers choose the best time, the best mode or the best route for their planned trips. Studies in the context of the DRIVE-project have shown that it is possible to considerably increase information levels in transport at relatively low costs, but that generating complete information on network conditions, and providing a continuous on-line service on route and mode choice will be very costly.

Although improved information will lead to better economic choices, one also has to consider that any remaining information failures may cause unexpected responses and often frictional losses. For example, a considerable percentage of road users does not follow recommendations on route-orientation because they have some previous experience that indicates that these recommendations are sometimes inaccurate. Even a bigger problem is that of unplanned user reactions to pricing schemes. In trying to escape from newly priced transport links or zones, people might move longer distances or choose sub-optimal routes. It is also possible that zonal road-pricing stimulates people to choose other destinations, e.g. to change the shopping centres that they visit (Steierwald *et al.*, 1992).

If the public sector tries to introduce more market efficiency into the transport sector by choosing the privatisation route, it has to consider that the private firm will maximise private profits and will not automatically fulfil public expectations. This means that regulating the private firm might be necessary, which will, in turn, impose monitoring and control costs. Therefore, the reduction of X-inefficiency may simultaneously induce an increase of Y-inefficiency (higher external diseconomies by private operations), if there is no insufficient public sector control. As Sappington and Stiglitz (1987) have shown, the efficiency advantages of private operations have to be compared with the additional costs of public interventions, monitoring, and control, before taking a decision concerning the desirability of privatisation.

Classification problems

It is well known that classification problems occur in private markets and may induce inefficient allocations in a world of uncertainty (for the case of the market for lemons, see Akerlof, 1970). If private market instruments are introduced into the transport market, some of these types of problem can also emerge. These can consist of both economically-based and politically-based classification problems.

In the first category, examples of segmentation problems include:

- defining user classes;
- separating zones; and
- separating time ranges

for both a road-pricing system, and for the allocation of environmental costs. The classification problem arises if users are assigned to classes according to mean or expected values of their behaviour. Take, for example, the case of heavy load lorries which may be assigned to the user classes 20-30 tonnes and 30-40 tonnes, according to their total weight. If these user classes have to pay very different charges, motivated by different road track costs, contribution to congestion and traffic noise, based on the mean values of costs (25 or 35 tonnes), then road haulage firms will be stimulated to operate trucks of 29 and 40 tonnes total weight only. As this does not correspond with economic efficiency such a classification would lead to a sub-optimal allocation.

There is also a political risk which occurs when classifying users with special rates:

- residential/non-residential users;
- emergency services (fire police, community services);
- special user groups (young, old, handicapped);
- income classes; or
- classes of advantaged/disadvantaged groups.

As a rule, classification problems are much more difficult to solve for public agencies than for private firms. This means that trying to introduce market instruments by letting public institutions act as private firms can provoke bitter resistance among people, because economic principles of classification can conflict with feelings of social justice and equity. For instance, the introduction of "Stockholm type" entry permits for cars, coupled with the purchase of public transit-tickets (they were planned, but not introduced, in Stockholm), failed in the Stuttgart region because the States' Ministry of Transport tried to classify users according to their estimated accessibility to PT-stations. So it could happen that a road was defined on the borderline between accessibility regions, such that residents living on two sides of the road had to pay different charges. People ultimately rejected this proposal because they thought the system was unfair. Political problems of this type will usually occur with zonal price systems. But price differentiation according to the time of the day, or the level of congestion, may also hit captive low-income groups, and will therefore induce similar equity problems.

Principal agent problems

"Principal agent" problems are well-known in private business, when the owners of capital assign management responsibilities to professionals. The principal agent problem can be roughly defined as the process of establishing a system of payments, information flows and control mechanisms to ensure that the professional managers fulfil the objectives of the capital owners, while still making a profit for themselves. Privatisation of public sector transportation activities leads to quite similar relationships. The public (being the principal) may assign management responsibility (e.g. for operating a railway service) to a private company, which is assumed to know more about their required technology, and which can produce the service more efficiently. The private agent is forced by contractual arrangements to observe the objectives of the principal (i.e. the public sector).

The big difference between private/private and public/private "principal agent" relationships is that, in private markets, all participants have the same concept of the overall efficiency of a firm (i.e. monetary profits). But if the principal is the public sector, objectives other than profit-maximising will prevail (e.g.

minimising environmental externalities or adverse distributional impacts). Until now, the theoretical research has not succeeded in providing clear answers concerning whether mixed public/private principal agent relationships are workable (Bös, 1991).

We can therefore assume that privatisation can proceed on the basis of sound economic theory, so long as the public objectives do not differ significantly from private ones. This means that overall efficiency has to be measured in terms of financial income or loss by both partners. In the light of this partial efficiency concept, the privatisation of the public bus companies in Britain can be seen as a success, because these measures contributed to the resolution of financial problems. But if there are other public objectives which are negatively affected by shrinking modal shares of public transport in Britain, then the evaluation of these measures may change. The example of the response of US-railway companies with respect to the passenger transport regulation before the Stagger's Act is helpful for illustrating the point that forcing the principal's objectives into the decision environment of the agent (generally by regulations), will lower overall efficiency of the management and will produce counter-productive incentives for the agents. Before the Stagger's Rail Act in 1980, U.S. private rail companies had to provide passenger transport service if there was demand. As passenger transport was not profitable, the companies minimised the quality of this service, and succeeded in most cases in reducing the demand so much that the service could eventually be cancelled anyway (see Boyer, 1990).

Impacts on land use

Strong voices are often heard on the road-pricing issue from the retail trade (see Jansson *et al.*, 1990). Retail traders are usually concerned that road-pricing schemes might reduce trips for shopping purposes. Flexible environmental charges, related to congestion, could have similar effects. These voices are supported by planning experts who apply partial models of spatial distribution which are calibrated by accessibility measures.

Experience which has been gained so far with restrictive policies towards cars in downtown districts does *not* support these arguments. Traffic restraint effects can create attractive spaces for shopping and other activities in the central districts. As road-pricing is a very flexible instrument it could help to substitute "hard" by "soft" restrictions, such that the attractiveness of downtown shopping could actually be *increased*. The structural effects which have been observed are a diversion of "low value/high transport needs" commodities from the centres to the suburbs, while "high value/low transport needs" commodities have been diverted from the suburbs to the centres.

The question whether road-pricing and environmental charges lead to more or less commuting activities cannot clearly be answered. As car travel in urban agglomerations becomes more expensive, the reaction of people could be to choose residential locations outside the agglomeration. On the other hand, prices for car driving would also increase in less congested areas such that a balance between the higher costs per km inside and the higher distances travelled outside the agglomerations could be achieved. Furthermore, the quality of public transport can play a decisive role. People can avoid the costs of car travel in agglomerations much better by choosing public transport than in areas of low population density. In any event, a policy of increasing centralisation of land use in the suburbs to improve the chances of public transport would be supported by road-pricing and environmental charges.

Privacy

An efficient pricing system cannot be based on charging tolls at turnpikes on the road or on the sale of coloured stickers in different cities or countries. Turnpike toll systems, as they have been introduced in some European countries on highways, tunnels or bridges, lead to high transaction costs and time losses for customers. These disadvantages outweigh the economic advantages if there are many interfaces between the toll roads (e.g. motorways) and the toll-free roads. In these cases, electronic road-pricing is necessary. Electronic road-pricing works either by external registration and direct charging to individual driver accounts, or by "smart card" readers inside the car. The "external registration" approach leads to problems of privacy and personal integrity, because data on the spatial movement of individuals would be recorded which theoretically could also be used to monitor private behaviour (fear of "Orwell's 1984"). When the charging is performed inside the car from smart cards, there is no problem about privacy concerning individual car drivers, but there is still the problem of control.

If control is carried out by video registration or electronic license plates, problems of privacy might arise once again. In this case, it will be necessary to restrict registration to those cars which are not equipped with active card readers and which therefore cannot be charged by the system. Car drivers may be afraid of tight electronic controls on driver behaviour (speed, distance, etc). Together with a general distrust that people have concerning the operation of electronic systems, the feeling of one's personal integrity being threatened by tight control systems is the main reason for the intrinsic reluctance of people to accept this type of control system. The present state of technological development continues to give experts representing opposing groups an opportunity to doubt the absolute reliability or legal security of electronic pricing systems.

Redistribution of income and equity

It was pointed out earlier that the distributional effects of road-pricing are not necessarily regressive, as argued by many interest groups. Since the distributive argument plays an important role, it is elaborated in more detail below. Small (1983), as cited in Sims (1992), has studied the effects of a road-pricing scheme on three income classes: low, medium, and high-income groups. The results of his analysis are summarised in Table 5.1. The main conclusions of this research are:

- The question of whether congestion charges have regressive or progressive effects has no unique answer. It cannot be answered by theoretical modelling, but only by empirical testing. And it depends on the particular effects which are included in the analysis.
- The absolute welfare-impacts of the toll are highest for the high-income groups and lowest for the low-income groups. But relating these welfare losses to income produces the reverse ranking. Therefore, absolute welfare impacts are progressive, while relative welfare impacts are regressive.
- If the toll revenues are redistributed uniformly to each consumer, the result is a net transfer from the rich to the poor. This means that the negative impacts on income distribution can be compensated for by a lump sum redistribution.
- If we ignore the redistribution of toll revenues and evaluate only the welfare effects of the imposition of the toll, and the resultant time savings, the result is clearly adverse to low-income commuters (Sims, 1991).
- The same holds if the revenues are distributed uniformly. The low-income group has the lowest net welfare gain.

Table 5.1 **The incidence of congestion tolls**

Effects	**Income class**		
Welfare effects of price increase	1 (low)	2 (medium)	3 (high)
	-17.1	-20.2	-22.4
Uniform redistribution of toll revenues	19.7	19.7	19.7
Net welfare effect (excluding savings)	+2.6	-0.5	-2.7
Welfare effects of price increase and time savings	-9.9	-6.3	-0.5
Net welfare effect (including time savings)	+9.8	+13.3	+19.2
	Cents/workday/commuter		

Source : Small (1983).

Therefore, the question is whether the equity effects are measured on the basis of net welfare effects, including or excluding the benefits from time-savings. Clearly, the rich benefit more because the value of their time is higher. From a microeconomic perspective, this higher value of time can be justified on the basis that higher-income people would produce a higher value added in the time saved. Therefore, the inclusion of the time-saving element can be interpreted as the productivity potential of time savings, which should in turn, be *ex*cluded from equity considerations. Following this reasoning, the net welfare effects (excluding time savings) is the appropriate measure of equity impacts. This measure has a positive sign for low-income commuters. This example clearly shows that the pricing system will only produce neutral equity results if compensation payments are made to correct for the relative welfare losses of the poor.

Impacts on international relationships and trade

The introduction of private market rules by infrastructure and environmental charges provides a better allocation of produced and natural resources. This statement, which is also in the spirit of the White Paper of the European Commission (1992) on a global concept for sustainable mobility in the European Union, is generally agreed on by the EU countries. But there are very different opinions concerning the implementation of this issue in the freight transport market. Although a proposal of the British presidency in December 1992 to introduce road user charges on the base of infrastructure costs (leaving the possibility to add a CO_2-charge to the fuel tax) was supported by six countries (U.K, France, Italy, Germany, Spain, Portugal) and could be accepted under certain conditions by three other countries (Greece, Belgium, Luxembourg), it was heavily opposed by the Netherlands, Denmark and Ireland. The latter fear a national way of fixing the charges, in particular in Germany, which is the largest transport market of the Union (about one third of the total freight transport volume of the EU countries is generated in Germany).

User charges, environmental fees and stricter traffic regulations in Germany based on the "territoriality principle" could have impacts on the market positions of the competing road haulage industries of the countries. German truckers would profit, while Dutch and Danish truckers would lose. Therefore, these countries strongly advocate a fixing of user charges on the EU level, i.e. by a "Euro-Vignette". Of course, a Euro-Vignette cannot be derived from optimal allocation calculus, it can only be derived from fairness considerations. The Dutch fairness arguments are twofold. First, it is pointed out that the importance of the road haulage industry is much higher in the Netherlands than in Germany, where other industries are also strongly protected by the public sector -- e.g. not regarding their environmental impacts on other countries (e.g. steel industry). And second, the Dutch argue that the environmental impacts of Dutch trucks in Germany are offset by the export of water pollution from Germany to The Netherlands through the river Rhine.

Because the German government has developed its position concerning cost allocation and environmental protection in transport only in the recent years, while it had previously agreed on establishing a European legacy in the transport sector where the principle of non-discrimination (and not the costs for the environment) played the dominant role, it will be hard to gain acceptance of the latter position. The European Law Court, for instance did not accept the environmental argument when it stopped the first German attempt to introduce a user charge for heavy load trucks in 1991.

This example shows that there is not only a problem of equity with respect to social groups which arises from introducing market instruments, but also a serious problem of international fairness for competing industries. In any case, the boundaries for "environmental arbitrage" have to be fixed in a new way in the EU, as well as for new competitors from central European countries (Poland, Bulgaria). For instance, a recent study of The Netherlands Institute of Economic Analysis (cited in DVZ, 1993, on the impacts on strict speed regulations in Europe) has shown that this measure would disadvantage the Dutch road haulage industry because of a labour cost increase of 10 per cent and a similar increase of time costs, which cannot be offset by a reduction of the costs of fuel consumption by 8 per cent. At this point, the argument of non-discrimination seems to be over-stressed, since it is directly posed against improving safety and environmental standards or the market position of the railways.

Government failures

Public policy tools have been developed in the past without paying much emphasis to environmental issues. The tax system for instance is often counterproductive in that it does not generate enough incentives to save environmental resources. But many controls and regulations which have been established in the past also have no environmental background. The OECD has issued a volume on this problem recently (OECD, 1992) the main results of which are summarised later.

An important consequence of government failures is inertia against introducing the market instruments that would be necessary for an optimal control of transport demand and supply. The public sector in general is a bad manager because the incentives for public servants are counterproductive (e.g. there is no correlation between economic efficiency and salaries), and because public agencies are exposed to the influence of lobby groups and of the press. Although several management and appraisal techniques have been developed in the public sector which could help to make public sector management more flexible and efficient, the deficiencies with respect to economic incentives are so grave that, in most countries, the introduction of market instruments would hardly generate major changes, unless it were also combined with significant institutional changes.

For reasons given earlier, there are also doubts that the public sector would be able to implement an optimal environmental charging/taxation policy. This can only change if the voters respond positively to environmental policy actions which put restrictions on their behaviour. This means that information on the state of the environment has to be improved, which should result in a change of values and more general acceptance of sustainability issues. Referring to the present discussion of an energy/CO_2 tax in Europe, it seems that much work still remains to be done in this direction.

Again, this weakness of the political decision mechanism could partly be overcome by institutional changes. Instead of charging people directly for polluting activities, the public could establish an "Eco-Bank", which could control the issuance of pollution permits, as well as the subsequent trade in these permits. The weak point of this type of system would be that a public authority would still have to decide on the national (or EU-wide) pollution limits. After some period of introduction, the lobby forces would probably concentrate on the public decision process of fixing the limit values. Therefore, the comparative advantages of tradeable permits approaches from the institutional point of view might vanish if there is not broad acceptance of the underlying environmental policy in general.

Summary of major obstacles to road-pricing from the viewpoint of involved parties

The concept

Economically-based user charges are necessary elements of a market concept for the transport sector. But this approach is so heavily opposed that it is worthwhile to analyze the reasons for the objections in the framework of institutional economics. This framework starts with defining the involved parties, i.e., the players in the societal game, their interests, and their viewpoints. In a study of the Swedish VTI-Institute on road-pricing Jansson *et al*. (1990) categorise the parties in the following way (Table 5.2):

Table 5.2. **Parties involved in the road-pricing issue**

Category	Sub-category	Interest/viewpoint
Road user	Private	Less out-of-pocket cost
	Commercial	More net trip benefit
Public transport user		Service quality of the public transport system
Resident		Relief from environmental problems
Retailer		Brisk business
Expert	Economist	Economic efficiency based on marginal social cost
	Engineer	Technical reliability and simplicity
Politician		More supporters for him/her

The political controversy can be represented on the basis of these categories. Obviously, the power of players may be different in different countries or in different periods of time. Nevertheless, this general framework is useful for characterising the difficulties in generating social consensus on road-pricing schemes.

A comprehensive synopsis

Conclusions relating to the major viewpoints of the "players" in the transport policy "game" were then summarised by Jansson *et al*. (1990), and are illustrated in Table 5.3.

Table 5.3. **Major Viewpoints in Controversies**

Player	Viewpoint	Position	Concern	City observed
Private	Discrimination against the poor	N	rp	Ac
Private & Commercial	Tangible charge and vague benefit	N	rp	Co
	Invasion of privacy by plate checking and videotaping	N	rp	HK
	A reasonable way of raising revenue for new road construction	Y	so	Be,Os
	Unnecessary, due to relatively moderate congestion in case study cities	N	so	Ac
	Interferes with right to travel	N	rp	Ac
	Relocation of traffic problems	N	rp	Ac
	Difficulty in enforcement	N	rp	Co
	Study report prepared by the government is not credible	N	so	HK
Public transport user	Probable improvement of public transport system in long-term	Y	rp	Co
	Infeasible capacity expansion to cope with demand transferred from car	N	so	Ac
Resident	Easy movement of pedestrians and cyclists	Y	rp	Co
	Necessary to tackle severe environmental problems	Y	so	St,To
Retailer	Harmful to vitality of business	N	rp	Co
	No insurance to compensate the adverse effects by road-pricing	N	so	Ac
Economist	Road-pricing's advantage on peak hours traffic reduction only	Y	rp	Co
	Empirical simulation models producing results favourable to road-pricing	Y	rp	Co
Engineer	Electronic Road-pricing's technical feasibility proved by HK experiments	Y	rp	Co
	Uncertainty of being able to cope with foreign cars without the coded plate after 1997	N	so	HK
Politician	Importance of strong political leadership	Y	so	Si
	legal barrier of prohibitive tolls on federally aided roads	N	so	Ac
Legend:	Position	**Y**: an approving viewpoint; **N**: an opposing viewpoint.		
	Concern	**so**: each city's particular socio-economic features without direct relation to road-pricing;		
		rp: advantages and disadvantages concerning inherent characteristics of road-pricing.		
	City observed	**Si**: Singapore; **HK**: Hong Kong; **Be**: Bergen; **Os**: Oslo; **St**: Stockholm; **Ac**: American cities; **To**: Tokyo; **Co**: several cities.		

Source: Jansson *et al*. (1990).

Without going through all the steps of modelling the decision-making process, we can derive some essential conclusions from this research (and from an institutional point of view):

- Imposing a pricing scheme is only acceptable if it can be associated with positive consequences by all of the major actors involved. For example, this probably means that user-charge revenues will have to actually be used to finance transport investments or to reduce other taxes. The argument that user charges help to increase welfare by reducing congestion is generally too abstract for many groups.
- Negative impacts on the distribution of income are simply not acceptable. Therefore, introduction of a pricing system must be combined with lump-sum redistributions to correct for regressive income effects.
- Road-pricing and environmental-charging systems have to be discussed with all groups involved, and the ground has to be prepared by a thorough communication process. This is because the politicians who decide on road-pricing systems are intrinsically interested in being re-elected, and they will not adopt such a system in the face of resistance from major lobby groups. Therefore, a dynamic process will have two important properties. First, there will be no policy solution without exercising some threatening power, e.g. by linking the road-pricing system to an investment program. Second, it will not be possible to introduce the optimal system (from the economist's point of view) all at once. It can only be done in a "step-by-step" process.

Possibilities for removing real and psychological obstacles

Real obstacles

Synergy in networks

To preserve synergy in networks, two approaches are possible. First, powerful regional- or network-wide coordination agencies could be established. In this case, the operations services could be auctioned in small pieces to private companies which can themselves be small, e.g. operating only one line. Second, contracts could be established with large companies for the provision of regional- or network-wide services.

In this case, it would be not possible to give free entry to small companies, because they could not guarantee a coordinated regional- or network-wide service. The development of public transport clearly shows that it is necessary to combine intra-city and intra-regional transport to supply an integrated service for cities and their environment. The examples of Karlsruhe and Manchester demonstrate that integration of networks is a most important step for improving the quality of public transport in the cities mentioned. These cities have either already realised (Karlsruhe) or planned (Manchester) combined urban and regional transport using network facilities of the national railway companies for building up an integrated urban/regional light rail system.

It is slightly easier to operate parts of road networks through private companies than it is for railway networks. This is because it is not necessary to coordinate time-tables, tariffs or information systems, and because the operation of cars and trucks works in a totally decentralized manner. However, since there is not much practical experience with regional- or network-wide private road network operating companies, a first step could be to establish private firms with public ownership.

In this case, it would be easier to work out appropriate arrangements for network interfaces, tariffs and income sharing. In a second step, a share of the capital (*e.g.* 49 per cent) could be assigned to private capital owners. On the other hand, a 100 per cent privatisation is possible for parking facilities, airports, airlines and value added services on networks (*e.g.* freight shuttle train operators on particular OD-pairs), without disturbing network synergy. In other cases (single links or network parts with private monopolies), the influence of the public remains very important to avoid synergy losses (occurring for instance by non-coordinated pricing strategies) or private monopoly failures.

Transaction costs

Of course, one of the important general issues is to minimise transaction costs stemming from privatisation, or from applying private enterprise instruments to the planning, pricing and management of transport by public enterprises or agencies. There are a number of instruments available here, of which the most important are the application of modern telecommunication systems and a proper segmentation of the supply sector.

It is not unrealistic to anticipate that, in some cases, transaction costs will be too high, even if modern techniques are applied. For instance, the costs of introducing an electronic road-pricing system on German Autobahnen are estimated at between 6 and 18 Billion DM, depending on the actual performance of such a system. Therefore, the economic requirements for an optimal level of control have to be adjusted to the financial possibilities.

Classification problems

If different zones or time ranges must be defined for a flexible pricing system, it is useful to define smooth transitions between zones and/or times. Experience from telephone price differentiation shows that too sharp a price differential causes unexpected demand responses, which can generate other problems (e.g. more congestion along the boundaries of zones).

The same holds for the definition of user classes and privileged groups, if these cannot be unambiguously defined (for instance, by technical characteristics). To solve these "acceptance problems", as well as to reduce the propensity to cheat, screening systems must be simple and intuitively understandable. In general, people object to public agencies more than to private enterprises, when they are confronted with discriminatory prices. For instance, in the case of mandatory accident or life insurance, people will accept discriminatory rules, even though these rules have consequences for the distribution of income. The same holds for time-dependent parking prices charged by private operators. As a rule, therefore, discriminatory strategies which affect equity should be implemented by private institutions. The public sector can then correct for equity problems, not by subsidising transport activities, but by lump-sum payments to affected groups.

"Principal agent" problems

Experience with regulated private companies offers us some clear advice: minimise regulations which are directly counterproductive to private profit-maximisation. This guideline concerns at least the following activities:

- pricing policy;
- quantity of production;
- use of technology; and
- obligatory unprofitable service (imposed by regulation -- see earlier discussion).

This means that the market segments for private agents have to be defined in such a way that the firms can act as profit-maximising units. For instance, the separation of infrastructure from operations management in the railway sector is a step towards this goal. Infrastructure is a natural monopoly, which needs public control, while operation of the network can be organised by private agents without the need for strong restrictions on their profit-maximizing behaviour.

If such a separation is not possible, and operators have to remain subject to tight public control or intervention, then some public form of the enterprise (possibly even including public ownership) is to be preferred. This is because, in this situation the costs of X-inefficiency are expected to be lower than the costs of monitoring/ control, plus the costs of violating public regulations (Y-inefficiency).

Impacts on land use

As pointed out earlier, land use is generally not influenced negatively by applying economic instruments in transport. But it is necessary to anticipate the potential impacts by a systems analysis, if the market instruments are only applied to parts of a region or of the network.

Privacy

Although personal integrity and privacy previously seemed to be a significant barrier to the use of electronic-pricing methods in the transport sector, the newly developed "smart card" systems have contributed somewhat to overcoming this risk. Only if the smart card reader does not work at a given control point must the data of the car be registered, and the personal data of the car holder identified.

One reason that the smart card might not work could be that the card itself is no longer valid. In this case, the fault would lie with the user. The recording of user data would be legal in this situation, but regular follow-up would be required. A second reason could be a technical failure inside or outside the car. This could provoke serious problems and, in a "worst case" scenario, the electronic-pricing system could be stopped by the law courts, if the technology is not absolutely reliable.

Redistribution of income

If politically necessary, compensation to low-income groups for equity distortions caused by economic instruments may be appropriate. If so, this compensation should be made in lump-sum payments, and should be independent from transport activities. The volume of the payments should be oriented to the expected net income losses of the affected groups. Alternatively, a "tax deductions" approach could be used. But the disadvantage of a taxation approach is that it is hard to directly target low-income groups with these deductions. Low-income groups do not usually profit from tax deductions, because their incomes are generally taxed at low levels, if at all.

However, the essential problem here is not so much to identify the best compensation strategy, but to identify the groups concerned, and to prevent others from adopting rent-seeking strategies. For example, in Germany, it has been found that the social groups which would be most disadvantaged by road-user charges are single parents with children and families with many children. If compensation were to be given in the form of tax relief, high-income families with children would receive higher compensations than low-income families. Therefore, lump-sum payments related to the number of children of a family would be a better solution to these equity problems. In the case of Germany, this could easily be implemented by increasing the existing children's allowance.

In the case of tradeable emission permits, one could look to a "fair" initial distribution of the emission permits to solve the equity problem: for example, every individual could receive a permit to emit a given quantity of CO_2. Individuals who produce less CO_2 than they are allowed could sell a part of their property rights to others who produce more emissions and are willing to pay extra for this right. This solution may be perceived as being fair because everybody starts from the same endowment.

Problems of international impacts

Facing the different national regulations of the transport markets of its member countries, the EU has decided to establish a new market structure based on economic principles. Liberalisation of the transport market is an element of the Treaty of Rome (Article 74) and will therefore be introduced step-by-step, ending with free cabotage on January 1, 1997. The common environmental policy of the Union has a much younger history. Article 130r of the Maastricht Treaty of 1990 defines the commitment of the EU countries to include the aspects of the environment into the common policy.

The liberalisation process in the transport market has been realised in a short time, as it basically started in 1985 after the judgement of the European Law Court. Therefore, it seems possible that the same speed might be realisable in environmental policy, such that medium term targets would be set and the countries could adjust to them gradually, in order to avoid losses for their industry.

Government failures

The major intervention failures, their effects and potential policy responses are summarised in Table 5.4.

Table 5.4. **Major intervention failures and policy response**

Nature of Intervention Failure	Features of Failures	Policy Responses
Economic Intervention Failures.	• Relative costs of using modes distorted. • Overall cost of transport too low. • Lack of long term incentive to adopt cleaner technology. • Excessive use of transport in sensitive areas.	• Full costing of environmental effects. • Full marginal cost pricing. • Charges directly related to the use of infrastructure. • Fiscal transparency. • Appropriate up-dating of charges. • Improving environmental evaluation techniques. • Full environmental costing in investment appraisal.
Command and Control Failures.	• Inertia in changing standards. • Lack of incentive to improve on standard. • Problems of policy outside of zones of control. • Sub-optimal method of attaining target improvements.	• Greater flexibility in operation. • More self-correcting systems of control. • Coupling standards with financial incentives. • Careful tiering of zones.
Administrative Failures.	• Poor enforcement of existing laws. • Confusion over who is responsible. • Development of conflicting policies. • Inertia in policy-making.	• Greater horizontal coordination of Agencies at local, regional, national and international levels. • Greater vertical coordination between levels of Administration. • More emphasis on enforcement of existing policies. • Greater integration of environment into transport policy. • Improved training with regard to the environment.

Source: OECD (1992).

Psychological barriers

Psychological barriers to the use of economic instruments can be identified in the following areas:

- fear of being exploited by a public or private monopolist, who tries to maximise the tax on income or profits;
- resistance against the loss of benefits stemming from the present cost allocation;
- a general feeling that transport networks are public facilities, which should be equally-available to all customers;
- distrust of decentralized territorial economic structures in the transport sector because of negative historical experiences, with road turnpikes or private institutions (e.g. private railway companies in Europe); and
- "missing fantasy" (e.g. in the case of markets for pollution permits, many people fail to imagine that this could work like trading shares at the bourse).

The basic ways in which these psychological barriers can be removed are:

- increased information;

- more risk-taking by experts in promoting the use of market instruments at the political level;
- using a piece-meal approach to ensure controllable outcomes;
- providing continuity in the policy debate and in political activities; and
- stressing positive aspects (e.g. profitability of environmental protection), instead of negative arguments (e.g. penalties for social costs).

The first rule is to provide better information about the effects of economic instruments. It is essential to convince high-income groups that they will profit (in terms of welfare gains) from a more efficient transport system.

The second rule says that experts can help in this process by transforming economic reasoning into more understandable terms. This means first that abstract arguments have to be made clear by using prototype examples. And second, it is necessary for expert judgements to incorporate not only synopses of the pros and cons of policy options, but also a weighting of these options, coupled with the clear recommendations in favour of more use of market instruments in transport. This also implies that the experts must take part of the political on risk themselves, and not let the politicians stand alone against the aggregate political power of lobby groups and the press.

Concepts are much easier to implement in aggregate if one can show that they work in the disaggregate (third point above). It seems to be impossible to introduce an optimal concept in its entirety at one time. The political "game" is a dynamic one, and new ideas have to prove their validity over time. Therefore, a road-pricing concept would stand a larger chance of success if it were started for selected parts of the network, with initially low prices, designed to adjust the demand behaviour smoothly, instead of producing "shocks".

Political recommendations

General conclusions

Some of the obstacles against economic instruments can be explained by normative deductions which show negative welfare impacts resulting of the imposition of these instruments in the transport sector. These negative impacts include such things as:

- The "synergetic entity" of networks might be disturbed.
- Transaction costs and other costs of adjustment may occur which exceed the benefits of using economic instruments.
- Economic treatment of different segments of customers implies screening problems which are more delicate in the public sector than they are in the private sector.
- If the management and operation of networks is assigned to private companies, problems of information, monitoring and control may occur.
- The outcome of applying market instruments may disadvantage low-income classes, and thereby conflict with the goal of social equity.
- Instruments designed to collect revenues or to control law-abiding may also disturb personal privacy.

Although these problems can often be resolved, and generally only constitute only a reason to amend the type or application of economic measures (i.e. rather than to reject the measures entirely, they are often reinforced by psychological feelings and by specific campaigns of lobbyists. These "psychological obstacles" include:

- People fear having to pay not only for infrastructure use, but also for monopoly profits or subsidies to other public sectors.
- Users accustomed to free-riding reject payment systems, even though they might actually realise welfare gains from pricing.

- Public sector managers fear losing responsibility for tasks which form the basis for their reputations.
- The history of road-pricing in the late Middle Ages, and of private railways since then, provides a number of illustrative negative examples which strengthen psychological barriers.
- Many car owners are organised in automobile clubs, and make up their mind against economic instruments on the basis of negative statements made by club management and by the press.

This gives rise to the need for work on both the reduction of real obstacles and on the removal of psychological barriers.

Recommendations for introducing economic instruments in transport policy

Specific recommendations for reducing obstacles to the introduction of economic instruments in transport policy are summarized in Table 5.5. The individual obstacles and their major causes are illustrated in the first two columns. The third and fourth columns contains recommendations for the cases of both private and public organisations considering the application of market instruments. Obviously, there are several policy measures which could help to remove more than one obstacle. However, to avoid undue complexity in Table 5.5, the policy measures have been assigned to the particular obstacles which are likely to be most affected.

Table 5.5. **Policy recommendations related to individual obstacles**

Obstacles	Major cause	Recommendations	
		Case of application by private agents	**Case of application by public agents**
Need to retain "network synergy".	Joint cost and production functions in networks; sub-additivity of infrastructure costs for a monopolistic supplier.	(1) Privatisation of joint network segments under public monopoly control.	(1) Formation of agencies according to specific need of joint network segment management.
		(2) Privatisation of single objectives under a strong regime of public coordination.	(2) Separation of central, regional, and local responsibilities.
		(3) Establishment of public coordination agencies to define areas of private competition; organising the auctioning of concessions to the private sector.	(3) Establishment of coordination agencies to harmonise tariffs and technical standards.
Classification problems.	*Economic* reasons in the case of user classes, zones, times, distances; and *public* reasons in the case of privileged users (emergency, fire, police, residents, etc.).	(1) Privileged groups (e.g. emergency cars, fire, police, residents in downtown areas) should not be treated differently by the private operator; it is up to the public sector to reimburse their costs, according to public policy objectives.	(1) If classification of demand is necessary (e.g. by user classes or privileged groups), private and public *enterprises* are preferred to public *agencies*, because enterprises are more robust in responding to the pressure of lobbyists.
		(2) Minimise conflicts with social goals when prices are discriminatory.	(2) If market instruments aim at attaining different political objectives (e.g. infrastructure, toll, congestion pricing, environmental charges), it is important to avoid an overloading of one type of fee; it would be better to construct a *"package"* of charges and taxes, each with a clear notion of its purpose.
		(3) Differentiated charges should be fixed and *known in advance*.	
		(4) Clear and simple rules for price differentiation; *smooth transitions* between zones are required (also for public enterprises).	
High transaction and management costs.	Differentiated charging regimes (with tolls varying in time, distance, and space); need for a highly efficient system of registration, for AVI-technology, and for enforcement.	(1) Clear segmentation of the supply side, in order to reduce complexity.	(1) Introduce complex methods for user charging only if technical problems are fully resolved. Otherwise, apply "second-best" policy instruments.
		(2) Preference for the use of *build-operate-transfer* models for separate objects (e.g. Channel Tunnel).	(2) Start with those parts of the network where the needs for market differentiation are lowest.
		(3) Intercity transport (expressways, major railway links) are more easily privileged than urban network segments, because of their high levels of interaction with other parts.	(3) Transaction costs can be reduced by international standardisation of technologies.

Obstacles	Major cause	Recommendations	
		Case of application by private agents	Case of application by public agents
"Principal agent" problems.	Assignment of management from public decision-makers to professional managers causes problems in setting payment schedules, in defining information flows, and in monitoring and control.	1) Define the supply segment in such a way that the private agent can still act as a *profit maximiser*.	1) Introduce private forms of efficiency-enhancing tools in public enterprises.
		(2) Do not introduce regulations which conflict directly with profit-maximising objectives.	(2) Give managers of public enterprises an opportunity to serve on the Boards of private companies, and thereby to eventually construct *mixed public/private networks*.
		(3) Give private agents the opportunity to combine their transport business with other value-adding services.	(3) Do not allow political parties to influence the careers of managers in public enterprises.
			(4) Define clear criteria for cross-subsidisation between various segments of the supply side (from road users to public transport).
Impacts on land use.	Change of land use induced by changing relative transport prices in space.	(1) and (2) of the "public agents" column also hold for private agents.	(1) Avoid sharp distinctions between zones (i.e. by using "pure" pricing strategies).
			(2) Suppress undesirable attributes of economic instruments by using complementary strategies (e.g. by introducing prices on access roads to shopping centres in the outskirts of cities at the same time as tolls are introduced on major highways).
Need for redistribution of income (equity issues).	Low-income groups are often disadvantaged by private market mechanisms.	(1) *Private* enterprises should be free of any redistributive burdens; this is clearly a matter for public policy.	(1) Construct *"packages"* that involve pricing, investments, and cross-transfers; avoid discussion about the isolated (partial) effects of road-pricing itself.
		(2) Pricing strategies should be coordinated with the responsible public coordinating agencies, in order to define appropriate public compensation schemes.	(2) If disadvantaged low-income groups can be identified, construct a system of redistribution to compensate these groups (e.g. allowances for families with children).
			(3) If the equity argument is strong but a clear identification of disadvantaged groups is impossible, a *lump sum redistribution* of excess income to all households is recommended.

Obstacles	Major cause	Recommendations Case of application by private agents	 Case of application by public agents
Need for privacy.	Modern technologies might be seen as an invasion of privacy.	(1) Apply AVI technologies with *anonymous charging*.	(1) Include a public authority to control privacy and personal integrity. Require this authority to issue yearly reports.
		(2) Restrict information flows to those who do not require personal data or license identification.	(2) Apply only AVI technology if unauthorised use of information is seen to be impossible.
		(3) Establish a control system in which the participation of the police is minimised. Clarify the legal requirements for private control and define the interface between private and public control activities (i.e. traffic regulations, cash control, etc.).	
Problem of international impacts.	Introduction of market instruments may change the competitive situation of companies which operate internationally.	(1) In the case of relatively small projects (tunnels, bridges), there will generally be no international problem.	(1) Integrate institutional and pricing policies in the EU policy framework. EU policy should strengthen the "territoriality principle", in order to stimulate national transport policies to apply economic instruments.
		(2) In the case of large network companies, the situation is similar to that of public agents.	(2) Binding agreements on environmental harmonisation are necessary before the liberalisation process can be completed.
Government failures.	Inertia in setting or changing standards (e.g. for the emission of pollution certificates) creates a risk that excessively low standards will be set, resulting in too-low prices being established for transport services.	(1) Establish an "eco-bank" to control the issuance of pollution certificates and trading at the bourse.	(1) Public agencies should only intervene in the market of pollution certificates as a transitional measure, during the initial implementation of the trading system.
		(2) Assign the task of defining standards to a public agency for the environment.	
Psychological barriers.	People are not accustomed to market instruments; consequently, the real problems associated with economic approaches tend to be reinforced by their intrinsic reluctance to accept these tools.	(1) Avoid the impression that user-charging is being done only to maximise profits.	(1) Avoid the impression that user-charging is being done only to meet public sector revenue needs. There should be a clear distinction between: -- user charges; -- general contributions to the public budget (taxes); and -- environmental fees.
		(2) Start with low prices and appropriate testing of new technologies.	

REFERENCES

ABERLE, G. AND M. ENGEL (1992)." Forschungsprojekte Straβengüterverkehr: Theoretische Grundlagen zur Erfassung und Bewertung des volkswirtschaftlichen Nutzens", *Internationales Verkehrswesen,* 44.3. pp. 169 - 175.

ABERLE, G. AND W. ROTHENGATTER (1991)." *Erstickt Europa im Verkehr? - Probleme, Perspektiven, Konzepte",* Materialband zum verkehrspolitischen Kongreβ der Landes regierung von Baden Württemberg, Stuttgart.

ABERLE, G. AND H. HOLOCHER (1984). *Vergleichende Wegerechnungen und Verkehrsinfra--strukturpolitik-- Theoretische und empirische Analysen zur Ermittlung und Verrechnung von Finanzmittelaufwendungen im Straβen--und Eisenbahnverkehr der Bundesrepublik Deutschland*, Schriftenreihe des Verbandes der Automobilindustrie (VDA), Nr. 46. Frankfurt a.M.

ADAC (1992). *ADAC-Motorwelt*, Vol. 6/92.

AKERLOF, G.A. (1970). "The Market for "Lemons": Quality Uncertainty and the Market Mechanism", *Quarterly Journal of Economics*, 488-500.

AXHAUSEN, K.W. AND P.M. JONES (1992)." Road User Charging: A British Perspective". Mimeo. London/Oxford.

BAUMOL, W.J.C, J.C. PANZAR, AND R.D. WILLIG (1982). *Contestable Markets*. New York.

BÖS, D. (1987). *Public Enterprise Economics*. Amsterdam.

-------- (1991). *Privatization: A Theoretical Treatment*. Oxford.

BOYER, K. (1990). "Lessons From the Deregulation of U.S., Japanese, and Canadian Railroads". Paper Prepared for the DVWG-Seminar on the Consolidation of Railways. Nuremberg.

BUTTON, K. (1993). *Transport, the Environment and Economic Policy*, Bodmin, Cornwall.

COASE, R.H. (1960). "The Problem of Social Cost", *Journal of Law and Economics*, Vol. 3.1-44.

COMMISSION OF THE EUROPEAN COMMUNITIES (1992). Green Paper on The Impact of Transport on the Environment,. COM (92) 45 Final, Brussels.

DEUTSCHE STRABENLIGA (1992). *Strabe, Vehrkehr und Wirtschaft.* SVW-Ino-Dienst, 2/7/92.

DIW (DEUTSCHES INSTITUTFUR WIRTSCHAFTSFORSCHUNG) (1987). *Erweiterung methodischer Ansätze zur Wegekostenrechnung und Erarbeitung eines Konzeptes für eine Gesamtkosten- rechnung des Verkehrs,* study for the Ministry of Transport, Berlin.

DVZ (1993). "Tempobegrenzer: Nur Vorteile für Deutsche". Deutsche Verkehrszeitung, No. 28/93.

ECOPLAN WIRTSCHAFTS UND UMWELTSTUDIEN (1992). *Der externe Nutzen des Verkehrs*. Studie im Auftrag des Dienstes für Gesamtverkehrsfragen und des NFP 25 "Stadt und Verkehr", Bern.

HANSSON, L. (1991). " Pricing of Air Pollution in the Swedish Transport Policy", *Transportation Research Record* 1312. pp. 83 - 89.

-------- (1992). "Socio-Economic Aspects of Transportation: A European Perspective". Mimeo. Brussels.

-------- (1992). "On the Political Problems of Implementing Emissions-Charges and Congestion-Pricing in Sweden". Mimeo. Brussels.

IWW (INSTITUTE FOR ECONOMIC POLICY RESEARCH, UNIVERSITY OF KARLSRUHE) (1990). *Fahrgastaufkommen einer Magnetschnellbahnstrecke Berlin-Hamburg*. Study for the Ministry of Transport, Karlsruhe.

JANSSON, J.O., T. NEMOTOOCH AND H.-E. PETTERSON (1990). *Road-pricing from Theory to Practice -- A Digest of Economic, Technical and Political Viewpoints During Three Decades.* VTI -- Publication T 97, Linköping.

KAGESON, P. (1992). *External Costs of Air Pollution. The Case of European Transport*. T&E -- Report 92/7, Brussels.

KOMMISSION DER EUROPÄISCHEN GEMENSCHAFTEN (1992). *Die künftige Entwicklung der gemeinsamen Verkehrspolitik. Globalkonzept einer Gemeinschaftsstrategie für eine bedarfsgerechte und auf Dauer tragbare Mobilität*. VII/580/92 -- DE Rev. 1. Brüssel.

LEIBENSTEIN, H. (1966). "Allocative Efficiency vs. "X-efficiency", *American Economic Review*, 56. pp. 392 - 415.

MAGGI, R. (1992). "Environmental Implications of Missing Transport Networks in Europe". Mimeo, Zürich.

NETHERLANDS MINISTRIES OF TRANSPORT AND PUBLIC WORKS; HOUSING; AND OF PHYSICAL PLANNING AND THE ENVIRONMENT (1990). *Second Transport Structure Plan -- Transport in a Sustainable Society*, The Hague.

OECD (1991). *Environmental Policy: How to Apply Economic Instruments*, Paris.

-------- (1992). *Market and Governement Failures in Environmental Management. The Case of Transport*. Paris.

PAPON, F. (1991). *Les Routes de Premiere Classe: Une Tarification Difference de la Circulation en Agglomeration pur en Ameliorer L'Éfficacite Economique de Manière Socialement Equitable*. Dissertation, Universite de Paris.

PIGOU, A.C. (1962). *The Economics of Welfare*, 4th.Ed.,London.

ROTHENGATTER, W. (1991). "Deregulating the European Railway Industry: Theoretical Background and Practical Consequences". *Transportation Research*, 25 A. 181-191.

-------- (1992). "Externalities of Transport". Paper prepared for the ECMT publication: *Transport Economics: A State of the Art*. Karlsruhe.

SAPPINGTON, D.E.M. AND J. Stiglitz (1987). "Privatisation, Information and Incentives", Working Paper No. 2196, National Bureau of Economic Resaerch, Cambridge.

SHEFER, D. (1992). "Pricing as a Means of Reducing Traffic Congestion and Air Pollution in Urban Areas." Mimeo, Berkeley.

SIMONS, J. (1992). "Benefits of Different Transport Modes", CEMT-Round Table 92, Paris.

SIMS, W. A. (1992). "Distributional Issues in Transportation Pricing Schmes for Infrastructure and Externalities". Paper prepared for the Technical Seminar on Infrastructure Pricing, Investment Decisions and Financing, The Royal Commission on National Transportation, Vol. 2. Ottawa.

SMEED-REPORT, MINISTRY OF TRANSPORT (1964). *Road-pricing: The Economic and Technical Possibilities*. HMSO, London.

STAEHELIN-WITT, H. BLÖCHIGER AND A. SPILLMANN (1992). "Distributional Effects, Public Opinion and Redistribution of Revenues", in Frey, R. and P.M. Langloh (eds.), *The Use of Economic Instruments in Urban Travel Management*, WWZ -- Report No. 37. pp. 145-151.

STEIERWALD, G., G. HEIMERL, G. KAULE, W. KÖHL AND W. ROTHENGATTER (1992). *Ansätze für ein integriertes Verkehrskonzept für den Verkehrsraum Stuttgart.* Study for the State`s Ministry of Transport, Stuttgart.

VERHOEF, E. (1992). "External Effects and Social Costs of Road Transport" Mimeo. Amsterdam.

WILLEKE, R. (1992). "Nutzen des Verkehrs und der verschiedenen Verkehrsmittel", *Zeitschrift*, pp. 137-152, für Verkehrswissenschaft, 63. Jhg. 3.

-------- (1992). "Benefits of Different Transport Modes", ECMT-Round Table 92, Paris.

WORLD RESOURCES INSTITUTE (1992). *An Analysis of Tolls to Reduce Congestion on Urban Highways in the United States*. Mimeo, Washington.