

The Road from Inequity
Fairer Ways of Paying the True Costs of
Road Transport

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1. Why we need to get a grip on road costs

An issue of the moment

Transport policy is currently centre-stage in public and political debate. Attention will become more intensely focused as a key function of the London Mayor and as a prominent issue in the general election that is expected within the next eighteen months.

The strategic role of transport in supporting a prosperous economy is widely recognised. Road transport in particular has enabled people to realise their own potential due to vastly improved and more flexible mobility.

These benefits have, however, come at a significant price. Growing levels of road traffic increase congestion: lengthening and reducing the predictability of journey times, raising businesses costs, damaging health and the environment and reducing the vitality of urban centres. What is to be done about it?

Road charging and the information gap

In response to a growing consensus for change, the Government published its White Paper *A New Deal for Transport* in July 1998. This paper brought forward for debate suggestions that would lead to a more integrated transport system that would be clean, safe and efficient.

Central to this aim is the proposal for **road user charging**, set and controlled by local authorities on the condition they reinvest the revenue in improving the local transport environment and the quality, availability and reliability of public transport services. The intention is to promote the sensible usage of cars by facing motorists with the real costs of road use; for the current system of flat rate taxation neglects the fact that road users inflict different degrees of costs depending on where and when they drive their vehicles.

To be credible, however, point-of-use charging requires a realistic assessment of the social costs, so that people can see some clear relationship between what they pay and the cost of the resources they consume or the costs they impose on others. The Department of Transport, Environment and the Regions stated in its recent report *Transport and the Economy* that:

'There are no up-to-date official estimates of the relationship between the price (including tax) and the marginal social cost of urban, inter-urban and rural road use. This gap needs to be filled in order to provide a basis for assessing the

future trajectory of taxes and marginal social costs both at current levels of road capacity and allowing capacity to change in a socially optimal manner as demand changes.'

This report aims to fill that gap by collecting a wide range of current evidence and collating it into a balanced view of the social costs of road transport. Such a task has required us to conduct some innovative analysis on the link between marginal social costs and taxation across different road user categories, which should make the report an invaluable aid to both policymaking and public debate.

To summarise: in order to get road transport policy right, the combined package of taxation and charging must be set at the correct level. This paper offers the background necessary to do so.

2. Economic costs to society of roads in the United Kingdom

Road users currently inflict economic costs on society through road accidents, noise and air pollution, and congestion. Rigorous examination of the costs imposed by different categories of road users is necessary if we are to have an informed debate about road transport policy and reflect these costs more accurately in our road and transport taxation and charging systems.

This section summarises our findings and the conclusions derived from them. Readers requiring a more detailed description of the issue of social costs, the approach to valuing such costs and a breakdown of how the figures were derived should consult the *Detail* sections below.

The balance of cost

To get the policy balance right, it is important to compare the costs that road users inflict on society with the benefits they return to society in terms of the tax they pay for road use — a comparison between what road users pay to the social ‘kitty’ and what they take away through imposing economic costs on society.

In 1999 road users paid around £32 billion in total road taxation, which includes fuel duty, vehicle excise duty and VAT. In the same year total road expenditure was close to £6 billion, representing an apparent surplus of over **£26 billion** that would seek to be siphoned off into general Government revenues.

While motoring groups complain about this as ‘highway robbery’ or ‘milking the motorist’, this revenue surplus can equally well be viewed as compensation paid to society for the damage caused through noise, air pollution, congestion and road accidents. Road users are therefore paying not only enough to cover the costs of supplying and maintaining roads, but also enough to reflect these wider costs and to support health, public transport, and other social services.

Broad findings

But is the balance about right? Or are motorists correct that they are paying too much and the government is using them as a convenient milch cow to sustain its other public services?

Our broad findings on this question are displayed in Figure 1. They derive from our detailed review and analysis of current academic literature and statistical research, and show the economic costs borne by society (in 1999) as a result of road use.

Figure 1. Aggregate social costs of road transport in the UK, 1999

Cost element	Estimate, £b (1999)	% Total
Congestion	18	72
Accidents	3	12
Air pollution	3	12
Noise pollution	1	4
Total	25	(100)

The estimates that we have settled on are *ex-post* — ‘after the fact’ — valuations of what congestion, accidents, noise and air pollution costs society in economic terms last year. This is distinguishable from *ex-ante* — ‘before the fact’ — values of what it would take to avert these costs, which is the normal basis of social cost estimations. This issue is discussed in further depth in our section *Detail 2*. Estimates of the value of prevention of social costs tend to be a good deal higher and therefore the figures provided by this report can be considered fairly conservative estimations.

The estimated aggregate social cost of road transport in 1999 was **£25 billion**. At the 1999 level of road usage this was equivalent to **5.4 pence per vehicle kilometre** (the cost of an ‘average’ vehicle driving one kilometre).

This figure is very similar to the level of revenue surplus in 1999, suggesting that there exists a fair balance, on aggregate, between what road users give and what they take from society. This implies that, **on average, road users pay the right level of taxation** to compensate for the costs they inflict on society as a whole. However, the situation is not so balanced if one looks at different categories of road users, and on closer inspection we find that **certain categories of road users pay far too much or far too little**.

Who, what, where?

Figure 1 indicates that **72% of the ‘true’ costs of road use are due to congestion.**

Blockages in the flow of traffic are largely confined to urban areas and thus urban road users are likely to be responsible for most of road transport social costs. Cars moving slowly in congested traffic also emit more pollutants per kilometre travelled and therefore create higher air pollution costs. Although this conclusion is directionally robust from Figure 1, a deeper understanding of the cost differences between different road user types and road vehicle types is necessary if road charging or tax policy is truly to reflect the costs that each sort of road user imposes on society.

A particular innovation in what we have done here is to bring together in a coherent framework the work that has been done on attributing these costs to different users. So far, there has not been a disaggregated general estimate of the total social costs of road transport. By reviewing the more detailed evidence and applying the derived weightings to the global figures estimates in Figure 1, we have been able to allocate costs between road users of different kinds.

The scarcity of reliable data limited the scope of this investigation to private cars and heavy goods vehicles (HGVs), but that does not significantly reduce the value of the analysis for policymaking purposes, since between them, these two vehicle types accounted for 90% of traffic in 1999.

For each vehicle type, social costs were broken down into six further categories of road users: rural, motorway, urban non-central peak and off peak, and urban central peak and off-peak.

Figure 2 gives the social costs of car usage, on the assumption drivers are using unleaded petrol. Figure 3 provides the true costs of heavy goods vehicle use, on the assumption that drivers use diesel fuel. These figures represent the costs of the respective vehicle use on a per-kilometre basis.

Figure 2. Social costs of petrol cars use by road user type (pence/km, 1999)

Road user type	Noise pollution	Air pollution	Accidents	Congestion	Total
Motorway	0	0.38	0.11	0.30	0.79
Rural	0	0.38	0.4	0.05	0.87
Urban non-central off-peak	0.22	0.8	0.52	10.1	11.6
Urban non-central peak	0.22	0.8	0.52	18.3	19.8
Urban central off-peak	0.22	0.8	0.52	31.8	33.3
Urban central peak	0.22	0.8	0.52	41.9	43.4

Figure 3. Social costs of diesel HGV use by road user type (pence/km, 1999)

Road user type	Noise pollution	Air pollution	Accidents	Congestion	Total
Motorway	0	0.53	0.04	0.6	1.17
Rural	0	0.53	0.15	0.1	0.78
Urban non-central off-peak	0.63	2.0	0.17	20.2	23
Urban non-central peak	0.63	2.0	0.17	36.6	39.4
Urban central off-peak	0.63	2.0	0.17	63.6	66.4
Urban central peak	0.63	2.0	0.17	83.8	86.6

These estimates are undoubtedly rather crude, but even after allowing for possible errors in estimation, Figure 2 and Figure 3 demonstrate that significant differences exist in the costs imposed on society by various road user types.

To obtain these estimates it has been necessary to make a few assumptions, which are outlined in further depth in our section *Detail 7*. Broadly speaking, however:

- Congestion is the only social cost that has been adequately broken down within the urban road user group. For the other costs, the same relationship has been applied to all urban user groups. We have assumed that heavy goods vehicles have a congestive effect twice as large as passenger cars.
- Estimates for air pollution costs were only available for urban and rural road users by fuel type. Motorway use was assumed to create an equal level of pollution costs as rural use on the premise that population density is low around both road types. This assumption neglects the relationship between vehicle speed and exhaust emissions. Evidence points to an inverse relationship between the two up to a certain speed, after which emissions increase with speed. This would lead one to believe that off-peak urban users and motorway road users create higher pollution costs than rural users. Figures 2 and 3 do not reflect this fact because doing so would involve placing a 'guesstimate' on the various costs of pollution in different road user groups. Considering the negligible effect that any realistic adjustment in these figures would have on the overall social cost allocation, we have chosen to stay with the published academic research.
- Noise pollution estimates assume that noise damage is an urban occurrence, on the basis that it only affects those areas with high population density near busy roads.
- Accident costs were obtained from the DETR. The proportion of road accident insurance claims made by cars and HGVs drivers were taken to be representative of the breakdown of accident occurrences between vehicle types.

Wide differences in costs imposed

These figures draw attention to the vast array of costs inflicted by road users depending on when, where and what they drive. For example, a heavy goods vehicle driving through an urban centre at peak times would inflict a cost to society equivalent to 87 pence for every kilometre it travelled. On the other end of the scale a private car travelling through the countryside will only cost society approximately 0.8 pence a kilometre. A social cost differential of over 100-fold!

Comparing costs against the overall average further highlights this cost differential and reveals how inadequate it is to compare aggregate social costs against the £32 billion aggregate revenues from road-user taxation as the basis for public policy.

Figure 4 identifies on an indexed basis the costs imposed by private cars, which account for over 83% of vehicle-kilometres driven. The table also includes the level of costs per kilometre compared with the excess taxation paid, providing an estimate of the level of 'social balance' for different road user types. Clearly, urban road users are paying too little in relation to the costs they impose and rural road users are paying a far greater amount than would be justified by the social costs created. Figure 4 offers an

approximation as to the extent that motorists in different areas are in either a deficit or surplus with society.

Figure 4. Social costs in relation to excess taxation paid by road type

Road user type	Marginal social costs Index (av = 100)	Under- or over-payment in relation to social costs (p/km)
Motorway	14.6	4.81
Rural	16.1	4.73
Urban non-central off-peak	214.8	-6.00
Urban non-central peak	366.7	-14.2
Urban central off-peak	616.7	-27.7
Urban central peak	803.7	-37.8

As stated earlier, the average taxation paid in excess of government road expenditure was £26 billion, equivalent to 5.6 pence per kilometre in 1999. On that basis, rural road users were overcharged 4.81 pence per kilometre driven too much, whereas urban central peak users were undercharged 37.8 pence.

Although these figures are rough estimates, they offer compelling evidence of the imbalance that exists in the social costs imposed by different road users. They suggest that ***rural road users currently pay nearly seven times too much in terms of excess taxation when compared with the social costs they create.*** Consequently they appear to be subsidising urban road users who are creating social costs between two and eight times the level of taxation they pay.

Other costs?

We have focused on discussing the costs to society in terms of road accidents, air and noise pollution, and congestion. These four costs are not the only costs society bears as a result of road transport, of course: in particular, much of the academic research on road transport costs has included an estimate for the damage costs of *global warming*.

We have not included global warming for the following two reasons. Firstly, economic evidence does not conclusively point to global warming causing a net negative effect on global output. Whatever other concerns there might be about global warming, it is only the *economic* effects that we are seeking to balance off here. Secondly, estimates suggest that the cost of road transport emissions of greenhouse gases is likely to be insignificantly small.

The *damage* that occurs to roads as a result of excessive use is also often included as a specific item in social cost estimations. Our approach, however, is to regard this cost as reflected in the size of road-repair budgets, and thus accounted for within national and local government expenditure on roads.

Other social costs which cannot be quantified due to the lack of availability of data, include *community severance, vibration, soiling of buildings and visual intrusion*. Again, however, it seems more than likely that these costs will be concentrated in urban areas rather than in rural ones, which would only add to the existing tax/cost imbalances that we have already identified.

3. Implications for government policy

As we have seen, when the available evidence is pulled together, it appears that last year (1999) **road transport cost society £25 billion in terms of congestion, air and noise pollution and road accidents**. This level is quite close to the total tax revenue that is raised from road users, net of expenditure. Hence, at the aggregate level, it would seem that road users on average pay enough in taxation to compensate the costs incurred by society.

However, our more detailed scrutiny of the evidence reveals that there are big differences in the costs of road use that depend on (among other things) where they occur. This means that **comparing the aggregate totals for tax revenues and social cost estimates is an entirely inappropriate basis for road user taxation or charging**.

Nowhere is this more true than in terms of congestion. Figure 1 shows that of the total social costs, **£18 billion** is attributable to congestion. With congestion mainly an urban occurrence and pollution costs likely to be worse in built-up areas (along with lower travel speeds), Figure 1 leads one to believe that urban road users are responsible for most of the costs borne by society. This is confirmed by Figure 2 and Figure 3, which offer powerful evidence of the discrepancies that exist between different types of road user and the costs which they impose. Even allowing for a large margin of error, these two figures suggest that **a social cost differential of up to 100-fold exists between rural car use and urban peak-time heavy goods vehicle use**.

Congestion as the main basis for road user charging

All three figures draw attention to the significant economic burden that congestion is to society. Importantly, congestion costs are likely to continue rising with increasing traffic levels, car ownership and GDP. The other social costs are predicted to either stabilise or decline with improvements in safety standards, stricter noise and air pollutant emission standards and advancing fuel and engine technology. The result is not only a rise in the real costs of congestion but also a rise in the proportion, within overall social costs, that congestion represents.

The probable consequence is that the costs to society of congestion will rise above inflation, with the real cost of congestion increasing as a percentage of GDP.

The rising dominance of congestion costs within overall social cost suggests a growing need to incorporate the costs of congestion into road transport policy — perhaps even to make it the central factor in taxation or pricing, since the evidence tells us strongly that:

- road users are highly differentiated by where, when and what they drive in terms of the social costs they create;
- rural road users currently pay significantly more than the costs of supplying and maintaining roads and the costs they impose on society; and
- urban road users, especially at peak times, are presently paying less than is justified by the social costs they create.

These factors suggest an urgent need for reforming the way in which we charge people for road use. For policy purposes, it may well be impractical to differentiate road users as finely as we have done in the cost tables above. However, some element of point-of-use charging would allow us to introduce a much fairer system of road user payments. Since most of the social cost occurs in urban setting, urban road pricing would offer several benefits:

- a reduction in the level of congestion in urban centres would reduce business costs, shorten journey times, and increase the reliability and predictability of bus and private car journeys;
- the reduction in traffic flow and the resulting increase in vehicle speed would reduce the damage done by vehicle exhaust fumes on human health; and
- a correction of the current imbalance between rural and urban road user payments.

Because it properly reflects the various social costs that we have identified above, road pricing can be presented as a fair, revenue-neutral solution to tackling congestion and reducing pollution. The revenue contribution of urban and rural road users would be more fairly distributed. Urban charges could be set at a level that reflected the economic damage of congestion and other social costs caused by urban road users.

Separating taxation and charges also allows a more visible system of payments whereby road users are aware of what the use of roads costs society and change their patterns of use accordingly. By increasing the price of urban road travel there will be a reduction in demand to levels that more rationally reflect the scarcity of surface space. More generally, incorporating social costs into road pricing would encourage people to use cars in a socially responsible manner.

So what basis for taxation?

For road charges to be accepted as fair, they must be accompanied by reform of the current road taxation system. As purely an extra revenue-raiser they would be publicly unacceptable and would not be fair to either rural or urban road users.

To the Government, however, the advantage of today's flat-rate taxation system is its ease of collection and of administration. It would be impractical to differentiate fuel and vehicle taxes on the basis of where or when people actually use their cars. It might just be feasible to differentiate a little on the basis of where the vehicle owner lived or where fuel was bought. But that would not reflect where and how the vehicle was used and thus where and what scale of social costs it really imposed: someone who lived and filled up in a rural area but who drove into town to work each day would not be paying for the congestion, pollution and risk of accidents attributable to them.

One solution might be to set flat-rate taxes at a level reflecting the public expenditure on the road system plus the social costs attributable to rural and inter-urban road use; with urban point-of-use charging to reflect the higher social costs arising from road use in towns. Then the flat-rate tax would be as easy to collect as it is today, while point-of-use charging could be confined, manageably, to urban areas.

To give a simple example, roads expenditure last year was in the region of £6 billion and the total tax take was £32 billion. Setting flat rate national taxes based on roads expenditure plus a reasonable amount to reflect rural and inter-urban social costs (at 2p per kilometre) would bring total taxation revenue to £16 billion. Urban point-of-use charging could then be responsible for collecting the other £16 billion (after the costs of installing and running road pricing schemes have been deducted). In broad terms, this would require charges equivalent to 3.5 pence per urban kilometre.

This would result in rural users paying roughly 3.5 pence a kilometre and urban users paying 7 pence. These are of course only average figures, and in reality the taxation element, and possibly the charging element, would be differentiated by vehicle types, as occurs in the present system of vehicle taxation.

Results of the system

Such a system would more closely (though by no means perfectly) reflect the costs imposed by different kinds of road use. However, to achieve other policy objectives, such as reducing demand sufficiently to provoke a sharp fall in congestion and pollution, higher charges may be needed, particularly in the London area.

Of course, urban users will object to paying more and therefore, as a matter of political practicality as much as of justice, it is necessary to have in place a viable public transport alternative for them.

With such infrastructure in place, incorporating road user charging into the system of road payments would offer a win-win situation. Rural users will pay less to use roads that they are more dependent on; urban users will pay for the costs they create and in doing so benefit from faster and more predictable journey times and lower pollution. The Government, meanwhile, will maintain an important source of revenue.

Detail 1. External costs and road network efficiency

External costs

Congestion, air pollution, road accidents and noise are all costs that society as whole bears as a result of the usage of roads. These are real resource costs that are not faced by motorists and are thus known as 'external costs'. They are also referred to as 'externalities' — an abbreviated form of 'external economies'. Such costs are 'external' to the decision making process of motorists and therefore do not affect their demand for road usage. But of course it is others who suffer the brunt of these costs: drivers are not likely to be very sensitive to them in terms of their decisions about how, when, and where to travel across the road network, and they will tend to use road space more intensely than is optimal.

Efficiency of road resource allocation

To the economist, an efficient allocation of road resources requires that the costs of each additional road user (known as the marginal costs) be equated with the benefits of each additional road user (the marginal benefits) and equal to the price. When this occurs consumption will be at an optimal level. When external costs exist, however, the divergence between private and social marginal costs creates a resulting divergence between the levels of consumption that are optimal from society's point of view and the levels that are privately optimal — an inefficient allocation of resources known as 'market failure'. With social costs not fully reflected in the direct cost of using a vehicle, road users are effectively gaining from consuming a scarce resource (road space) at a discounted price. If the external or social costs were fully included in the price faced by motorists, then they would then reduce their consumption of road space accordingly.

As we have seen, road users are highly differentiated with regard to the level of external or social costs they create. Rural motorists are paying a price below marginal social cost (MSC) levels, urban users a price in excess of MSC. With urban prices therefore failing to reflect the underlying scarcity of road space, over-consumption of urban road space is occurring, which would justify some future intervention to improve the efficiency of the use of the urban road network. Hence the purpose of this report: to clarify the extent of the external or social costs of road transport. As the Department of Transport, Environment and the Regions (DETR) stated in *Transport and the Economy*:

'In order to move towards a more efficient allocation of resources in the economy, using, where appropriate, measures to reduce traffic, it is important

to have a robust understanding of the size of the external costs of road transport where these arise.'

Detail 2. Quantifying external costs

- ex-ante versus ex-post

To obtain a valuation of external costs, two fundamentally different approaches can be undertaken.

Ex-ante

The *ex-ante* valuation of an externality is the future economic benefit that would be obtained by avoiding the creation of such costs. This is measured mainly through the 'willingness to pay' approach, which measures the amount of money members of society as a whole would be prepared to part with in order to remove the external costs – for example, how much people are willing to pay to avoid the risk of being in a road accident. *Ex-ante* valuations are therefore used in social cost-benefit analysis when deciding how to allocate investment funds, for example, in deciding the level of funds to be directed into road safety measures. When applied to the valuation of external costs they thus measure the 'before the fact' economic benefits that would be obtained from prevention. Unfortunately, values based on 'willingness to pay' (wtp) will vary with income. Consequently, an individual with a higher income will place a greater value on their life than someone who earns less. With 'willingness to pay' translating into 'ability to pay', obvious moral and ethical issues are raised. Whilst willingness to pay figures are useful in cost-benefit analysis as they take into consideration personal factors such as suffering and grief, they *do not* represent the economic costs resulting from the externality.

Ex-post

While *ex-ante* approaches estimate the value obtained by preventing future external costs, *ex-post* approaches do the opposite and place an 'after the fact' economic value on the economic damage that resulted from the externality. *Ex-post* approximations include both the direct economic costs of damage created by the externality — for example, the cost of hospital treatment for victims of road accidents — and the indirect cost of reduction in economic output resulting from externalities. This approach is often criticised as it neglects elements of human suffering.

Our view is that the external costs of road transport are best reflected in *ex-post* valuations, which provide a more authoritative estimation of the economic costs of road transport. This method must, of course, come with a health warning. What it measures is the economic cost of externalities in the past, not the social benefits that any future investment will bring. Such a

confusion would lead to considerably too little investment into such measures as pollution control and road safety.

Detail 3. The economic costs of road accidents

Accident trends

- In 1998 there were 3,421 fatal road accidents, 40,834 serious injuries and 280,957 slight injuries (DETR, 1999). This means that, ***on average, an accident of at least slight severity occurs every 97 seconds.***
- The 1998 statistics represent a mere 1% rise in the total number of accidents affecting all road users since the first half of the 1980s. However, the severity of those accidents has changed. Over the same period, ***the number of fatal accidents has dropped by 39%, and there are 45% fewer serious accidents.*** However, ***slight injuries now occur 16% more often*** — and due to the much higher number of these incidents, the total number of casualties thus stays relatively stable.
- The reductions in fatal and serious road accidents have been achieved despite a ***55% increase in total kilometres driven over the last 15 years.***
- Interestingly, ***the number of accidents casualties suffered by men over 17 has fallen by 6.6%, whereas there are 28% more accidents involving females over 17*** in the same period. This is largely due to an increase in the number of females holding driving licences and an increase in distance driven by female drivers.
- ***The 15-59-age group accounts for 76 % of all casualties***, children make up 14% and the over 60-age group 10% of all casualties in 1998. The elderly, however, constitute 25% of fatal injuries.

Figure 5. All casualties in the UK, 1998 compared to 1981-85 yearly average

Severity	1981-1985 average	1998	% Change
Fatal	5,598	3,421	-38.9
Serious	74,534	40,834	-45.2
Slight	241,787	280,957	16.2
Total	321,919	325, 212	1.0
Vehicle-km rate ¹	2,986	4,634	55.2
Casualty rate ²	108	70	-34.9

¹ 100 million-vehicle kilometres

² Per 100 million vehicle kilometres

Source: DETR

Figure 6. Casualty percentages by age group, 1998

Severity	Children <15	Adults 16-59	Adults >60
Fatal	6	69	25
Serious	14	71	15
Slight	13	76	11
Overall %	14	76	10

Source: DETR and our calculations

External costs of accidents

External costs arise from road accidents as a result of vehicles flowing along the road network, creating the possibility that fellow road users, cyclists and pedestrians will become involved in an accident, either fatal or non-fatal. The components of accident costs include:

- the human costs of injury or fatality; including pain, suffering, grief, value of lost life for fatalities;
- lost productive capacity and value of lost time;
- material damage;
- medical costs; and
- administrative/police/emergency-service costs.

In 1998 the DETR placed an average value on the prevention of road accidents, with both a cost per casualty and a cost per accident. The former represents human values whereas the latter also includes non-casualty-specific *ex-post* costs such as medical, police and insurance costs and property damage. The total cost-benefit value of accident prevention in the UK was placed at £15.962 billion, with £11.493 billion attributable to casualties and £4.469 billion attributable to damage only accidents where there was no personal injury. The value obtained for a prevention of a fatality is based on the 'value of a statistical life' technique, using the extensive work carried out by Jones-Lee in this field.

As previously mentioned, our approach here is to argue that *ex-ante* valuations are inappropriate when aiming to obtain an estimate of the economic costs of accidents. The figures above describe the value of preventing road accidents and are thus used in cost-benefit analysis to allocate investment funds: instead, we emphasise the economic costs to society of road accidents, and this must be measured by examining what the economic impacts of accidents were in the past. Again, it is vitally important to use *ex-post* figures with a strong health warning; **they do not measure the benefits of reducing the risk of accidents** and no suggestion is made in this report that they should be used for cost-benefit analysis. Doing so would undoubtedly lead to under-investment in measures to increase public safety.

The above figures can, however, be used to obtain an *ex-post* valuation of the cost of accidents. The DETR figures provide an estimate that includes a value for personal injury, the direct costs (medical, ambulance, police) and the indirect costs (lost output). In order to obtain *ex-post* estimation, the direct and indirect costs of accidents are taken, but not the values of personally injury. The latter is not included, as it does not represent an economic cost to society. The *Highways Economic Note, 1998* provides the figures for these *ex-post* costs in 1998, displayed in Figure 7.

Figure 7. Elements of accident costs (£ million, 1998)

Accident Severity	Lost output	Medical and ambulance	Police	Insurance administration	Total
Fatal	1,250	20	4	1	1275
Serious	570	340	6	4	920
Slight	390	160	7	20	577
All accidents	2,210	520	30 ¹	140 ¹	2,900

¹Total includes damage only accidents

Source: DETR, 1999

Accidents that do not involve personal injury also involve police and insurance administration costs so these are included as *ex-post* costs. The material damage of accidents is not included due to mandatory third party insurance. It does not represent an additional cost to society of road accidents, but the administration and processing of insurance claims is included. Updating these figures in line with nominal GDP growth suggests that **the aggregate level of the external costs of road accidents was £3 billion in 1999.**

Detail 4. The economic costs of air pollution

Concern over the level of air pollutants and the health risks associated with them have been growing steadily, especially in urban areas. This is largely due to media coverage of scientific findings, although the public in general remain unsure of the extent to which road vehicle emissions of air pollutants actually harm health or damage the environment. Many people are also unaware of the reductions in emissions that have resulted from the adoption of stricter emission standards on motor vehicles. Air pollution has numerous negative effects on the surrounding environment and inhabitants. These include damage to human health, vegetation, buildings and animals. Economic research has concentrated on the effects of air pollutants on human health, largely because of the impracticalities of estimating the other costs and the prime importance on human health concerns.

The declining trend in vehicle exhaust emissions

As mentioned above, as a result of stricter emission standards, improved vehicle technology, higher fuel quality, vehicle inspection and maintenance programmes, emissions of the main pollutants are estimated to have fallen by between 50% and 70% in the last decade, despite a 20% growth in traffic over the same period (AA, 1999). These initiatives have been successful at tackling the problem directly at its source. Emissions are set to further decline with the rewards of technological advancements and will be further enhanced if more is done to reduce congestion on the road network.

Table 8 contains a full list of the main pollutants emitted in fuel exhaust fumes and gives the percentages of total emissions that road transport is responsible for. The external costs of air pollution are highly location specific with more damage occurring to human health when pollutants are emitted in densely populated areas. Unfortunately, air pollution from motor vehicles results in mainly low-level urban emissions, creating more damage to human health than an equal quantity of pollutant emitted from a high level non-urban source, for example industrial smokestacks.

Table 8. Contribution of road use UK air pollution (1997)

Pollutant Emissions	% National Emissions	% London Emissions
Benzene	65	82
1,3 Butadiene	77	97
Carbon Monoxide	75	97
Lead	61	n/a
Nitrous Oxide	48	75
Particulates (PM ₁₀)	26	78
Sulphur Dioxide	2	23
Volatile Organic Compounds	30	60

Source: DETR/NETCEN, 1997

Table 8 provides both the percentage of overall emissions and the percentage of emissions in London resulting from road transport. Vehicles account for 26% of overall national emissions of particular matter yet are responsible for 78% of London levels. Almost all emissions of carbon monoxide, considered to be very harmful to human health, are due to road transport; highlighting the need to reduce the level of vehicles concentrated in urban areas. The reduced speed of traffic results in more emissions per kilometre travelled; a car moving at 15mph will emit 20% more pollutants than one travelling at 40mph.

The Committee on the Medical Effects of Air Pollution (COMEAP) conducted a groundbreaking study into the effects of air pollution on human health for the Department of Health. The report found no evidence to suggest that healthy individuals suffer health detriment as a result of local air pollution at current levels in the UK. However, it did conclude that air pollution may bring forward 12,000-24,000 premature deaths in susceptible people, the main culprit being particulate matter (PM₁₀), estimated to be responsible for 8,100 premature deaths annually. Figure 9 provides details of the incidence of premature death that results from vehicle exhaust emissions.

Figure 9. Premature mortality resulting from road pollution, 1998

Pollutant	COMEAP Report
PM ₁₀	2,025
Sulphur Dioxide	1,129
Nitrous Oxides	5,356
Volatile Organic Compounds	2,313
<i>Total</i>	<i>10,823</i>

Source: Department of Health, 1998L Extracted from the Committee on the Medical Effects of Air Pollution (COMEAP).

On examination of the COMEAP report, the evidence available points to a central estimate that ***the social cost of air pollution on human health is around £3 billion***. This figure is likely to fall in the future taking into account the declining emissions of air pollution from vehicle exhaust.

Detail 5. The economic costs of noise pollution

Pollution of the acoustic environment is associated with busy roads in residential areas, causing aggravation to the people who are exposed to it. Annoyance is not the only consequence; disrupted sleep through exposure to high levels of noise has implications on human health and workers' productivity. One study discovered that the number of prescriptions, people attending psychotherapy sessions and people taking sleeping pills or tranquillisers are all higher in areas which are consistently subjected to noise pollution (Button, 1996). The World Health Organisation considers noise levels over 65 decibels to be obtrusive, and estimates that 19 % of the UK's population is exposed to daytime road traffic noise levels above this standard.

Evaluating noise pollution as an external cost

As the social costs of noise damage of motoring are not included in the costs drivers face, they are considered external. *Ex-ante* approaches to estimating the economic costs of noise pollution are largely based on what is known as the 'hedonic pricing' technique. This enables a value to be placed on a resource that is not openly traded in a market; the resource under consideration here is unobtrusive ambient noise levels. The technique involves linking the environmental resource to a proxy commodity that is traded in markets. For noise pollution the link examined is that between noise levels and house prices. A cost value is thus placed on noise pollution by determining how much it depresses house prices, given that other variable factors are fixed. A study by Lambert et al (1986) resulted in a cost estimation of £3 billion in 1999 prices for noise pollution in the UK.

This method is, however, based on a rather tenuous link, and it does not establish a true value for how much the public would be willing to pay to avoid noise pollution. Trying to control for other factors that affect house prices (which are numerous) is invariably a futile exercise.

Another survey, carried out by Quinet in 1989 for the OECD, was based on the *ex-post* effects of noise levels on productivity. The conclusion reached was that high noise levels from road traffic were responsible for productivity losses amounting to 0.1% of GDP across the OECD countries. This figure is not UK specific, but rather an average across all the countries in the OECD. Friedrich (1995) estimated the costs to be between 0.03-0.06% of GDP across Europe. These studies would suggest that **the aggregate cost of noise pollution was the region of £1 billion in 1999**. This figure has to be hedged with a reasonable degree of uncertainty given the date of these estimates and the fact they were not specifically carried out with reference to the UK; since

these studies were carried out traffic levels have increased significantly, although noise emission standards have become stricter.

Detail 6. Congestion costs

Earlier, we showed that congestion accounts for 72% of aggregate social costs in the UK. This figure varies from 38% of total social costs for rural road users to 97% for urban peak-time users. It is therefore congestion costs that are mainly responsible for the cost differentials between road user types. Congestion is also the most directly visible of all social costs.

Why congestion is an externality

Academics are more divided over the issue of whether congestion is an externality than they are over the other costs. Most agree that accidents, air pollution and noise are all social costs that are external to the market for road space. The argument put forward against congestion being an externality is that when one extra vehicle joins the flow of traffic it does increase the costs on other users, but the extra user also incurs an increased cost in the resulting prolongation of their journey time and increased fuel consumption.

However, this argument neglects the central idea behind externalities, that being that a cost is external if it does not enter the decision-making process of individual road users. Motorists are still comparing the private costs of making a journey with the private benefits, not conducting a social cost-benefit analysis. The marginal users almost certainly do not perceive, nor take account of, any additional costs that arise as a result of their own addition to local congestion. The result of this price distortion is a 'market failure'.

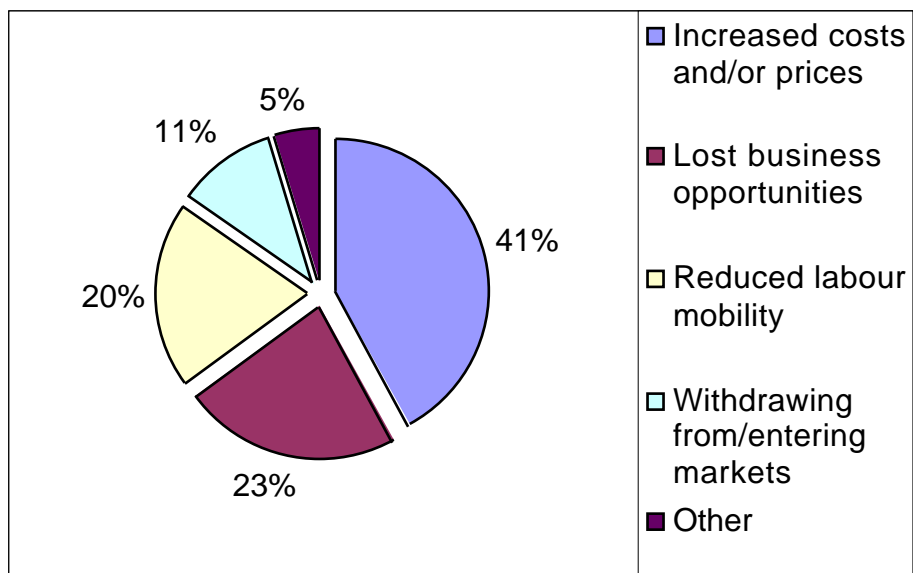
Who suffers from road congestion?

Road use imposes social costs on several different kinds of person.

- **Road users** stuck in traffic suffer from an increase in their journey time, loss of reliability in journey times and increased cost in reduced fuel efficiency. Personal costs include anguish, frustration, annoyance, a sense of restricted freedom of movement, the waste of time that could have been used for other purposes — all of which reduce the welfare of individuals and adversely affect their productivity.
- **Businesses** incur greater distribution costs, which account for up to 15 % of industry's overall costs, as a result of reduced traffic speed. Lack of reliability and predictability in delivery times also incur knock on cost effects and reduce their competitiveness. A survey by the British Chamber of Commerce in conjunction with Alex Lawrie found that the costs of congestion on businesses could be broken down as in Figure 10.

- **Pedestrians, cyclists and residents** who are subjected to poor air quality resulting from higher pollutant emissions in areas of congested traffic flow.
- **Owners of property** may be left with capital that does not appreciate as a result of the noise, poor air quality and vibration resulting from heavy traffic

Figure 10. The cost of congestion on business



What really is the cost of congestion?

The Confederation of British Industry (CBI) attempted to place an *ex-ante* value on the economic costs of congestion by surveying motorists on how much they would be willing to pay to drive on uncongested roads. They also surveyed a small number of distribution companies, seeking to discover the costs of traffic congestion on their business. Consequently, the CBI placed a value of £15 billion in 1994. This value is likely to be around £18 billion when updated into 1999 prices to reflect growth in nominal GDP.

Newbury (1992) used mathematical modelling to produce estimations of the cost of congestion for different road users types, producing an aggregate nation-wide figure of £19.1 billion in 1993 prices. He produced an index of the different costs of congestion, with the startling conclusion that the ratio of peak time central urban users to rural road users is 1,071:1, further evidence of the need for a more egalitarian approach to road transport policymaking.

National Economic Research Associates (NERA) took a similar approach but argue that the costs of congestion in 1996 were £7 billion. They stated that the figures obtained by Newbury were based on out of date estimates and based on the marginal costs of congestion, which are higher than average costs for most traffic and therefore exaggerate the social costs of congestion.

Updating to 1999 prices the Newbery estimates from 1993, the NERA figure from 1995, and the CBI estimate from 1994, it would seem that ***in the year 1999 congestion cost society £18 billion***. This is a significant figure both in its absolute size (which represents around 2 % of current GDP) and also its relative significance to other external costs (representing 72 % of aggregate external costs in the UK). The growth of road traffic also suggests that it will continue rising.

Even so, the cost of congestion is a matter of concern not just in itself, but also because of its impact on other external costs. An end to urban congestion would not just reduce the social costs of road transport by around £18 billion: it would also reduce the health hazards of air pollution, improve the vitality of urban centres, lower the need for businesses to move out of town, and cause less fragmentation of local communities.

Detail 7. Disaggregating the external costs

This section describes in further detail how the estimates presented in Figure 2 and Figure 3 were obtained after the aggregate social costs levels had been calculated. Social costs are calculated on a marginal basis, that is, they are presented in pence per kilometre to reflect the additional cost to society of an extra vehicle driving in the respective area.

The cost of accidents

DETR statistics allow us to compare the costs of road accidents between built-up areas, non-built-up areas, and motorways. For simplicity, the average value of an accident in these areas is multiplied for the total number of accidents. This provides a breakdown of the DETR cost estimates by area, which can then be aligned with the categories used in this report. The area values are then divided by the amount of vehicle kilometres driven in the respective regions, giving a range of the costs of accidents per kilometre depending on the area. This yields the following results.

Figure 11. Marginal accident costs by road type, 1999 prices

Road Type	Accident Costs (£ billion)	Marginal Accident Costs (Pence/km)	Index
Motorway	0.49	0.15	23
Rural	1.10	0.6	92
Urban	1.41	0.7	107
<i>Total</i>	<i>3.0</i>	<i>0.65</i>	<i>100</i>

The index column shows how motorway, rural and urban road accident costs compare to the national average (which is set to equal 100).

The figures reflect variance in the casualty rate, costs of accidents and number of casualties per accident across road user groups. The casualty rate in built-up areas is almost ten times higher than on motorways, although the cost of accidents on motorways is nearly twice as high due to higher impact speeds.

DETR's 1998 review of road accidents also includes a section on motor insurance claims for different vehicle types. These figures enable a rather crude analysis to be undertaken which seeks to attach an estimate to the cost of accidents according to not just the road type but also the vehicle type. By

taking the relative proportion of claims being made by owners of cars and heavy goods vehicle, it is possible to gain an indication of the relative percentage of accident costs for which they are responsible. Applying these proportions to the data in Figure 11 provides the basis for the cost estimations put forward in Figure 2 and Figure 3.

Congestion costs

Newbery (1992) produced a detailed and oft cited estimation of the marginal costs of congestion in the UK. These costs represent the average value of time lost in traffic in different scenarios, breaking down road users spatially and temporally into 11 different categories. For the purposes of this paper, six of the appropriate categories are listed below with their respective marginal congestion costs (MCC). These have been updated to 1999 prices. The unit of calculation for congestion costs is the Passenger Car Unit (PCU), which represents the road space taken by a standard passenger car, with heavy goods vehicle equivalent to 2 PCUs. HGVs are therefore considered to create a congestive effect twice as large as cars. This allows comparative calculations of the marginal congestion costs for different vehicle types.

Figure 12. Marginal congestion cost 1999 (pence/km)

Road user Type	Passenger Car Unit	Index (weighted av. =100)
Rural	0.05	1
Motorway	0.30	8
Non-central off-peak	10.1	257
Non-central peak	18.3	467
Urban central off-peak	31.8	861
Urban central peak	41.9	1071

As is to be expected, there exists an enormous divergence between the congestion costs created by rural and urban peak road users; and also between vehicle types. The costs of congestion of HGVs are obtained by multiplying the above table by two for the aforementioned reason.

Air pollution

A thorough study of the economic damage costs of vehicles exhaust emissions was carried out by Eyre, Ozdemiroglu, Pearce and Steele (1997). This provided a detailed breakdown of the costs of air pollution from diesel and petrol fuel in rural and urban areas. The aggregate costs obtained in this study were around 25% higher and thus the estimates provided by their paper were adjusted to fit the £3 billion estimate made by this report. The result are shown in Figure 13:

**Figure 13. Damage costs of fuel exhaust emissions, 1999
(Pence/km driven)**

Fuel Type	Rural	Urban
Petrol	.38	0.8
Diesel	.53	2.0

These estimates offer a clear distinction between the damage to human health caused by different fuel in different areas. Diesel fuel exhaust emits a greater volume of pollutants per kilometre travelled. Urban damage costs are higher because of a greater population density and because vehicles travelling at lower speeds emit more pollutants per kilometre driven. Air pollution costs are therefore highly positively correlated with population concentration and negatively with speed (up to a certain point). On this basis pollution costs are likely to be different within the urban road user group and should also be higher for motorway users who are not included in the above research. It is worth noting that the above table presents estimates that are similar to those offered by Tinch (1995) in a report commissioned by the DETR.

Noise pollution

Tinch (1995) reported that the ratio of noise costs between cars and HGVs is approximately 1:3. Tinch argues that for costs such as noise pollution it is more appropriate to evaluate the costs in built up, or urban, areas where there is high population density near busy roads. The limited availability of research into the damage costs of noise pollution means that this report must adapt the same stance. As the economic costs of noise pollution are relatively insignificant it is believed that this position adequately serves the purpose of the report. Adaptation of Tinch's report enabled the following estimates to be obtained for urban noise costs by vehicle type.

Figure 14. Marginal costs of noise pollution 1999 (pence/km)

Vehicle Type	Urban Noise Costs
Car/Van	0.21
HGV	0.63

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