UK Road Pricing Feasibility Study: Modelling the Impacts

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UK

Abstract

In July 2003, the UK government set up a comprehensive study to examine how a new system of charging for road use could help make better use of road capacity in the UK. The study focused on whether and how road pricing might work, not whether it should be adopted. This paper briefly considers the case for road pricing then explains the national modelling undertaken as part of this study, focusing on the impacts of different national road pricing schemes on traffic, congestion, public transport use, the environment and economic welfare.

1. Why road pricing?

1.1 Economic theory suggests that efficiency occurs when prices paid are equal to the cost of the relevant good or service. Consumers make decisions about consumption based on the information available, which is normally reflected through pricing.

1.2 In the case of motoring, it is possible to analyse the costs falling on both motorists themselves (individually, and as a group), and on society. It is also possible to analyse the charges that motorists pay, and consider whether the prices paid by motorists cover the costs of their activities, and therefore whether their decisions take account, through pricing signals, of the full costs of the activity they are about to undertake.

1.3 Pricing motorists according to the costs their journey places on society (marginal social cost pricing) increases overall economic efficiency, as activity only takes place where the benefits outweigh the overall costs.

1.4 In the case of pricing for road use, key elements of the costs imposed by a motorist on other transport users and society in general are:

- Infrastructure operating costs and maintenance
- Congestion
- External accident costs
- Air pollution
- Noise
- Climate change emissions.

1.5 Motorists pay charges, resulting in revenues. The key revenue elements are:

- Vehicle Excise Duty, a fixed annual rate of tax per car
- Fuel Duty, and VAT on Fuel Duty, a tax on each litre of fuel consumed.

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2. The modelling framework

2.1 In order to analyse the impacts of different policies at a national level, the study drew extensively on the Department for Transport's National Transport Model (NTM). This is a multi-modal transport model which includes 6 modes of transport: car driver, car passenger, rail, bus, walk and cycle. The model covers the whole of Great Britain and contains a representation of every vehicle km in the country. It produces forecasts of the impacts of policies on key transport and environmental outcomes.

2.2 The NTM is able to represent a number of different pricing schemes. Prices can be set by time of day, area type, road type, level of congestion and vehicle type. When prices are input into the model, there are 3 initial responses related to drivers changing either their route or time of travel. They can switch:

- to a different road of the same type;
- to a different road of a lower order, eg from a motorway to an A road;
- to a different time period - from the peak to one of the adjacent time periods.

2.3 These responses are underpinned by evidence from stated preference research. Once road users have initially changed their route or time of travel, the cost of travelling on different roads is re-estimated, taking account of journey time, fuel costs and other road user charges. These costs are then passed back to the multi-modal Demand Model. The Demand Model re-estimates the mode share and any changes to traffic through people choosing to travel to different destinations as a result of the changes in costs (eg a distance-based pricing scheme may encourage people to select destinations nearer to home).

2.4 In terms of outputs, the model is able to assess the impact of different pricing schemes on traffic, mode choice, vehicle occupancy, congestion and emissions. A Welfare Module has also been used to assess the impacts of different schemes on economic welfare.

Key assumptions

2.5 The NTM assumes that the total number of trips by all modes, including walking and cycling, is not affected by road pricing or any other policy. Trip rates for each category of person in the model (eg employed female in a two adult, one car household) are assumed to be broadly constant over time. This is in line with evidence from the National Travel Survey, which suggests that the average number of trips made per person per year is around 1,000 and this has remained stable over time.

2.6 The NTM includes car passengers as a separate mode. The model makes a number of assumptions about how car passengers respond to changes in cost. In the base year, the number of car passenger journeys matches evidence from the National Travel Survey. In the absence of any hard evidence on how costs are split when car sharing, the modelling assumes that the car driver pays all of the money cost. However, the passenger is assumed to perceive costs equivalent to 50% of the money cost. In the pricing scenarios, the passenger also perceives 50% of the charge. The results are sensitive to this assumption.

2.7 The modelling assumes that the value people place on their time increases in line with their income. This means that, in 2010, money costs such as fuel and prices form a smaller proportion of the overall costs of travel (which combine time and money costs), so people are therefore less responsive to changes in fuel costs or prices. This is compounded by an assumed 30% fall in fuel costs over the decade, a combination of a 20% improvement in fuel efficiency (as a result of the voluntary agreements with car manufacturers to improve efficiency) and a 12% fall in fuel prices from peak in 2000.

2.8 The charges are all in 1998 prices.

2.9 The model assumes that people respond to road charges in the same way they respond to changes in other money costs, such as fuel prices. The model is calibrated so that, in 2000, a 1% increase in fuel costs leads to a 0.3% reduction in traffic, in line with behaviour over several decades. The response will be less in 2010 (around 0.17%) due to the reasons outlined in paragraph 2.7 above.

2.10 The process of valuing travel time savings and comparing the benefit of travel time savings with construction and other costs has been established for many years as part of the methodology used to appraise transport infrastructure schemes. The value of saving an hour's travel time will depend on the circumstances and on the individual. When appraising road schemes, a value of approximately £5 is used for trips made by car drivers outside the course of work and a value of £18 in the course of work. A value of £8 is used for drivers of vans and other commercial vehicles. These values have also been used in the analysis described in this report to estimate the benefits of the time savings that road user charging will deliver.

2.11 Time spent travelling as part of the working day is a cost to the employer's business. The value is based on the assumption that savings in travel time convert unproductive travel time to productive use. So the value of an individual's working time to the economy is reflected in the wage rate paid, plus a mark-up to allow for other employment related costs. The value is derived from national data on the earnings of those who travel in the course of work.

2.12 For all other journeys, including commuting trips, the value is based on surveys of people's willingness to pay, supplemented, where possible, with evidence from situations where people trade a cheaper, slower journey against a faster, more expensive one. This measure of willingness to pay to save time will vary according to the circumstances of the trip and of the traveller[2].

2.13 For the purposes of this study an average value of non-working time savings has been used which covers all trips and all travellers. A separate national average value has been used for trips in the course of work.

[2] The modelling assumes that people's willingness to pay for travel time savings is related to their income.

2.14 It is assumed that the road network in 2010 is based on the existing network augmented by planned investment. In general, more road capacity implies that lower charges would be needed for pricing at marginal social cost because the congestion costs element of marginal social costs would be lower.

2.15 Further details of the NTM and its assumptions can be found on the Department's website[3].

Limitations

2.16 The NTM contains a statistical representation of the road network: it is not a geographical model. It is therefore not able to capture route changes at the network level, which more localised models have highlighted as an important response to pricing.

2.17 The NTM does not show the impact of pricing on the location of activities. It assumes that land use and hence the impact this has on the pattern of trips is unaffected by transport policies.

2.18 As outlined above, the range of values of time in the model is limited: a fuller distribution of time savings would more accurately capture the impacts and benefits.

3. Results from the National Transport Model

3.1 Introduction

3.1.1 The modelling results provide valuable information on the likely responses to different road pricing schemes and the potential impacts. However, it is not possible for any single model to fully capture all the impacts and the limited empirical evidence on pricing schemes means that there is a range of uncertainty around all the forecast results presented below. Much more analysis would need to be undertaken prior to introduction of any scheme at either a local or national level. In addition, the study has not assessed the various options for how any revenues raised through pricing could be used, which is crucial in determining the overall impacts, other than through returning it to road users via a fuel duty reduction.

3.1.2 The pricing schemes modelled are explicitly not proposals for introduction. In particular, the prices that have been modelled have been selected solely to illustrate the potential impacts and transport outcomes from different types of schemes and charges.

3.1.3 A variety of different pricing schemes have been modelled using the Department for Transport's National Transport Model. The modelling has focused on the

[3] http://www.dft.gov.uk/stellent/groups/dft_econappr/documents/divisionhomepage/030708.hcsp

impact of hypothetical pricing schemes in 2010. Although not practicable on this timescale, the aim of the analysis is to provide broad estimates of the potential impacts of different types of national scheme. The charges are purely illustrative.

3.1.4 All the forecasts are presented as central point estimates. As with any forecasts, there is a range or uncertainty around these estimates. More confidence can be placed in the relative outcomes of the different schemes modelled than in the absolute numbers.

3.2 Estimating marginal social cost prices

3.2.1 In 2001, research commissioned by the Department for Transport was published[4] containing estimates of the marginal external costs of road use and revenues from road users. The main marginal external costs included in the analysis were congestion, accident costs, infrastructure operating costs, and environmental costs. The main revenues were fuel duty and VAT on fuel duty, which count as the current charges.

3.2.2 The research concluded that transport charges would need to rise if charges are to be set on economic efficiency grounds. In particular, a far higher degree of differentiation in charges would be required than existing instruments allow for. Current charges are too low overall, especially on congested roads and busy times, and sometimes too high, mainly in rural areas.

3.2.3 Table 1 is based on the same methodology as the research, updated to 2000 and including forecasts to 2010. In 2000, it is estimated that road users faced only half the costs they impose on others. This situation is worsening. By 2010 road users will pay less than a third of their external costs. This is because:

- The externalities will increase because of growth in congestion, traffic and in the value travellers place on their time;
- Improvements in fuel efficiency could reduce the fuel duty per km by 25% in real terms from the 2000 peak.

3.2.4 Congestion forms the largest proportion of external costs - estimated to be around 77% in 2000 increasing to around 88% of external costs in 2010. Accident and emissions costs account for the remainder and, unlike congestion costs, are forecast to fall over time.

3.2.5 The numbers in Table 1 are mileage-weighted averages of the marginal cost, that is 7.3p represents the extra cost of the 'typical' additional vehicle added to the road network in any place at any time. Marginal external costs will vary widely across the country, with time and place, reflecting variations in congestion and other externalities.

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4 Sansom T, Nash C, Mackie P, Shires J and Watkiss P (2001) *Surface Transport Costs and Charges: Great Britain 1998*. Institute for Transport Studies, Leeds.

Table 1: Marginal external costs and tax paid by road users

Pence per km	Marginal external cost of congestion (a)	Environment and safety costs (b)	Fuel duty and VAT on duty (c)	Charges less sum of external costs
Year 2000	7.3	2.2	5.2	4.3
2010	12.3	1.6	3.9	10.1

3.2.6 From an economic perspective, the "best" set of charges would reduce the difference between the charges paid and total external costs in Table 1 to zero. Vehicles would therefore be charged according to the level of congestion, accidents and emissions they impose on the rest of society. The estimated charges would be lower than the 'uncovered externality' because people respond to charges by driving less in congested areas which reduces the externality imposed. There is therefore an iterative process to find the best set of charges and this process has been included in the results below.

3.3 Scenarios modelled

3.3.1 Our estimates of marginal social cost pricing have been based on a relatively complex pricing structure where prices vary by 5 different levels of congestion, 4 area types and 4 road types. This results in up to 80 different charges[5]. To avoid further complexity, prices have been estimated for the "average" vehicle. This means that cars, light vans and heavy goods vehicles all pay the same rate per km.

3.3.2 For modelling purposes, the road network is divided into links (on average 3 miles long). The charge varies on each link by:

- Location (rural, large urban area etc);
- Type of road (Motorway, A road etc);
- Whether or not the travel is in the busy direction of a road (especially an issue for peak driving);
- Time of day.

3.3.3 These factors determine how busy any link is at any time of day as measured by the relationship between the volume of traffic and capacity of each stretch of road. The charge varies by these factors because congestion (and to a lesser extent environmental and accident costs) is sensitive to location, road type, direction of travel and time of day.

3.3.4 The following scenarios have been modelled:

i. Marginal social cost pricing with 75 charges;

ii. Using the same methodology, the study looked at the impacts of much fewer charges, by grouping the 75 charges into 10 with a maximum charge of 80p/km (which would be paid by only 0.5% of traffic). Many of the 75 charges were very

[5] There are actually 75 charges because some of these road type/area type/congestion combinations do not exist.

similar and grouping the most similar and roughly taking the mid-point led to 10 charges. The 10 charges mean that motorists would pay the following charges per km, **including fuel duty**: 1.5p, 2.5p, 3.5p, 4.5p, 5.5p, 8.5p, 14.5p, 23.5p, 53.5p and 83.5p/km. As fuel duty is forecast to cost around 3.5p/km in 2010, a significant amount of traffic would be paying pence/km charges that are lower than they otherwise would pay in fuel duty.

iii. A revenue-neutral version of Scheme (ii), where for the purposes of the modelling it has been assumed that fuel duty is reduced to compensate for the pence per km road charges.

iv. Scheme (ii) but with maximum prices of 60p/km, 50p/km, 40p/km, 30p/km and 20p/km.

v. Applying the charges in scheme (i) but only in London and the conurbations or in all urban areas with a population of over 10,000.

3.4 Results

Impact on traffic and congestion

3.4.1 Table 2 shows the relative impacts of the schemes on traffic and congestion. The numbers relate to the impact in 2010 on top of already announced transport policies.

<u>Marginal social cost pricing (scenarios 1-9)</u>

3.4.2 Charging by marginal social cost is forecast to significantly reduce congestion[6]. The level of congestion in urban areas in 2010 could be halved. According to economic theory, this is the ideal level of congestion - the benefits of reducing it further would be outweighed by the costs. This result is maintained as the number of charges is reduced from 75 to 10 with a maximum of 80p/km. This is because many of the 75 charges are very similar (within a penny) or identical.

3.4.3 The modelling has assessed the importance of the maximum charge rate. The results suggest that each successive reduction in the maximum charge has a relatively small impact on the overall congestion benefits. However, with each reduction the benefits fall by an ever increasing amount. When the maximum charge is reduced to 20p/km (or thereabouts) the congestion benefits are considerably lower but even then a reduction of around 28% on 2010 levels is forecast.

[6] Congestion is modelled as being the average time lost per km relative to travelling at free flowing speeds.

Table 2: Impact on traffic and congestion relative to the 10 Year Plan

England, 2010 % change on 10 Year Plan		Change in traffic			Change in congestion		
		All roads	Urban roads	Inter-urban roads	All roads	Urban roads	Inter-urban roads
1	Charging by marginal social cost: 75 charges	-3%	-9%	0%	-48%	-52%	-34%
2	Charging by marginal social cost: 10 charges capped at 80p/km	-4%	-9%	-2%	-46%	-52%	-34%
3	Revenue neutral version of (2)	2%	-4%	6%	-41%	-48%	-17%
4	Increasing fuel duty to raise same revenue as (2)	-5%	-5%	-7%	-7%	-7%	-15%
5	10 charges capped at 60p/km	-4%	-9%	-2%	-44%	-49%	-34%
6	9 charges capped at 50p/km	-4%	-9%	-2%	-42%	-46%	-34%
7	9 charges capped at 40p/km	-3%	-8%	-1%	-39%	-42%	-33%
8	9 charges capped at 30p/km	-3%	-7%	-1%	-35%	-36%	-31%
9	8 charges capped at 20p/km	-2%	-6%	0%	-28%	-29%	-29%
10	Charging in London & conurbations only	-3%	-8%	-2%	-27%	-44%	-10%
11	Charging in all urban areas	-6%	-10%	-5%	-43%	-53%	-18%

3.4.4 Marginal social cost pricing has a limited impact on total traffic, which falls by 3-4%. This reflects that such a scheme would have a relatively small impact on the overall cost of travel. When forecasting the decisions made by travellers, the model converts time costs such as travel time and time spent waiting and accessing public transport into monetary units which are added to money costs such as fuel costs, parking costs and any road user charges. Because congestion is halved, the time costs associated with travel have fallen - because journey times will be quicker.

3.4.5 In addition, with MSC pricing, around half of traffic would pay less than they would in fuel duty alone so, for some drivers, particularly those in uncongested rural areas, there is an incentive to travel further. Some drivers would be shifting onto different road types (changing route) and, to a limited extent, to different time periods in response to the charges.

3.4.6 These factors combine to produce a relatively small reduction in total traffic.

3.4.7 There would be significant gains from marginal social cost pricing even if fuel duty was reduced so that overall road users paid no more under marginal social cost charging - see scenario 3 in Table 2. This is because the charges are better targeted than is possible with fuel duty, charging people where congestion is worst. This shows that the pricing structure, rather than the level of prices, is the more important factor.

3.4.8 The revenue neutral version of marginal social cost pricing is forecast to increase traffic by around 2%. This is because the combined time plus money costs of road travel have fallen. The money costs are neutral because it has been assumed, for modelling purposes, that fuel duty is reduced to offset the charges. However, because the charges lead to a significant reduction in congestion, the time costs of travel have fallen which mean that overall it costs less to travel by car.

3.4.9 For comparison, the study looked at the impacts of an increase in fuel duty to raise broadly the same amount of revenue as from MSC pricing. This would have a more significant impact on traffic - around a 5% reduction - but less than a fifth of the impact on congestion. This reinforces the conclusion that the structure of charges is more important than the level. An across the board increase in fuel duty would result in higher charges for some traffic than under MSC pricing.

Charging in urban areas only (scenarios 10 & 11)

3.4.10 Marginal social cost pricing in London and the conurbations would have a significant impact on traffic and congestion on urban roads - reductions of 8% and 44% respectively. Overall, congestion would be around a quarter lower in 2010 than without pricing.

3.4.11 Extending this pricing scheme to all urban areas (with a population over 10,000), has an even greater impact and the congestion results are very similar to the schemes in Table 2 showing marginal social cost pricing in all area types. This is to be expected given that only rural areas (which account for less than 20% of total congestion) would be excluded from the scheme.

3.4.12 There is a larger reduction in traffic than with MSC pricing on all roads, urban and rural. This is partly because with MSC pricing some traffic, particularly in uncongested rural areas, would pay less which will lead to increases in some areas.

Impact on other modes and the environment

3.4.13 Table 3 shows the impact on other modes and the environment. With all the schemes there is a modest shift to other modes of travel, up to a 5% increase in bus trips and rail passenger km. This reflects the limited reductions in road traffic.

3.4.14 Further analysis of mode shifting shows that the vast majority (around 80%) of people who have stopped driving switch to being car passengers, ie car sharing. As discussed in paragraph 2.6, this result is sensitive to what is assumed about the costs of car sharing and further work would be needed to assess the impact of alternative assumptions.

3.4.15 Across Great Britain, the increase in car passengers represents an increase in average car occupancy of around 5%. In London, an increase of around 20% is forecast. Around 10% of car drivers switch to bus and a further 7% switch to rail. Between 4% and 7% switch to walking or cycling.

Table 3: Impact on other modes and on the environment, relative to the 10 Year Plan

England, 2010 % change on 10 Year Plan		Impact on other modes				Impact on environment		
		Bus	Rail (GB)	Walk	Cycle	CO2[1]	London and large urban areas NOx	London and large urban areas PM10
1	Charging by marginal social cost: 75 charges	3%	2%	0%	2%	-4%	-7%	-7%
2	Charging by marginal social cost: 10 charges capped at 80p/km	3%	2%	0%	2%	-5%	-7%	-6%
3	Revenue neutral version of (2)	1%	-1%	0%	0%	-1%	-4%	-5%
4	Increase in fuel duty to raise same revenue as (2)	2%	3%	0%	1%	-4%	-3%	-2%
5	10 charges capped at 60p/km	3%	3%	0%	2%	-5%	-7%	-6%
6	9 charges capped at 50p/km	3%	2%	0%	2%	-4%	-7%	-6%
7	9 charges capped at 40p/km	2%	3%	0%	2%	-4%	-6%	-5%
8	9 charges capped at 30p/km	2%	2%	0%	1%	-3%	-5%	-4%
9	8 charges capped at 20p/km	2%	2%	0%	1%	-3%	-4%	-3%
10	Charging in London & conurbations only	3%	4%	0%	2%	-3%	-6%	-5%
11	Charging in all urban areas	3%	5%	0%	2%	-6%	-8%	-7%

Notes:

1. *Tailpipe emissions.*
2. *The impact on CO2 from the revenue neutral scenario does not include potential impacts on vehicle choice and driving style as a result of the modelled reduction in fuel duty.*

3.4.16 The non-revenue neutral schemes have a similar impact on CO2 emissions, a reduction of 3% to 5%. This equates to a reduction in carbon of up to 1.5 MtC. The modelling suggests that a revenue neutral scheme could be broadly neutral. However, this does not include the potential impacts on car choice if the charge was accompanied by a fuel duty rebate.

3.4.17 There are also significant impacts on emissions of local pollutants, with falls of between 2% and 8% in London and large urban areas (population over 250,000). These findings generally mirror the falls in traffic in urban areas. The impact of more simple schemes is generally less, reflecting the reduced impact of these schemes on urban traffic and congestion.

3.4.18 The reduction in rail patronage from revenue neutral pricing is a result of the lower costs for longer distance road trips, particularly those travelling on inter-urban roads.

Impact on economic welfare

1.6 A well-targeted road pricing scheme would be expected to deliver economic welfare benefits. This is because if motorists were priced according to the costs their journey places on society (marginal social cost pricing), activity would only take place where the benefits outweigh the overall costs. This is instead of the current system where some people are paying too little (much) and therefore tend to make more (fewer) journeys than is economically efficient.

3.4.19 The increase in economic efficiency largely arises through time savings to motorists who, because of the reduction in congestion, have quicker journeys. These time savings are estimated using the values of time outlined in paragraph 2.9. There are also benefits from reductions in other external costs such as environmental pollution and accidents.

3.4.20 Public transport users could experience a reduction in economic welfare as a result of increased overcrowding as motorists choose to use buses and trains instead of driving. However, this finding could be reversed if some of the revenue was invested into public transport improvements.

3.4.21 The Welfare Module takes the full range of outputs from the NTM, attaches a monetary value to each output and summarises to produce an overall estimate of welfare, ie the total benefits of each scheme.

3.4.22 At this stage, no assumptions have been made about how any revenues from the different road pricing schemes would be spent. The use of revenues would have important implications for the 'final' welfare impacts on different groups, the estimates presented below should therefore be treated as 'first round' welfare effects.

3.4.23 For a full cost benefit analysis, the estimated benefits would be compared with the costs of setting up and maintaining the different pricing schemes. These costs have been excluded from this analysis due to a lack of clarity of the future costs.

<u>Marginal social cost-based pricing schemes</u>

3.4.24 Table 4 presents a summary of the estimated welfare benefits and revenue from the schemes presented in Tables 2 and 3. The main results are:

- The overall welfare benefits of each scheme broadly follow the reductions in congestion. The most detailed MSC pricing scheme with 75 charges would deliver the largest increase in benefits, worth around £10.2bn. Reducing the number of charges to 10, with a maximum charge of 80p/km, would not reduce the benefits significantly (£9.9bn), but lowering the maximum charge to 50p/km would lose a further £0.9bn worth of benefits (total £9.0bn).

- The revenue neutral version of the MSC-based scheme with 10 charges involves a relatively small reduction in overall welfare, relative to the revenue raising schemes. But the pattern of benefits is very different. Road users would gain both from the substantial time savings (worth around £10.1bn), as well as through the reduction in fuel duty and other vehicle operating costs. These savings would outweigh the welfare costs from the extra charges they would pay.

- When modelling this scheme, revenue neutrality has been achieved by reducing fuel duty so that the savings to road users from fuel duty and VAT paid on fuel duty are roughly equal to the charges paid, ie the scheme is revenue neutral to road users. Table 4 shows the charges assumed have not succeeded in hitting the target exactly - the scheme modelled results in the charges paid by road users being lower than the amount saved in fuel duty plus VAT on fuel duty.

Table 4: Estimated welfare benefits of marginal social cost-based pricing schemes

£bn (GB) 2010, 1998 prices Negative numbers represent a loss of social welfare	MSC pricing: 75 charges	MSC pricing: 10 charges capped at 80p/km	MSC pricing: 9 charges capped at 50p/km	Revenue neutral version of 10 charges	Increase in fuel duty to raise the same amount of revenue as (2)
Road users' benefits from time savings	+11.8	+11.3	+10.2	+10.1	+2.1
Road users' change in costs (road charges, fuel duty and vehicle operating costs)	-10.2	-10.4	-10.5	-0.1	-10.2
Revenue	+8.2	+8.6	+8.8	-2.2	+10.5
Environment and safety benefits	+0.5	+0.5	+0.5	+0.1	+0.5
Public Transport	-0.2	-0.2	-0.1	-0.2	-0.1
Total benefits	+10.2	+9.9	+9.0	+7.8	+2.8

Increasing fuel duty to raise the same amount of revenue as from MSC pricing

- Increasing fuel duty to raise a similar amount of revenue as from marginal social cost pricing schemes is estimated to yield benefits of around £2.8bn. This largely reflects the much lower time savings achieved relative to marginal social cost pricing schemes.

Charging in urban areas only

3.4.25 Table 5 shows the estimated welfare benefits from charging in urban areas only.

3.4.26 It is estimated that charging in all urban areas with a population over 10,000 would result in welfare benefits of around £6.4bn. This is around £3.8bn less than if the same charges were applied nationally. The main difference is that the overall time savings are lower because rural traffic (including strategic inter-urban roads) accounts for around 20% of total congestion.

3.4.27 Road users pay more in charges because most traffic in urban areas would pay more (unlike in the national scheme where many people in rural areas would pay less because their marginal social costs are estimated to be below what they pay in fuel duty and VAT on fuel duty).

3.4.28 Reducing the scope of a charging scheme further, to London and conurbations only, reduces the benefits by around £1bn relative to charging in all urban areas. Nevertheless, very significant economic welfare benefits of over £5bn are forecast.

Table 5: Estimated welfare benefits from MSC-based charging in urban areas only

£bn (GB) 2010, 1998 prices Negative numbers represent a loss of social welfare	London and conurbations only	All urban areas (>10,000)
Road users' benefits from time savings	+6.5	+8.6
Road users' change in costs (road charges, fuel duty and vehicle operating costs)	-7.9	-11.5
Revenue	+6.4	+9.2
Environment and safety benefits	+0.4	+0.2
Public Transport	-0.2	-0.2
Total benefits	+5.4	+6.4

4. Areas for further work

4.1 The modelling work has highlighted a number of areas for further research.

4.2 The issue of how any revenues are spent is critical in determining the final welfare impacts of any charging scheme.

4.3 The issue of re-routeing and diversion is an important one. As mentioned above, due to the lack of a geographic road network, the NTM is unable to capture detailed route changes in response to pricing. Local modelling has shown the importance of taking account of re-routeing in the design of road pricing schemes. Local charges would need to be set to avoid such unwanted effects such as diversion to unsuitable and circuitous routes.

4.4 The results are sensitive to assumptions on car sharing and further research is needed to assess how willing motorists are to car share and how costs are shared between drivers and passengers.

4.5 The schemes modelled assume an instantaneous nationwide introduction of road pricing. This is probably infeasible from a practical point of view and further work is needed to assess the best way of rolling out charging schemes.

5. References

Sansom T, Nash C, Mackie P, Shires J and Watkiss P (2001) *Surface Transport Costs and Charges: Great Britain 1998*. Institute for Transport Studies, Leeds.

Department for Transport (2004) *Feasibility Study of Road Pricing in the UK: A report to the Secretary of State for Transport*