VALUING TRANSPORT EXTERNALITIES

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1. INTRODUCTION

Transport was one of the first sectors in which the importance of externalities was recognised with respect to traffic congestion, and the proposed solution in the form of a congestion tax formulated. More recently attention has been paid to a range of other externalities arising from the activities of the transport sector, of which the most important are accidents and a wide range of environmental effects. At the same time, argument has arisen as to whether all of these factors should really be seen as external disbenefits from transport systems and whether they may be balanced by external benefits.

To the extent that such externalities do indeed exist, it is generally recommended that they should be taken into account both in pricing policy, generally through the medium of a Pigovian tax, and in project appraisal by means of quantification and valuation in a social cost-benefit analysis. Both of these recommendations clearly require that the externalities in question be valued in money terms. However, despite several decades of research, no unanimity exists on the methodologies to do this, or on the results such methodologies give. Doubts have consequently arisen in some quarters as to the practical value of this whole approach to the problem. Nevertheless, both the European Commission (CEC, 1995) and the British Department of Transport (DOT, 1996) have recently reiterated the need to ensure that transport prices cover the full social costs that transport causes.

In this paper we shall seek first to give a brief account of the externalities arising from the transport system. We discuss both the principles and practice of the valuation of transport externalities, and the relevance of such valuations for practical policy issues. Finally we examine some recent attempts to value the external costs of transport systems, and seek to understand why the values differ so widely, before reaching our conclusions on whether monetary valuation makes sense. Where arguments affect different modes of transport differently, we shall concentrate on road transport, as this is widely recognised as the major cause of externalities in the transport sector (Mauch and Rothengatter, 1995). Most of this paper is based on Nash (1997).

2. EXTERNALITIES ARISING FROM THE TRANSPORT SECTOR

Externalities are commonly described as impacts on the utility, cost or production function of one economic agent by variables under the control of another economic agent and where the effect is

not the subject of a market transaction. Whilst other definitions may exist, it is this definition that is useful in the analysis of cases of market failure, for it is only in these circumstances that intervention is needed to ensure that the cost or benefit in question is taken into account by relevant decision-takers.

It is often argued, following Coase (1960) that the prime - or indeed the only - cause of such effects is the inadequate definition and policing of property rights, since otherwise externalities would always be eliminated by market activity in the form of bargaining. However, as here defined, externalities are frequently also public goods (or bads); in other words they are both non-rival (that is to say that consumption by one economic agent does not prevent their simultaneous consumption by others) and non-excludable (it is not possible to prevent their consumption by others). Therefore even if property rights were adequately defined and enforced, market failure might still occur as a result of the free-rider problem. For instance, if it were possible for residents of a particular area to trade with motorists in order to reduce levels of noise or air pollution, each individual resident would have an incentive not to pay, in the hope of benefiting from the trading of others without having to pay themselves. In addition, bargaining has transaction costs and therefore may not occur even if it is in principle possible. Consider for instance the problem that has just been suggested. It is hard to see how a market could be established in which motorists and residents traded over the amount of noise and air pollution they emit and suffer whatever the legal position regarding property rights, given the number of people involved and the difficulties in identifying them. Therefore, externalities may remain as a cause of market failure even if property rights are adequately defined, and other measures therefore remain potentially desirable. At the same time, it must be borne in mind that government intervention is neither perfect nor costless, and that the risk exists of replacing market failure by government failure.

The most long-standing example of an externality in the transport sector to be found in the literature is that of congestion (Pigou, 1924). The entry of an additional vehicle on to the road system will, if traffic is already sufficiently dense to prevent free flow conditions, lead to a further reduction in speed for all traffic. Thus, as well as the delays suffered by the additional vehicle, all other vehicles on the road system will suffer delays. At the margin, the external congestion cost caused by one more vehicle is the additional delay to all other vehicles it causes. This must be distinguished from the average delay compared with free flow conditions, which may be a much greater (or even smaller) number.

A second major externality takes the form of accident costs. But here again the identification of the externality involved requires care. When a driver is involved in an accident, part of the cost is borne by the driver him or herself. This may be directly in terms of pain or suffering, as well as financially in terms of damage, loss of income or in terms of what they pay in insurance premiums. These costs are not necessarily externalities; they may simply be part of the user cost of road transport, although it may be doubted whether users are always fully informed about the risks they run, suggesting a possible alternative form of market failure in terms of imperfect knowledge. For a vehicle to be deemed to be imposing an externality in this case requires the simultaneous presence of two conditions. The first is that the accident should not have taken place or should have been less serious in the absence of the vehicle in question, and the second that some of the costs should have been borne by individuals other than the driver of the vehicle

in question. It follows that by no means all the costs of accidents may be regarded as external costs.

More recently most attention has shifted to environmental effects as externalities. Here there are a wide variety of effects, as listed in table 1. Transport is a very significant source of most of these pollutants. For instance, in Great Britain over a million people are exposed to road noise in excess of 70 dB(A), and around 15 million in excess of 60 dB(A). In Western Europe as a whole, transport accounts for 61% of emissions of nitrogen oxides, 49% of volatile organic compounds and 26% of carbon dioxide (Mauch and Rothengatter, 1995).

Table 1
PRINCIPAL ENVIRONMENTAL EFFECTS OF TRANSPORT SYSTEMS

Resource	Effects
Land	Land take, property destruction, extraction of building materials
	Visual intrusion, waste disposal
Air	Local pollutants
	(C0, HC, N0X, Lead, particulates)
	Acid rain (N0X, S0X)
	Global warming (C02)
Water	Pollution by run off; oil extraction and transportation
Other	Noise and vibration

Source: Adapted from OECD (1988)

The impact of these externalities varies from purely local, in the form of land take, property destruction, noise and local air pollution, to regional in the case of acid rain and its impact on wildlife, forests and buildings and to global in the case of greenhouse gases. Whilst some, such as certain local air pollutants, may be expected to reduce over the coming few years as the use of catalytic converters - now compulsory for all new cars within the European Union - grows, others such as emissions of particulates and greenhouse gases, continue to worsen.

Whilst land take, property destruction and the extraction of building materials may be seen as not being external costs, since they are generally the subject of market transactions, the transactions in question are frequently not entered into voluntarily as market transactions but rather as a result of compulsory purchase orders, and they frequently have an effect on third parties through changing the amenity level of the environment in which they live and work, or indeed through more drastic implications such as the elimination of jobs. Thus there may well be externalities associated with these effects. In all other cases, the effect concerned is quite clearly an externality.

It is worth commenting also that these effects may have a variety of impacts. For instance, local air pollution may be a direct disamenity (i.e. perceived as unpleasant), and it may have indirect effects (e.g. damage to property or damage to health). In the latter case the indirect effect may be perceived without the recipient knowing the cause of it, a matter of some importance when it comes to valuation procedures.

Thus it is clear that the transport sector is the producer of many external effects which are the cause of serious concern. In the next section we look at principles of valuation of externalities.

3. PRINCIPLES OF VALUATION OF TRANSPORT EXTERNALITIES

The reason why externalities interfere with the efficient working of the economy is that those taking the decisions leading to their creation have no incentive to take them into account. Therefore, the most obvious way of achieving economic efficiency is to ensure that a price be charged which represents the compensation required by those adversely effected by negative externalities (or a payment be made representing the willingness to pay of those benefiting from positive externalities). Implementing such a pricing structure costs money, however, particularly in terms of the degree of monitoring required to establish the scale of the externality each agent is creating and - to the extent that those affected by it may not be in possession of perfect information or act rationally - it may not be the most effective solution in any particular situation. A cost-benefit analysis is required to consider whether pricing, or some other form of intervention is the most efficient approach and whether it is worth the costs. Nevertheless, the principles and the need for valuing externalities remain unchanged. If the aim is to establish whether a particular measure will be economically efficient, then the approach should be to try to measure the compensation required for tolerating negative externalities and the willingness to pay for positive ones.

This is far from easy to establish, however. Firstly, as stated above most externalities are public goods, and suffer from the usual difficulties in achieving unbiased preference revelation. Secondly, some external effects (global warming for example) stretch well into the future, and it is difficult to forecast the circumstances in which they will be experienced and the preferences of those affected by them. Valuation of such effects also runs straight into the continuing debate about social discount rates; many studies find such externalities to be insignificant because they are discounted at relatively high opportunity cost based discount rates. Others argue that placing a very low value on such future effects on these grounds is unjustified when there is no good reason to suppose that the resources saved by ignoring them will be ploughed into other investments which will in fact compensate future generations for the damage caused. Thirdly many external effects are poorly understood both by the population at large and even by specialists in the fields in question. For this reason, environmentalists frequently invoke the `precautionary principle' whereby emissions suspected of being dangerous are more strictly controlled than would be justified on the basis of hard evidence of their harmful effects. Fourthly, but by no means least, many would argue that environmental problems should not be seen solely in terms of barriers to economic efficiency, but as ethical issues concerning the survival of species, and ultimately of the planet as we know it. In approaching such issues, people may not regard them as goods which can be traded off against money.

These problems point to an alternative approach to handling the externalities of transport systems which may be preferable in many cases (Bowers, 1993). This consists of determining standards in terms of emissions levels or other externalities which must not be exceeded. The standards based approach is particularly helpful in dealing with the problems of international negotiations on

global pollutants, where an approach based on willingness to pay measures may be seen as exceptionally unfair in that it gives little weight to the preferences of the poor countries of the world. Of course the standards must rest on views on the benefits of restricting the level of the externality relative to the cost of so doing. But standards tend to rest more firmly on the views of experts in the field rather than willingness to pay or willingness to accept compensation. Once a standard has been established, it may be translated into a money value by means of an opportunity cost argument. This relies on the fact that if the emission in question is allowed to increase from one source then it must be reduced from another. The cost of achieving a reduction in the level of the emission from the most cost-effective alternative source then becomes the cost of additional emissions.

Thus we have two broad principles on which the valuation of externalities may be based, either of which may be deemed appropriate in any particular context. There is nothing wrong in principle with mixing the two forms of valuation in a single study. It may be that for some externalities, where the effect is readily perceived and immediate (noise for instance) a direct willingness to accept compensation type of measure is seen as appropriate, whilst for others with long term and little understood effects (such as global warming, for instance) the opportunity cost argument is deemed appropriate. What is not acceptable is to adopt whichever approach is most convenient in terms of availability of data, unless it is believed that the economy is already at an optimum in terms of levels of externalities, when the two approaches should yield equivalent results.

4. VALUATION OF TRANSPORT EXTERNALITIES IN PRACTICE

The previous discussion of principles of valuation will be irrelevant if it is not possible to devise ways of implementing them with a reasonable degree of reliability in practice. A comprehensive review is contained in Nash and Bowers (1988). It is possible to divide the methods used to value externalities broadly into three groups:

a. Revealed preference methods

These methods rely on finding a market in which members of the population reveal the value (in terms of willingness to pay for or to accept compensation for) they attach to the attribute in question. For instance in the case of time savings, a long established approach is to apply discrete choice modelling techniques to circumstances in which people have a choice which involves a trade-off between time and money costs of travel (most commonly mode choice decisions). Slightly more heroically, the same approach has been applied to decisions involving safety (for instance by modelling whether people choice to use a seat belt or not). The heroism here is in the assumption that people are fully aware of the consequences of their choice and decide rationally. This may be a reasonable assumption in the case of the choice of mode of transport for a regular journey to work, although many would dispute even this; that people are well informed on the quantitative risks involved in not wearing a seat belt is less plausible.

Turning to environmental issues, there are two long standing revealed preference approaches in use - hedonic pricing, and the Clawson approach. Hedonic pricing is most often used in the

context of house price models, although it is also used for instance in the estimation of the value placed on accidents via wage rate studies. The approach is to estimate the relationship between house prices and the environmental characteristics of houses, controlling for other factors such as the physical characteristics of the house and its accessibility (for results of some such studies see Table 2). The estimated hedonic price for environmental characteristics, such as the level of noise and air pollution, is often taken as some sort of mean valuation of the characteristics in question, although it is possible to apply a two stage procedure which goes on to estimate the relationship between this value and characteristics of the population such as age and income (See Rosen, (1974)).

Table 2
RESULTS OF U.S. HOUSE PRICE MODELS

% reduction in house prices from:	
1 unit increase in Leq measure of noise nuisance	0.08 - 0.88
1% increase in sulphur deposition	0.06 - 0.12
1% increase in particulates	0.05 - 0.14

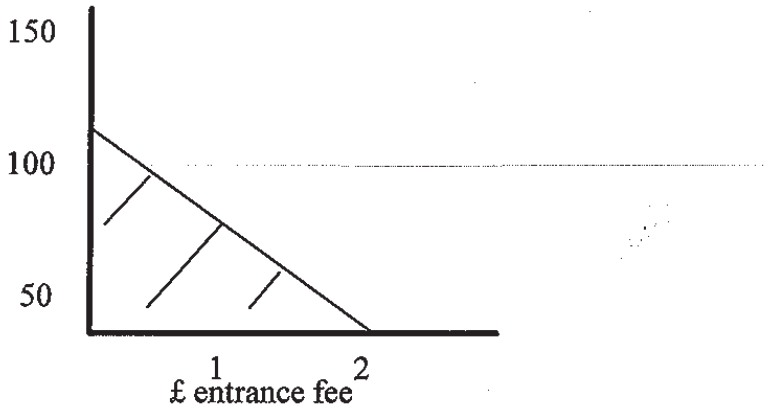
Source: Pearce and Markyanda (1989)

The house price approach has been subject to many criticisms. For instance, as usually applied, it assumes a perfect market in which buyers with perfect knowledge can obtain any combination of characteristics they wish. In that situation, the implicit price of each characteristic would represent the value placed on it by all who trade in that characteristic. At best it can obviously only be used to value attributes experienced in the home, and where people correctly perceive the effect on themselves. Thus it is likely to be more appropriate as a way of valuing noise nuisance than of valuing the health impacts of air pollution. A further problem is that it effectively represents some sort of present value of a stream of future benefits, discounted at an unknown discount rate which may differ from that used in project appraisals.

The Clawson, or travel cost, approach by contrast is only applicable for valuing the benefits of visiting facilities (e.g. country parks, nature reserves, forests, beaches). It relies on estimating a demand curve relating the frequency of visit to the travel cost involved (see example in Table 3). Again there are many practical problems involved, of which the frequent occurrence of multi-purpose trips with no easy way of determining the degree to which the cost is incurred on behalf of any one purpose may be the most prevalent. Again it is a very partial technique; at best it can only measure the benefit from visiting a site rather than the benefit the site may hold in terms of scientific research, in terms of forming the subject of books and films or simply because people are willing to pay to preserve it.

In general then it appears that revealed preference methods are likely to be of value only in measuring amenity values of benefits readily perceived and understood and experienced in a limited number of locations; even there many problems exist. Use of the revealed preference approach might fit well with a policy in which the more complex environmental effects are valued on the opportunity cost approach in accordance with environmental standards.

Table 3
Example of the Travel Cost Approach
Everett's Study of Visitors to Dalby Forest (N. York Moors)



TOTAL WILLINGNESS TO PAY = £103,116 p.a. (+ £10,700 actual revenue), 1976 prices
Source Everett (1979)

b. Stated preference

An alternative to finding markets in which people reveal their valuations by the choices they make is to use surveys to ask them about hypothetical decisions. We shall refer to such hypothetical methods as stated preference methods.

In recent years, stated preference methods have taken over from revealed preference as the dominant method used in overcoming valuation problems in cost-benefit analysis. In some contexts, such as the value of time savings, the reason is simply one of cost-effectiveness. By asking a respondent to choose between a number of hypothetical alternative pairs of options (often 12-16), estimates may be obtained of the relative value they attach to different attributes of the options with much smaller and therefore cheaper samples than if revealed preference data were used, since in a revealed preference survey only one response is obtained per respondent.(An example of a single stated preference question is given in Table 4). Moreover the values in the questions may be framed to yield the maximum information, and problems such as multicollinearity, may be avoided. A second reason for preferring stated preference methods is that uncertainty about perceptions may be reduced by the provision of information; for instance the journey times and costs of the alternative modes (MVA et al., 1987).

Similar stated preference exercises have now become used for valuing the 'human' costs of accidents. As discussed above, accident costs take a number of different forms. Some - damage to property, loss of output, medical expenses - are clearly 'economic' costs, readily valued in money terms. But over and above that there is clearly a desire to avoid the pain and suffering associated with injury or death in an accident that would still exist even if there were no 'economic' loss. Whilst there are circumstances in which this can be valued using revealed preference data, there is always a concern about the respondent's perception of the risks they are running. Thus again stated preference methods have become used in this context (Jones-Lee, 1987). Whilst there may remain concerns about respondent's abilities to answer questions involving changes in very small

probabilities of death or injury in an accidents, such studies do appear to produce consistent results and to have led to a big increase in the values used in practice in Britain (Table 5).

Table 4
EXAMPLE OF A STATED PREFERENCE QUESTION

OPTION A

LONDON, dep	250	320	350	420	450
Stockport...	510	540	610	640	710
Manchester, arr.	520	550	620	650	720

Fares: One way £12, Return £24
Scheduled Journey Time; 2 hrs 30 mins

OPTION B

LONDON, dep	250	•	350	•	450
Stockport...	540	•	640	•	740
Manchester, arr.	550	•	650	•	750

Fares: One way £10, Return £20
Scheduled Journey Time: 3 hrs
Up to 30mins late

In this situation I would:

Definitely Prefer A	[ ]
Probably Prefer A	[ ]
Like A & B Equally	[ ]
Probably Prefer B	[ ]
Definitely Prefer B	[ ]

Source: Fowkes and Nash (1991) P. 44

Table 5
DOT values - average cost per casualty in Great Britain by severity (1985 prices)

	PRE-REVISION	POST 1987 REVISION	POST 1988 REVISION	CURRENT (1994 PRICES)
Fatal	180330	252500	*500000	859100
Serious	8280	13500	13500	89400
Slight	200	280	280	7300

* 1987 prices
Source: Department of Transport

However, stated preference methods also exist in a number of different forms. The one which has become most popular in the environmental field is the contingent valuation method. This actually asks a straight 'willingness to pay' to achieve or avoid some particular result, such as to protect a forest from destruction or to prevent building of a power station in a particular location.(see the example in Table 6). The attraction of this approach is that in principle it can be used to value anything, whether it can readily be quantified or not, whether it has actually been experienced or not. It can estimate not just use values, but option (the value people place on having a resource available in case they want to use it), existence (the value people attach to the existence of a resource even though they never expect to use it) and bequest (the value people attach to being able to make a resource available to future generations) values as well. With the aid of this technique it would appear possible to quantify all the externalities involved in the transport sector.

Table 6
Example of a Contingent Valuation Question

A firm proposes to undertake a major tourist development in your neighbourhood (details are attached). Without the revenue from this development, your local tax bill will have to increase.

What is the maximum increase in taxes you would be willing to pay to avoid the necessity for this development to go ahead?

Source: Adapted from Mitchell and Carson (1989)

But again there are a number of problems. There has been concern ever since the approach was first formulated with the likely biases that may creep in (Mitchell and Carson, 1989). The most important of these may be listed as:

i. Information bias. By providing incomplete or partial information, a biased result may be obtained (whether accidentally or by design)
ii. Strategic bias. We are usually using these techniques to value public goods, and there is a large literature on the incentive people will have to distort their valuations of public goods according to the payment mechanisms they expect to be used.
iii. Instrument bias. People are usually asked their willingness to pay in terms of some particular tax or charge, and their views on whether that particular payment mechanism is fair or not may distort their answer
iv. Starting point bias. If people are simply asked, unprompted, what is the most they would be willing to pay for a particular benefit they find it very difficult to answer. Therefore the interview usually proceeds in the form of a 'bidding game', in which a figure (e.g. £1 per week) is named and then is increased or decreased according to whether the respondent is willing to pay it or not. Starting point bias occurs if the first named figure influences the final outcome.

There is conflicting evidence on the seriousness of all these problems, and in part this reflects the fact that they are likely to be much more serious in a badly designed survey than in a well designed one. But it is also the case that despite the apparent universality of the technique some issues are easier to deal with than others. For instance it is likely to be easier to tackle the preservation of a feature which is well known but about which feelings do not run strong, than either a very controversial issue or one which is complicated and poorly understood. It is also the case that strategic bias is likely to be less severe if the study is seen as a hypothetical academic study rather than part of the appraisal for an actual decision. This means it is easier to research values which may be measured in one location and applied in another than to obtain values for unique assets, such as a particular nature reserve, park or view, which are known to be under threat

c. Opportunity cost

This approach is quite different from both stated and revealed preference approaches in that it does not attempt to estimate willingness to pay for the benefit or to avoid the cost. Rather it asks what expenditure would be needed to offset it. In general the problem with this approach is that if we do not know the value placed by the population on the effect in question then we do not know whether in fact it is worth offsetting it. In some circumstances we may be clear that it is worth while offsetting it (for instance, where air pollution damages a building and it is cheaper to repair it than to replace it, or where it destroys crops and we know their market value is at least as great as the cost of replacing them).

As explained in the previous section, a version of this approach which may more appropriately be termed the opportunity cost approach has become much more common in recent years as a result of two developments. The first is a tendency in the face of uncertainty about the true damage costs caused by different pollutants to adopt a precautionary principle of limiting the level of the pollutant to what is considered a safe level. In this situation, any project which pushes pollution above the limit must be balanced by another (shadow) project to offset this effect. For instance if we are already at the limit and greenhouse gas emissions in transport are to be allowed to rise, then emissions must be reduced elsewhere. In this context, the cost of reducing greenhouse gas emissions elsewhere by one unit becomes the opportunity cost of allowing them to rise in transport. Quantification of this opportunity cost is also not without its problems; strictly it requires examination of all possible ways of reducing greenhouse gas emissions elsewhere in the economy in order to identify the one with the least cost.

d. Indirect methods

Surveys of valuation methods often contrast `direct' methods of valuation as listed above with `indirect' methods generally following on `dose-response' relationships. These estimate the effects of, for instance, local air pollution on health, mortality, crops, buildings etc. Strictly speaking, the dose-response approach is not a valuation technique; these effects then have to be valued using one of the approaches listed above. But the indirect approach appears very much more sensible than a direct approach whenever people are unlikely to perceive or understand directly the effects of the pollution in question.

5. SOME PRACTICAL EXAMPLES OF VALUATION STUDIES.

One of the biggest problems facing work in this area is the fact that different studies tend to come up with totally different results for the external costs of transport. Having discussed the principles, it may be of interest to examine some actual examples of attempts to quantify the external costs of transport to try to understand why these differences occur.

Table 7 shows four recent estimates of the accident and environmental costs of road transport in the UK. It will be seen that Mauch and Rothengatter's estimates are substantially higher than those of Pearce et al, with the biggest difference being in the category of air pollution/climate change.

A detailed examination of the differences makes it clear that there are differences not just of detailed methods but also of principle in the way the costs are assessed. In the case of climate change, for example, Pearce et al rely on studies which have attempted to predict the cost of climate change over the next 200-300 years and thus work out the marginal external cost of the emissions which cause it. Most such studies only examine the effect on Gross Domestic Product, and typically they use results for the USA to generalise to the world as a whole. Generally these costs are found to be relatively small when discounted (even at low rates of discount) and expressed per unit of emissions. According to their methodology, it is only worth incurring a very small increase in costs or loss of benefit from reduced travel to offset the effects of climate change. In other words, according to the results of Pearce et al, climate change should be a very minor consideration in transport policy.

Mauch and Rothengatter adopt a totally different approach. They do not attempt to cost climate change. Rather they take the view that, in the light of the uncertainties involved, the precautionary principle should rule and targets for the reduction of greenhouse gases should be achieved. They select the fairly stringent target of a reduction in greenhouse gas emissions for Western Europe of 50% by the year 2040, this target being met 50% by an equiproportionate reduction and 50% by a move towards an equal emissions allowance per capita. In this case the costs of additional transport emissions of greenhouse gases, in terms of the need to offset these by reductions in greenhouse gas emissions elsewhere in the economy, are very much greater than the direct damage cost estimates used by Pearce et al. In other words, Mauch and Rothengatter are using the standards based approach discussed above rather than a direct attempt to assess the damage caused by global warming. The same issue arises regarding valuation of a number of other pollutants.

The Royal Commission study reinforces the uncertainty by quoting a wide range of figures, whilst that of Maddison et al (essentially the same team as Pearce et al) appears to have reached a consensus with Rothengatter and Mauch at the upper end of the range. However, the consensus is more apparent than real; the main reason why Maddison et al have greatly increased their figures is new evidence on the health effects of small particulate matter from diesel engines; this evidence was not available at the time of the Rothengatter and Mauch study.
Thus whilst there may be problems resulting from different studies giving different results which derive from inadequacies in valuation methodology, many of the differences in this case derive

from a far more fundamental source. The basic issue is whether it is appropriate to seek to value directly effects which may be poorly understood and remote in time, or to derive values which result from an environmental policy which put forward standards in the form of constraints within which conventional economic analysis may proceed. The notion of sustainability as most commonly defined (i.e. seeking to meet the needs of the current generation without compromising the ability of future generations to meet their needs) might be taken, in the face of uncertainty, as lending support to the second view.

It should be noted, however that attempts to value the total external cost of transport are not necessarily very helpful when it comes to pricing and investment decisions. What is needed is the marginal cost in specific circumstances. The cost of noise and local air pollution vary greatly with location and time of day, and the relationship between emissions and social cost is not necessarily linear (for instance, it is generally stated that changes in noise of less than 3 dBA are imperceptible; changes in some pollutants below a safe threshold may involve no cost). Table 7 makes no attempt to value many site specific costs, such as property destruction and visual intrusion.

The most recent attempt to recommend values for the DOT to use in practice (Tinch 1995) was relatively pessimistic. He only felt able to recommend values for noise and local air pollution. Figures for global warming he felt were not robust, and other effects generally had inadequate evidence (Table 8).

Table 7
UK External Costs of Transport, 1991 [units: £ billion]

	Pearce et al (1993)	Maunch and Rothgatter (1995)	RCEP (1994)	Maddison et al (1996)
Year	1991	1991	1994/5	1993
Accidents	4.7 to 7.5	13.3	5.4	2.9 to 9.4
Noise	0.6	3.4		2.6 to 3.1
Air Pollution + Climate Change	2.8	10.3	4.6 to 12.9	19.8
Total	8.1 to 10.9	27.0	10.0 to 18.3	25.3 to 39.3

Table 8
Suggested Values of Environment for use in transport appraisals (£)

	Low	Best Estimate	High
Noise (per dB(A) per person p.a.)	5.50	7.75	10.00
Health Effects of Local Air Pollution (PM_{10}) per gm^{-3} per person per annum (urban)	5.75	11.50	17.25
Global Warming	Estimates not robust		
Land take, visual amenity	Site specific		
Other effects	Inadequate evidence		

Source: Tinch (1995)

6. RELEVANCE OF VALUES FOR PRACTICAL POLICY DECISIONS

In practice, there are two main ways in which valuations of externalities might be used. These are in transport pricing policy and in cost-benefit analysis of transport investments or other transport projects (such as regulatory measures).

In an ideal world, vehicles would be charged in accordance with the externalities they created. This would require a pricing structure in which a price per kilometre was charged which varied with:

a. the characteristics of the vehicle, which determine the noise, emissions, delay to other vehicles and accident risk involved. Strictly these obviously depend not just on the characteristics of the vehicle when new, but also on its condition and the way it is driven; accurate measurement would therefore require continuous monitoring of every vehicle on the road.
b. the characteristics of the road it is being driven on, including physical features (width, gradient, curvature) of the road itself and the surrounding land use (housing, countryside etc.). These again influence both the congestion effects and the environmental impact.
c. the time at which it is being driven (which is important in terms of the degree to which noise is a nuisance) and the traffic conditions on the road at that time.

Such a pricing structure, in which the price per kilometre is adjusted in accordance with continuous monitoring of the location and condition of the vehicle and the road conditions in which it is being driven is currently still in the world of science fiction, although the road pricing proposals recently considered in Cambridge, in which the charge would depend on traffic speeds, would if implemented represent a significant move towards fulfilling it for a particular city. Even if it were technically feasible, one would still need to consider whether it was worth the cost of implementation, and whether people would actually adjust more effectively to a simpler more understandable tariff than one where one would not know the price one was going to be charged for a journey at the time of setting out on it.

What most countries have at the moment is a very different structure consisting of a fuel tax, which may vary with the type of fuel (diesel, leaded/unleaded petrol) and an annual fee which varies with the type of vehicle. Additional tolls may be charged on motorways (where one might expect that typically external costs would be less than on other types of road). This offers some possibility for influencing both the type of vehicle people buy and the extent to which it is used, but can only charge for external costs on the average in each case. The case remains then for using a variety of other means to influence the way in which vehicles are used in specific circumstances. These means might include pricing measures (e.g. electronic road pricing in particular areas, kilometre based taxes using metering of specific types of heavy goods vehicles) and physical measures (bans on particular types of vehicles, parking controls, traffic management). There is no prospect in the foreseeable future of being able to handle transport externalities solely through pricing measures even if that were clearly seen as the most efficient approach. Nevertheless, having information on the value attached to the externality in question is

an essential element in the appraisal of any measure to overcome the problem of transport externalities.

Suppose that it is accepted that, even with the existing pricing instruments at the disposal of governments, the combined sum of fuel taxes and annual licence duty should at least equal the sum of relevant marginal costs incurred by the road authorities and marginal external costs for each individual vehicle type. There is generally no agreement even on the direction of movement of individual prices required. The British government for many years argued that, by ensuring that taxes for each vehicle type cover the road provision costs allocated to that type, with a margin ranging from some 30% for the heaviest goods vehicles to 100% for cars and light vans, it is ensuring that no vehicles are undercharged, whilst some are making contribution to tax revenue considerably in excess of the relevant costs.

However, the methodology used in this comparison is simply to take the total capital and current expenditure on roads and to allocate it between vehicles on a 'fair' basis. The inclusion of capital costs suggests that if this procedure has any economic significance, it must be as some form of long run costing. However, simply allocating capital expenditure (in fact a 3 year moving average is used), rather than making some estimate of depreciation and interest on capital, is an unusual and unjustified approach. The British government has now withdrawn this methodology and is in the process of examining alternatives. When Newbery (1988) explored alternative long and short run marginal cost pricing approaches using data from the mid-1980's, including accident externalities but not environmental costs, he concluded that all types of vehicle were being undercharged, the surplus on cars revealed by the Department of Transport approach being offset by allowing for their disproportionate use on congested urban roads (Table 9). Including of environmental costs would obviously add to this discrepancy. Similar debates about the methods used to allocate the costs of road provision and maintenance to vehicles are to be found in many other countries around Western Europe, with the road lobby arguing that motorists are already paying a surplus more than sufficient to cover any environmental costs.

Table 9

Relationship between road taxes and road costs by vehicle class in Great Britain 1986

Vehicle Class	Road taxes	Road costs including accident	Ratio of tax/cost including accident
Motorcycles	65	748	0.09
Cars, light vans	8260*	10129	0.82
Buses and coaches	50**	604	0.08
LGVs	65	609	0.11
HGVs	1320	1833	0.72
Total	9760	13973	0.70

* Includes car tax of £980 mn.

** Includes fuel tax rebate on stage services of £125 mn deducted

Source: Newbery (1988)

If the application of money values of externalities in pricing is not straightforward, what about the position regarding project appraisal? The current position in Britain is that environmental effects of road building are not explicitly valued in money terms, but are considered along with those items (construction and maintenance costs, operating cost savings, time savings and accidents) in a table of impacts based on that originally recommended by the report of the Advisory Committee on Trunk Road assessment back in 1978, and still often referred to, after the Chairman of that committee, as the 'Leitch framework'. Some idea of the range of effects taken into account in this approach is given in Table 10. This permits the full consideration of local environmental impacts (regional and global effects are not considered) of a particular road scheme when the individual decision is taken. But because the formal cost-benefit analysis is undertaken excluding valuation of environmental impacts, it does not contribute to more strategic decisions about road investment. Benefit cost ratios for individual schemes are quite misleading as a guide to the extent to which resources should be diverted from elsewhere in the economy into building roads, partly because of the omission of environmental costs but also because they are assessed as the rate of return on short stretches of new road and on the assumption that traffic growth is going to be allowed to continue at a substantial rate - i.e. they fail to look strategically at alternative policies for corridors or areas as a whole.

Given the above discussion of the difficulties of environmental valuation, would the introduction of money values for environmental effects in investment appraisal be beneficial? (This issue was discussed by the Standing Advisory Committee on Trunk Road Appraisal (SACTRA, 1992). In favour of such a move would be the fact that it would permit a more accurate assessment of the overall rate of return on road building to be assessed; that it would ensure that regional and global environmental externalities were taken into account as well as local, and that it would promote clarity and consistency at the level of decisions on individual schemes. Against it are the arguments that environmental valuation remains very uncertain, that as we have seen above there is no consensus even about the basic principles on which it should be based, and that it is usually incomplete. At the project appraisal level, valuation of local environmental effects is particularly problematic, in that it is dealing with the value to be placed on particular assets such as parks, buildings and the aesthetic amenity of the townscape or landscape.

If values for factors which are, in principle, readily measured such as noise and air pollution are to be used in pricing decisions - and arguably here there is no choice - then there seems no good reason not to use them in project appraisal as well. What is of more doubt is whether it makes sense to introduce values of unique local features into project appraisal. But it must always be remembered that if this is not done, then any benefit cost ratios quoted are incomplete and misleading.

7. CONCLUSION

The orthodox view of transport externalities is that they are a relatively simple case of market failure, to be resolved by valuing them in money terms and charging a tax which will lead decision takers to place appropriate weight on them when making transport decisions. In reality the position is much more complex than this. Firstly we have found that there is no consensus on

the principles that should be used in environmental valuation, and in particular on when it is appropriate to use willingness to pay type measures and when opportunity cost derived from environmental standards. Secondly we have found that even if there is agreement in principle existing methods of valuation are not adequate to reliably value all the relevant externalities. Thirdly we have found that it is not possible actually to devise pricing structures which fully reflect the way in which external costs vary across vehicles, times and places.

Does this add up to a conclusion that, in practice at least, monetary valuation of environmental externalities does not make sense? In the view of the current author, the answer is no. Both in pricing decisions and in the cost-benefit analysis of alternative projects and regulatory measures, a view has to be taken on how much it is worth paying to avoid particular external costs. Although existing methods are not capable of producing a definitive answer to the issue they do provide guidance. They should be used, but they should be used in the context of a full understanding of their limitations and of the controversies which remain, and in particular in the context of clear and explicit statements on the crucial issue of the degree to which environmental standards are seen as more appropriate than willingness to pay type studies as an approach to valuation.

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