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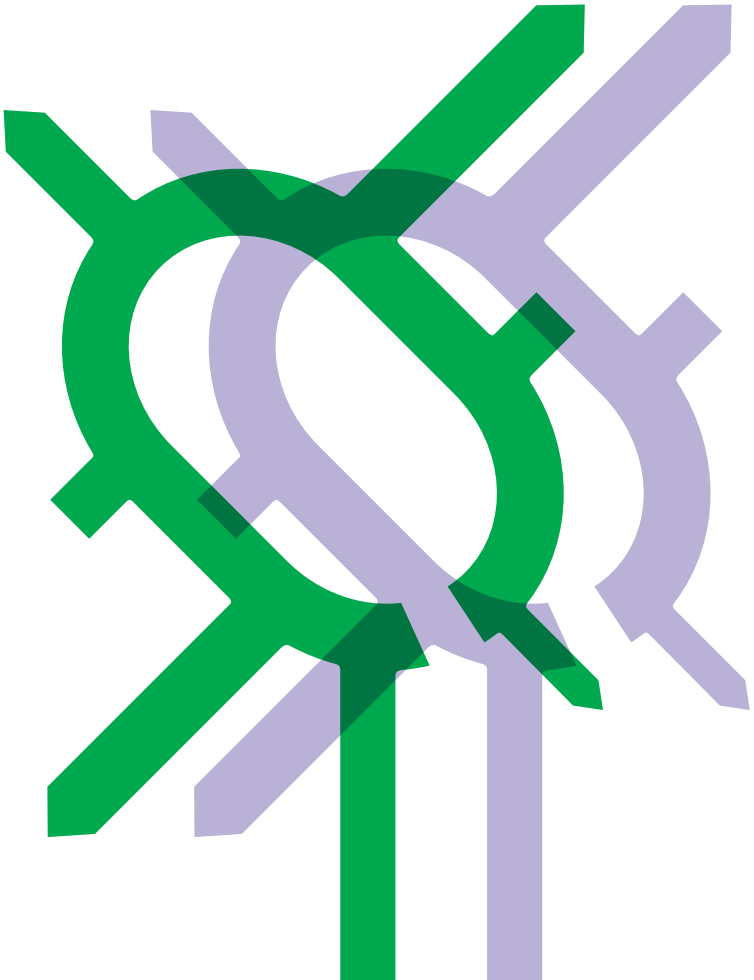
Road User Charging: A Road Map

Jeegar Kakkad and Ann Rossiter



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Foreword

Driving on the UK's roads is becoming, for many, a necessary evil – or at best a guilty pleasure. A political consensus is growing that more radical policy action is now needed to address the twin problems of congestion and the environmental damage caused by road use. As the external costs created by our individual decisions to drive are escalating, the case for radical policy change has been conclusively made – not least by the Eddington and Stern studies published at the end of last year.[1] These in-depth examinations each provided new evidence and compelling economic analyses to back up their calls for urgent and incisive policy action.

But because our society has become so dependent on road use, the wider impacts of sustained, long-term policy changes will be complex and far-reaching. Moves away from the status quo with simplistic solutions could potentially damage a range of different stakeholders. Analysis undertaken by the Department for Transport for the Eddington Review suggested, for example, that a 'purist' structure of road user pricing would make commuters worse off, while delivering significant benefits to business and leisure travellers. The Stern Review acknowledged that more radical measures to combat climate change will make people worse off now, in exchange for assuring the long term future of future generations.

Not surprisingly, therefore, the task of finding practical 'win-win' solutions has largely eluded UK policymakers of different complexions in the 40 years since the Smeed Report[2] first made the case for policy change in relation to road pricing, and on current government assumptions, a national system could await two more general elections.

However, in recent times a number of parallel develop-

1 Sir R Eddington, *Transport's role in sustaining UK's Productivity and Competitiveness: The Case for Action* (The Stationery Office, 2006) and Sir N Stern, *Stern Review Report on the Economics of Climate Change* (Cambridge University Press, 2006).

2 Smeed et al, *Road Pricing. The Economic and Technical Possibilities* (Ministry of Transport, The Stationery Office, 1964).

ments have been smoothing the path towards fairer and more efficient ways of using our valuable roads.

In the UK, the problems of urban congestion are already now being tackled more vigorously at local level by local policymakers where they are empowered to do so. The pioneering large-scale use of camera-enforcement technology in central London, which Deloitte helped to make a reality, has raised awareness, in the UK and internationally, of what can be done in a major city. In policy terms this form of road pricing has had mixed reviews, but the implementation process has underlined the importance of determining bespoke urban solutions to specific urban problems.

These bespoke urban solutions ideally involve balanced transport strategies across the interdependent public transport modes, on the one hand, and the roads (often controlled by different authorities under existing structures) on the other. While devolution in Scotland and Wales has already enabled more 'joined up transport thinking' to be taken forward, the government has acknowledged that further institutional and funding changes may be needed for the English city-regions if empowered policy-makers are to emulate London's radicalism, and implement coordinated strategies for public transport, road capacity, parking and road pricing. It is significant that the Lyons Inquiry into Local Government has been deferred following the Eddington review.

Meanwhile, other major international cities are also taking steps to develop and use technology to support more radical ways of bringing road provision and use into a more sustainable balance. Again the solutions are bespoke to the local problems, and the surrounding political environments. For example the new national government in Sweden recently confirmed congestion charging for Stockholm in order to help fund new capacity to bypass the city, while in Norway different city-charging objectives have evolved over time. But with active policy debates now underway from Milan to Auckland, and the US, urban road pricing is likely to be an international reality in the longer term.

In parallel, an increasing number of countries in the centre of the EU are rolling out national systems to charge freight vehicles for inter-urban road use, in line with the European

Commission's policy objective to move towards fairer and more efficient ways of paying for transport right across the EU. As the number of user charges multiplies, issues of interoperability, and consistency with tolling for individual privately-financed roads, become more complex and will need to be addressed with an evolving framework of new European legislation.

These complexity issues will also need to be tackled in the UK, as the policy thinking on urban and longer distance road user charging is brought together into a unified framework. Deloitte has been working with clients at national and local levels on the issues, and the central conclusion of this report – that a more defined 'road map' is now needed to help put policy into practice – is timely from our perspective.

This research also helps to clarify and underline the need for policy to tackle congestion and environmental issues on an integrated basis. Although congestion remains the dominant external cost of UK road use tackled by road pricing (DfT modelling for the Eddington study implied that the carbon benefits would be only around 1% of the economic benefits), 'green' solutions are not optional add-on extras, but are integral components of a sustainable transport policy.

This does not mean that a single, combined, 'revenue-neutral' replacement to the existing framework of fuel taxes and vehicle excise duties will do the trick. Air quality problems, for example, are localised and specific, and may need targeted solutions such as the Low Emissions Zone planned to commence in London next year. But it will be important for the policy debate to embrace a wide range of interdependent policy instruments – ranging from international carbon trading mechanisms in the post-Kyoto period when wide-ranging road user pricing is anticipated, to national taxes, localised and time-specific road use charges, and refinements to existing administrative limits on road occupancy, speed, parking and vehicle emissions.

The other theme of this report is that moving from the formulation of new policy to its implementation requires care and attention to detail, given the complex balancing acts required.

In this respect, technology should be an enabler rather than the problem. In Stockholm, for example, following last year's successful technical trial, it is still nevertheless possible that the more 'advanced' tag and beacon technology will be discontin-

ued – but because it is not needed, rather than because it works less well. More difficult implementation issues include the need to sustain cooperation across multiple delivery organisations – a programme management challenge that the Transport Innovation Fund pilots that are now being developed in the UK will also need to rise to.

Clearly, therefore, this report is a particularly timely and thoughtful contribution to the evolving national debate on road user pricing initiated by the government. While such debate should not be used as an excuse for inaction, the important policy issues that are raised demand our attention.

Ian Simpson
Partner
Deloitte

Executive Summary

The economic growth and prosperity of the past 40 years has resulted in greater road usage – both in the number and the length of trips. Recent contributions to increased road use are internet shopping and just-in-time doorstep deliveries. This growth in road use has its benefits, but it also results in time lost queuing in traffic, unpredictable journey times and dangerous driving habits, all of which negatively affect the public's quality of life and national productivity.[3]

The problem has worsened in the past two decades and the trend is set to continue. Various estimates place the cost of congestion on the United Kingdom's (UK) roads at £10-£20 billion per year.[4] The Eddington Transport Study predicts that an extra £22 billion worth of time will be wasted in England by 2025 due to congested roads.[5] Meanwhile, road transport currently accounts for just over one-fifth of all UK carbon emissions – the greatest climate change contributor. As congestion worsens and reducing climate change becomes an even greater priority, transport policy urgently needs to manage traffic better. Road pricing could be an effective, market-based solution to these pressing issues. It has the potential to provide clear, transparent, yet strong signals to drivers about the true costs of motoring and thereby change their behaviour.

By providing a road map for pricing, this report pushes forward the debate on *how* to make road pricing work in practice.

Why road pricing and why now?

By changing motorists' behaviour, it is possible to improve traffic efficiency on the UK's roads – resulting in quicker journeys and reduced emissions. Road pricing is politically imperative because the current tax and charging structure is insufficient

3 CBI quoted in *House of Commons Transport Select Committee Seventh Report* (March 2005).

4 Department for Transport, *Feasibility Study of Road Pricing in the UK – Report* (DfT, 2004).

5 Eddington, op. cit.

to address all the negative externalities, including the increasing costs of congestion, emissions, infrastructure depreciation, noise pollution and external accident costs.

However, it is unlikely that all of the costs of private car use could be fully managed by any road pricing scheme. Not only might there be political objections to some policies, but other policies may not be technically feasible or desirable. The impact of different models of pricing on different social groups is also an important issue, both for public acceptability and because of potential equity implications, and therefore needs to be carefully assessed.

Fuel tax is currently the primary form of transport taxation in the UK. It has had some success in reducing motoring, marginally reducing growth in carbon emissions and raising revenue. However, even under the most optimistic of estimates, traffic levels and congestion are predicted to worsen significantly over the coming decades. Consequently, fuel duty looks increasingly unlikely to either inhibit or cover the social costs of this additional motoring – lacking the precision necessary to tackle congestion efficiently or effectively. Unable to distinguish between different types of drivers, it cannot accurately penalise those who contribute the most to traffic.

Both a road user charge and fuel duty follow the principle of 'user pays'. But road pricing could potentially be a more effective policy instrument, both for changing motorists' behaviour and consistently raising revenue. However, road pricing is unlikely to be effective on its own.

How to use road pricing revenues

As is the case with congestion charging in London, road pricing across the UK would raise significant amounts of revenue. This money could be completely additional to current taxes and, for example, be reinvested in roads and public transportation. Alternatively, government could make road pricing revenue-neutral and return the money to motorists through lower fuel duties or lower road taxes.

Although some observers seem convinced that road pricing could only be successful in the UK if it were revenue-neutral, public opinion surveys consistently show that there is actually no clear winner between these two polar opposite

policy choices.

While either option could be made to work, we argue that in practice road pricing in the UK should fall somewhere in the middle. Some of the revenue should be set aside for greater spending on improved public transportation, as well as better road maintenance and management and improved road capacity. Only then could road pricing have the greatest impact on drivers' behaviour while also giving them real choice between driving or using public transport.

Road pricing and the environment

Road pricing on top of fuel duty and road tax is often seen as double taxation. The vehicle excise duty (VED), for example, is already used to incentivise drivers into owning environmentally friendly cars, while punishing people who drive 'gas guzzlers'. Yet, the VED is inefficient at reducing the amount people drive. It treats a sports utility vehicle (SUV) parked on the side of the street and used only occasionally the same as one used for the daily commute.

By scrapping the VED in favour of a charge that varies by fuel efficiency and/or emissions standards, road pricing could provide the same incentives, while also punishing people for driving their gas guzzlers more often.

Another option for making road pricing more environmentally friendly would be to lower fuel duty on more efficient fuels, such as biofuels and diesel. Although this could lead to more traffic, it would help limit the growth in carbon emissions. However, as much of the increase in road transport emissions of the past fourteen years has come from the freight sector, incorporating environmental objectives into a road pricing system for the freight industry alone – rather than for all motorists – may be easier and have a more significant impact in the struggle to reduce carbon emissions.

Until road pricing becomes a reality, alternative pricing measures, such as steeper gradations in VEDs and incentives to increase fuel efficiency, could help change the behaviour of the freight hauling industry to reduce carbon emissions and curtail the growth in traffic.

Of course, road pricing will not in itself be sufficient to make the necessary changes in behaviour. Investment in com-

plementary measures - such as consolidating the freight industry, better public transportation, improved road maintenance, management and capacity – should also play a central role in reducing road transport, and thus carbon emissions and congestion. Much of this investment should come from the revenues of road pricing.

6 S Glaister and D Graham, *National Road Pricing: Is it Fair and Practical?* (SMF, 2006).

Making road pricing a reality

Moving forward with road pricing and the complementary packages of interventions to sustain reductions in traffic, congestion, and carbon emissions requires:

- understanding the nature of congestion and traffic growth;
- assessing the current transport infrastructure;
- identifying future pressure points;
- planning the systems operations; and
- ensuring the equity of any scheme put forward.

Piloting would enable the government to explore these issues and also develop a coherent and consistent national framework, thereby fostering public approval. This process would also facilitate the transition to wider implementation and enable policymakers to devise a scheme that balances the potentially opposing objectives of national consistency and local flexibility.

Given the general move towards devolution of powers away from Whitehall, it seems likely that considerable powers and discretion in this area could be left with local government. This is certainly the spirit of the current policy of encouraging local authorities to work out 'pilot' schemes under the Transport Innovation Fund (TIF).[6]

The technology required to support road pricing would need to deliver on the policy objectives of a reduction in congestion and carbon emissions, as well as the operational requirements.

In addition, the effectiveness of technology would depend on the system in which it operates. Factors such as piggy backing proven technologies, running costs, data sharing and interoperability are vital to convincing motorists and government that a system of road pricing is worthwhile and effective.

Achieving public acceptability and equity

The success of road pricing will depend on the public's perception of its necessity, justification and value.

This will require careful handling. Motorists potentially see road pricing as inherently unfair, as they will be charged for something that was originally free. Moreover, they may feel it is coercive if they perceive that they are forced into paying the charge because of a lack of alternatives.

This may be of particular concern for those on low incomes. Most of the research into attitudes in this area shows the two main equity concerns are for those on low incomes and those with no real alternative.[7] Consequently, raising revenue from this scheme may be more acceptable if it is transparent that it is diverted to investment in other forms of transport, in order to provide viable alternatives.

It would be worth considering the use of exemptions for those particularly affected. The appropriate use of exemptions, while investing revenue into viable alternatives to car usage for motorists, would go a long way to increasing acceptability in the public arena and the political sphere.

Policymakers will need to weigh these concerns about acceptability and equity alongside other issues, such as efficiency and effectiveness. Some trade-offs may need to be made. Although not necessarily mutually exclusive, policymakers should be wary of sacrificing one objective at the expense of another.

A road map for road pricing

We suggest that the precursor to road pricing should be a road map, especially as the scale of a national road pricing scheme in the UK would be unprecedented across the world. This would be a clear and transparent guideline setting out the government's vision for road pricing, which would enable both the public and business to judge adequately their level of support for road pricing until policymakers are able to provide greater detail on any potential schemes.

International comparisons show that other schemes required political leadership promoting the benefits of road pricing, and a clearly defined, coherent and complete policy as a prerequisite for success. Establishing political leadership and

consensus is, therefore, essential to develop and follow a road map for road pricing.

First, the road map should clarify the objectives of the scheme, the finance and governance, the desired type of charging and the technologies to be used.

Second, local and national government would need to develop the necessary political leadership and build a public consensus around road user charging. Together, they would then develop or implement the appropriate technology and put in place the appropriate financial and governance structures needed to pilot the scheme.

Finally, lessons would need to be learned from the pilot before a wider roll out.

But what would road pricing in the UK look like? What would it need to test? It is important to strike the right balance between the potentially conflicting objectives:

- reducing congestion;
- reducing carbon emissions;
- economic and political viability; and
- equity concerns.

This would seem to favour setting aside significant portions of the revenue for investment in roads and public transportation. Consequently, we favour a road pricing system that includes:

- a significant degree of additionality;
- VED discontinued in favour of a high-level fuel environmental objective;
- banded road pricing based on fuel efficiency and emissions output;
- additional revenues hypothecated for reinvestment in roads and public transportation; and
- a distance-based charge that forms the basis for charges that vary by time of day and traffic levels.

By working within the consistent and coherent framework already in place with the Transport Innovation Fund and the Road Pricing Local Liaison Group, this approach would see local and regional authorities taking on a degree of responsibility over road pricing in their respective areas.

We also suggest that a clear timetable for implementa-

7 Lyons et al, *Evidence-Base Review – Attitudes to Road Pricing* (Centre for Transport and Society, 2004), and E Green and V Stone, *Public Attitudes to Road Pricing in the UK: a Qualitative Study* (prepared for the DfT, BRMB Social Research, 2004), and Raje et al., *Edinburgh, Road Pricing and the Boundary Problem: Issues of Equity and Efficiency* (report for the Scottish Economics Policy Network, June 2004).

tion should be established. While this could imply a 'big-bang' approach with charging introduced on a specified date, we would strongly urge a more measured approach in which road pricing is implemented in stages. For example, this could proceed from piloting to charging in urban areas and the strategic road network, up to charging for driving on all UK roads.

By advocating a road map for road pricing, we note that there is neither a single preferred route nor a single preferred destination. Nor would we suggest an upfront commitment by government to a single concept of road pricing. Rather, we argue that by setting out more detailed objectives for road pricing in the UK, the government would be better positioned to begin developing public acceptance to ensure a successful introduction of any scheme.

Nor is road pricing a miracle cure for all land and transport policy issues. Road pricing works best when it provides clear and simple, yet strong signals to motorists about the costs of driving. As such, road pricing can be an effective policy tool for tackling congestion and reducing carbon emissions.

Introduction

Given the immense growth in the number of vehicles, the present taxation methods do not effectively restrain the use of the roads in the right places at the right times and new methods may have much to contribute in limiting the losses due to traffic congestion.
Smeed Report, 1964[8]

Economic growth and increasing prosperity over the past 40 years have meant an increase in car ownership and car use. Internet shopping and just-in-time deliveries mean that more goods are delivered by roads than ever before. As a result, the UK is suffering significant time lost queuing in traffic, unpredictable journey times and rat-running through residential streets, which also damage quality of life and hinder national productivity.

The reasons for tackling congestion on UK roads are compelling. Estimates place the cost of congestion at between £10 and £20 billion per year[9] while road transport currently accounts for just over one-fifth of all UK carbon emissions – the main gas responsible for the human contribution to climate change.[10]

There are a range of policy options to tackle congestion, other than road user charging. These include regulations designed to move traffic efficiently, such as one-way streets, parking restrictions and zebra crossings, and restrictions on certain types of vehicles in city centres. Yet these approaches have obvious limitations. As a market-based solution to tackling congestion and reducing emissions, road pricing has the potential to provide clear, transparent, yet strong signals to drivers about the true costs of motoring.

The merits of road pricing in tackling congestion in the

8 Smeed, op. cit.

9 DfT (2004) op. cit.

10 DfT (2004) op. cit. and DEFRA, *E-digest of Environmental Statistics,* 31 March 2005, http://www.defra.gov.uk/environment/statistics/index.htm (22 February 2006).

UK were recognised as far back as 1964 in the Smeed Report.[11] The question now is not *whether* road pricing could work, but rather *how* best to make it work in practice.

If we are to maximise the effectiveness of road pricing in reducing congestion it will need to be accompanied by complementary investment in public transport. This would allow motorists to choose alternative transport for essential journeys. Investment to maintain the road network would also be crucial to promote productivity, stability and economic growth in the UK.

There are significant questions to address about the design of a road user charging system that would work for the UK. These questions are political, technical and economic in nature.

For example, what should the objectives of any road pricing system be? Tackling congestion, reducing carbon emissions or both? And should the potentially significant revenues raised be returned to motorists, reinvested in roads and public transport, or returned to the Exchequer as part of general taxation? The answer to this latter question would not only have an impact on motorists' behaviour, but also on the degree of public acceptance any scheme would enjoy.

The design of a road pricing scheme would also need to take account of equity considerations. We would risk socially excluding drivers on low incomes in areas with poor public transportation if they could not afford to pay the charge. Businesses too could be hurt if road pricing made going to the shops in certain areas too expensive, or if it favoured shops just outside of a charging area.

Ultimately the success of any road pricing scheme would depend on policymakers' ability to balance the inevitable trade-offs between efficiency, public acceptability and equity.

This report explores this balancing act and goes on to suggest a road map for road pricing. It does not seek to provide final answers on road pricing in the UK. Instead it sets out a path for policymakers as to how to make road pricing work in practice.

11 Smeed, op.cit.

Chapter 1: The economics of road pricing

An efficient and free-flowing road network is essential to the UK's productivity, stability and economic growth. Yet the already significant pressures on the existing road system are set to increase as the economy and population grow over the next decades.[12] Increases in car ownership, commuting distances and use of just-in-time deliveries suggest that by 2010, traffic levels will have risen by around 25% over 2000 levels.[13]

Traffic levels are also damaging the environment. Road transport currently accounts for just over one-fifth of all UK carbon dioxide (CO2) emissions – the main gas responsible for the human contribution to climate change.[14] If current trends continue, this rate will rise to just under a third by 2010, damaging the prospects of the UK meeting its 2010 emissions targets and eroding carbon savings from increased energy efficiency.

Road traffic has worsened in the past two decades. Since the mid-1980s, the average number of trips by car per person has increased by 24%. Traffic on UK roads increased by over 20% between 1993 and 2004.[15] By 2010, traffic levels are expected to rise a further 23-29% over 2000 levels.[16]

The problems associated with congestion on UK roads have been recognised for a long time: the 1964 Smeed Report was the first to recommend the introduction of a pricing system to combat congestion.[17] Now government ministers have called for a national debate on road user charging in response to these daunting road transport statistics.

This chapter explores the economic principles that underpin road pricing, including the negative externalities that should

12 Office for National Statistics, *National Population Projections 2004-based* (The Stationery Office, 2006).

13 Department for Transport, *Transport Statistics of Great Britain: 2005* (DfT, 2005).

14 DEFRA (2006).

15 Julie Foley and Malcolm Fergusson, *Putting the Brakes on Climate Change: A Policy Report on Road Transport and Climate Change* (ippr, 2003).

16 DfT (2005) op. cit.

17 Smeed, op. cit.

be addressed by a scheme. These are the economic, social and environmental costs of driving that are borne not just by the driver but also by the broader public. Specifically, it looks at the degree to which the real cost of congestion, road transport emissions or road wear and tear can be reflected accurately or effectively in road pricing, and the variables to be considered when taking this decision. We also consider the price sensitivity of different groups of road users.

Why road user charging and why now?

A March 2005 Populus/*The Times* poll on experiences with public services indicated that voters are less satisfied with transport than with education or health services. In the poll 43% of respondents rated transport as 'bad' compared with only 22% for education and 23% for health.[18] A MORI poll in August 2005 showed that 57% of respondents thought road congestion was a problem everywhere, while unreliable journey times and pollution/health concerns were both listed by 45% as the biggest impacts of road congestion.[19]

To deal with the strains of rising congestion, air and noise pollution, road accidents and infrastructure depreciation, government is increasingly relying on policies that help manage the demand for motoring more efficiently. For example, the active traffic management pilot on the M42 helps to distribute traffic efficiently during peak hours. The Department for Transport (DfT) has also promoted ride-sharing by introducing high-occupancy vehicle or car pool lanes on the A467 in Leeds and the A432 to the M32 in Gloucestershire.[20] More dynamic means of managing traffic include the London congestion charge and road pricing in Durham's historic district.

Traditionally taxation mechanisms, such as the fuel tax and the vehicle excise duty (VED), have been the main levers used to constrain growth in traffic levels and emissions. Yet these have had a limited impact. Despite a rise in the real price of petrol since 1990, road traffic increased by 14% between 1990 and 2000 and is predicted to rise another 25% by 2010.[21] In addition, road transport's share of total UK carbon emissions is set to rise by just under a third by 2010, overtaking domestic, industry and service sector emissions.[22] These issues are discussed further in the next chapter.

18 Populus Limited, *Populus/The Times Poll, 8-12 March 2005* (http://www.populuslimited.com/, 14 November 2005).

19 MORI, *Detica Poll, 4 August 2005* (http://www.mori.com/polls/2005/detica2.shtml, 14 November 2005).

20 Alistair Darling, *A 21st Century Transport System for the North West* (speech to the Manchester Chamber of Commerce, 21 October 2005).

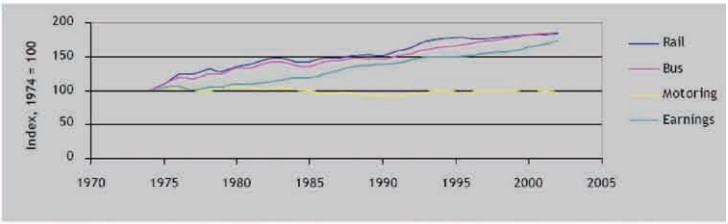
21 DfT (2005), op. cit.

22 ippr, op. cit.

The limited impact of the fuel tax and VED in reducing traffic and emissions may in part be due to the fact that, despite the real rise in petrol prices, the costs of motoring have fallen relative to the costs of public transport and to the level of average earnings (shown in figure 1).

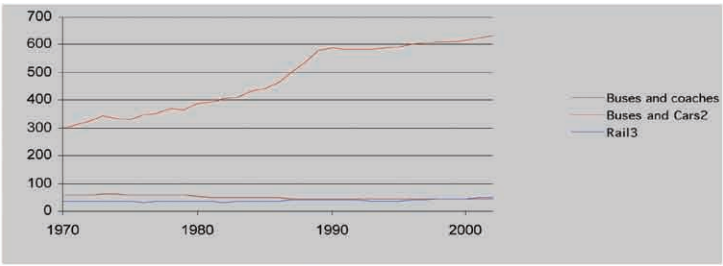
It is not surprising, therefore, that car traffic has risen steadily over the last three decades while public transport traffic has remained relatively constant (see figure 2). As car travel has become relatively cheap compared to both earnings and alternative modes of transport, more and more people have chosen to travel by car.

Figure 1 – Average earnings and the costs of road transport



Sources: DfT Bus Operators Survey, 2002; ONS New Earnings Survey, 2002a; ONS Cost of Motoring Index, 2002b; and ONS/SRA Rail Fare Index, 2002.

Figure 2 – Passenger transport by mode – billions of passenger kilometres



Source: Department for Transport

Although fuel duty is a form of distance-based road pricing, its primary effect has actually been to encourage fuel efficiency rather than reduce car use. Motorists' response to rising petrol prices has been to lower their fuel duty by increasing fuel efficiency but without altering their travel behaviour. As the impact of fuel duty on congestion and emissions appears limited, the

current policies for pricing road use in the UK are not likely to reflect adequately the economic, social and environmental costs of motoring. There is little political appetite for further increases in fuel duty - which has not risen with inflation since the fuel duty escalator was abandoned in the 1999 Pre-Budget Report. This is unsurprising given public attitudes. In an August 2005 Mori poll, only 5% of respondents thought increasing taxes on road users would be the best way to tackle congestion, while only 4% approved of increasing the price of petrol.[23]

Since the necessary increases in fuel duty to reduce congestion are unlikely, road pricing is the only feasible alternative mechanism to help motorists face the full cost of their road journeys.

23 MORI, op. cit.

The economics of road user charging

The primary economic problem regarding road use is that the person making the journey does not face the total cost of each road journey. By their use of the road network, motorists impose additional costs – such as congestion, road wear and tear, noise and air pollution, and external accident costs – borne not by themselves alone but rather by the general population. These additional costs, or *marginal external costs,* are separate from the costs that motorists themselves face, such as time costs, the fuel duty and vehicle wear and tear.

The objective of road user pricing is to change motorists' behaviour by making the cost of each journey more closely reflect the actual social cost rather than the individual cost of driving an additional mile.

According to economic theory, motorists will drive until the point where the benefit they get from driving is exactly offset by the cost they face: that is, the more someone values a particular journey, the more they would be willing to pay to make it. As the true cost of motoring is not limited to just the private costs faced by an individual motorists, motorists tend to drive to a point at which they are contributing to congestion and harming the environment.

Road pricing works, at least in theory, by giving priority to those with the greater willingness to pay a higher price that truly reflects the economic, social and environmental costs.

Efficiency, equity and welfare

By making drivers pay for the external costs of their own motoring, road pricing can improve the efficiency of the road transport system. Efficiency can either imply *allocative efficiency,* which refers to the level of traffic thought to be optimal from a society's point of view, or *technical* or *x-efficiency,* essentially how productive the road system is. In theory, road pricing can achieve both.[24]

Though introducing road user charging can improve welfare in the simple model discussed above, there would be distributional or equity effects of moving towards a system of charging motorists for road use. As noted, road pricing is meant to ration road travel on the basis of willingness to pay. Richer people tend to place a higher value on time and so will pay the charge, while those on lower incomes tend to place a lower value on time and will seek to travel less frequently or at other times, by other modes and to other destinations.

However, many of those for whom the charge would be an imposition may not be able to make alternative arrangements without compromising their participation in society, particularly where alternative forms of transport are not available. Consequently, introducing road user charging runs the risk of increasing social exclusion if inadequate public transport means that there are few options when choosing whether or not to pay a road user charge. This lack of equity across socioeconomic groups, addressed in chapter 6, could undermine public support for road pricing and offends against equity concerns.

24 S Smith, 'User Charging: Some Efficiency and Equity Implications', in J Asato, ed., *Charging Ahead: Spreading the Costs of Modern Public Services* (SMF, 2006).

Choosing the policy objectives of road pricing

While economic theory suggests an optimal road pricing scheme would price-in the costs of congestion, including carbon emissions among other social costs, policymakers would have to decide which of these social costs it would be desirable as well as feasible to include in the objectives of any road pricing scheme. Thus far in the UK, the debate about road pricing has focused on tackling congestion. Yet a charging system could potentially address a range of other issues.

The nature and extent of these negative externalities can vary by road type, location, time of day, vehicle type and speed. It is possible to develop a pricing mechanism that is sensitive

25 CBI, *The UK as a Place to do Business: Is Transport Holding the UK Back* (CBI, 2003).

26 Bernhard Oehry, *Swiss Heavy Vehicles Fee LSVA* (RappConsulting, 15 September 2006).

to the varying nature of the marginal costs. It is also possible to retain simplicity by designing a crude flat-rate charge large enough to account for these variations. The London congestion charge explicitly targets congestion only, with a flat rate, daily charge, yet it has reduced emissions and accident rates, as well as congestion, within the charging zone.

ongestion, greenhouse gas emissions and road wear and tear are issues that rank highly in public opinion surveys about the negative impacts of road transport. They have a direct link to the broader economic, environmental and social goals of current policy objectives as well as any potential road pricing scheme.

Congestion

Road congestion in the UK is worse than in any other country of the old European Union of fifteen. In the UK, nearly 25% of trunk roads are congested for more than an hour a day, compared with just 15% in the Netherlands. Twenty per cent of motorists in the UK regularly experience congestion, compared to 7% in Germany and 4% in France. The UK's reliability-of-journey ratings are 10% lower than those of the US and almost 9% lower than those of Germany.[25]

Congestion, however, is not homogenous. Its nature depends on its location, with congestion on trunk roads differing from that on dense urban road networks. For example, making motorways and trunk road more efficient and productive could lead to more traffic driving at faster speeds. In this case, reducing congestion could increase emissions. By comparison, in dense urban networks such as London, much of the benefit from cutting congestion stems from reducing the queuing times at junctions. Here, reducing congestion lowers emissions, as vehicle emissions are at their worst when cars are caught in traffic.

In other words, though using road pricing to reduce congestion will necessarily imply lowering traffic levels at a given location and time of day, it might also imply raising overall traffic flows and congestion. In the modelling of potential UK schemes congestion can fall even as traffic and carbon emissions rise: less congested roads can be more productive and accommodate more cars.[26] In contrast, the congestion charge covers

the dense roads of central London and has benefited from the latter effect, reducing congestion by 30% and overall traffic flows by 18%.[27]

These examples raise the question of whether motorway/trunk road congestion and dense urban road congestion can be considered as the same phenomenon, and whether they should be treated as such by a congestion charge. They also raise the question of whether reducing congestion should be the only marginal external cost made explicit by road user charging.

Though London serves as a good example of charging in urban zones, it is unlikely that reducing congestion at the expense of increased emissions and overall traffic would be an acceptable outcome of road pricing in the UK.

Greenhouse gas emissions and other air pollution

As road transport's contribution to greenhouse gas emissions is predicted, on current trends, to rise over the coming decades, it is important that motoring internalises these costs in some way. As greenhouse gas emissions are a negative externality of motoring, road user charging could include simple mechanisms that make these costs explicit.

For example, the Swiss lorry charge is based on distance, weight and emissions class. By explicitly incorporating emissions and weight classes into the charge, the Swiss scheme brought about changes to fleet composition and the overall structure of the road transport sector, while lowering the trend in mileage for lorries. Annual increases of 7% in lorry traffic in the years before the charge were followed by a 4% drop in 2001 and a further 3% decline in 2002, before stabilising in 2003. Emissions of CO2, nitrogen oxides (NO_X) and particulate matter$_{10}$ (PM_{10}) [28] were each 6-8% lower than expected.

A relatively simple charge, the London congestion charge does not vary its rate as a function of emissions, beyond rebates for electric vehicles. However the nature of congestion in London means that emissions in the charging zone and during charging times have lowered: CO2 emissions are down by 20%, total primary emissions of NO_X and PM_{10} by 16% and fossil fuel use by 19%. Emissions on the inner ring road (the boundary for the charging zone) were predicted to rise as traffic from the centre was displaced on to these roads, but in fact have only

27 Transport for London, *Central London Congestion Charging: Impacts Monitoring, Third Annual Report* (TfL, 2005).

28 PM_{10} is particulate matter with a diameter of less than ten microns.

changed by 1% from pre-charge levels.[29]

So although simple pricing mechanisms make environmental costs explicit, they might not be necessary in some areas, as reducing congestion could reduce emissions (as in London). But as congestion varies by road type, so do the secondary effects of congestion on emissions. As a general rule of thumb, emissions reduce as speed goes from 0-10 kilometres per hour (kph), but tend to increase sharply after 45 kph.

A charging scheme that focuses solely on congestion might see emission benefits isolated to areas with congestion on dense urban networks, without effectively accounting for the full extent of environmental costs incurred on the rest of the system.

However uncertain we are about the science and the economics, it is known that a small change in emissions will not make much difference to the problem of global warming. In the short run, given the capital structure of mechanisms to reduce emissions, even quite small reductions of emissions can be expensive. Thus it is reasonable to assume that, in the short run, the damage function (the welfare benefit of a decrease in greenhouse gas emissions) is fairly flat, relative to a steeper cost function of reducing greenhouse gas emission. Hence a tax is a more appropriate tool than permits or a regulatory solution.[30] If the fuel tax is not constructed in such a way as to internalise the marginal cost of emissions, then perhaps including emissions in the road user charge is an appropriate mechanism for making explicit the marginal cost of emissions.

Road wear and tear

An increasingly strained transport infrastructure can undermine sustained productivity growth. The CBI has stated that an increase in public spending commitments for transport infrastructure over the next ten years would have the effect of reducing congestion, improving efficiency and supporting economic growth and employment.[31] Road user charging could incorporate the costs of the wear and tear on the road networks, thereby ensuring that motorists pay for the marginal social cost of their travel.

The wear and tear caused by both rigid and articulated heavy goods vehicles far outweighs the cost of cars and light delivery vehicles.[32] However, cars and vans contribute more

29 TfL (2005), op. cit.

30 D Helm, *A New British Energy Policy* (SMF, 2005).

31 CBI, *Transport Policy and the Needs of the UK Economy, Transport Brief* (CBI, 2005).

32 T Sansom et al, *Surface Transport Costs and Charges* (Institute for Transport Studies, University of Leeds, 2001).

heavily to congestion than lorries. This raises the question of whether both should be part of the same charging scheme. The cancelled lorry road user charge (LRUC) scheme in the UK was originally designed to modernise the tax structure of the freight hauling industry, by creating a fairer taxation (vis-à-vis international lorries) and by decoupling taxation for haulage industry vehicles from that of private vehicles.[33] A road user charging system focused solely on congestion or emissions might have difficulties maintaining these objectives.

Price sensitivity of different user groups

The extent to which motorists respond to road pricing will depend on how sensitive they are to changes in the price of driving. A wide range of factors influence this behavioural shift, including: the current costs of motoring; the level of fuel duty and VED; the availability and cost of alternative modes of transport; the purpose of the trip; and the time of day and the socioeconomic status of the driver.[34] Understanding motorists' sensitivity to price changes would be essential to balancing improved efficiency with concerns for equity and public acceptability in any road user charging scheme.

Alternative/public transport

Price sensitivity will depend on the cost and availability of alternative modes of transport. Expensive or inaccessible public transport could leave the motorist with an inelastic demand for motoring and little choice but to pay the charge, no matter the cost, while good public transport links or relatively cheaper options will result in a more sensitive response to road pricing.

Trip purpose

Motorists' willingness to pay the user charge would also depend on how integral road transport is to their trip purpose.[35] For example, a survey in 2002 of 91 express lanes users in southern California showed that the most frequent travellers on these toll roads were females aged 30 to 50 on the school run.[36]

In the UK, 29% of all car trips in 2004 were for leisure, 20% for commuting or business, 19% for shopping, and 8% for education purposes (or escorting family to education).[37] Commuting and trips for educational purposes are of particular

33 HM Treasury, HM Customs and Excise and DfT, *Regulatory Impact Assessment: Lorry Road User Charge* (The Stationery Office, 2005).

34 See Appendix A for further details.

35 G de Jong and H Gunn, 'Recent Evidence on Car Cost and Time Elasticities of Travel Demand in Europe,' *Journal of Transport Economics and Policy* (36, 2001, pp1-26), and S Glaister and D Graham, *Transport Pricing and Investment in England: Technical Report* Working Paper (Imperial College: London, 2003).

36 *Regional Value Pricing Corridor Evaluation and Feasibility Study* (North Central Texas Council of Governments, June 2005).

37 Department for Transport, *National Transport Survey: 2004* (DfT Transport Statistics, 28 July 2005).

concern when considering how congestion can be reduced, as these trips are essential and take place at the most congested times of day. Motorists for whom a car is essential for their trip are likely to have a higher willingness to pay for that journey.

Socioeconomic status

While a variety of factors, such as the availability, quality and price of public transport, will, along with socioeconomic status, determine which motorists pay the user charge, frequency of willingness to pay tends to be correlated with income. Thus, while a demographic breakdown of motorists who pay the road user charge, for example mothers on the school run on the 91 express lanes, might reflect the demographics of non-users, the frequency with which a certain income group is able to pay could be biased towards those with higher incomes.[38] In such cases, ability to pay, rather than willingness to pay would determine motorists' price sensitivity.

Rural versus urban roads

Motorists in rural areas make more road trips, drive further and use less public transport than those in urban areas, at least partly due to the lack of alternative transport. Consequently, people living in rural areas could have difficulties finding alternatives to paying a road user charge. A one-size-fits-all charge would probably not be sensitive enough to their road transport needs.

Other taxation

The inter-relationship between road pricing and other forms of taxation on car use, including VED and fuel tax, could affect how charging would change motorists' behaviours. If it were introduced in addition to the existing tax structure, road user charging has the potential to reduce traffic by 9% overall. On the other hand, a revenue-neutral road user charge could raise national traffic by 12% as lower marginal private costs, through lower road taxation, induce higher overall levels of car traffic.[39] Understanding this inter-relationship is integral to the design and implementation of road user charging and is explored further in the next chapter.

38 North Central Texas Council, op. cit.

39 ibid.

Time of day
Price sensitivities may vary by peak and off-peak times – motorists able to adjust their journeys to just before or just after peak traffic periods might not see their demand for vehicle kilometres drop as significantly as those whose journey times are fixed.

Conclusion

In a perfect market, motorists faced with a road user charge would have the choice to pay the charge or seek alternative arrangements. As discussed, road pricing rations road transport on the basis of willingness to pay and ability to pay. Thus, there will always be people for whom the car is essential to their current pattern of participation in society. Varying degrees of price sensitivity would have implications for how a road user charge affected motorists' behaviour and thus contributed to the goals of the charging system.

It is unlikely that the full costs of private car use could be reflected in any road pricing scheme, not simply because of any political barriers but also because doing so may not be technically feasible or desirable, or because added complexity may lower public acceptability. Indeed, the impact of different configurations of pricing on different social groups will be an important issue, both for public acceptability and for equity.

Although policymakers need to be concerned about its equity implications, road pricing is an economic instrument for changing the behaviour of motorists that can improve the efficiency of UK roads. The current tax and charging structure is insufficient to address the increasing social costs of congestion, emissions, infrastructure depreciation, noise and external accident costs. Road pricing can fill the gap.

Chapter 2: The revenues of road pricing

The current primary form of road transport taxation in the UK, the fuel tax, has had some success in inhibiting motoring, limiting growth in CO_2 emissions and raising revenue. However, as traffic levels and congestion are predicted to worsen over the coming decades, even under the most optimistic of estimates fuel duty is increasingly unlikely either to inhibit or cover the costs to society of this additional motoring. With no means of differentiating journeys made by motorists – for example, by time of day, location or road type – fuel duty is also a rather blunt policy instrument with which to tackle congestion.

Significant increases in fuel duty might also be politically untenable. The fuel protests of 2000 and the likelihood of sustained, high pre-tax pump prices have limited the political acceptability of increases in the fuel duty over the short- to medium-term. Since the increases in fuel duty necessary to reduce congestion are unlikely, road user charging has emerged as a policy instrument with the potential to reduce congestion by making motorists face the full cost of their road journeys.

How road pricing affects motorists behaviour depends, in part, on how the revenues would be used. For example, research shows that road charging introduced on a nationally revenue-neutral basis (for example, by reducing other road transport taxation) may decrease congestion but at the cost of increases in overall traffic levels and emissions.[40] In contrast, an alternative approach may be to levy the charge on top of current taxation, with the additional revenues spent on improving local and national public transport and road capacity, management and maintenance. While a UK road pricing scheme could fall somewhere in-between these two polar opposites, they illustrate the

40 See S Glaister and D Graham, *National Road Charging: Winners and Losers* (Independent Transport Commission, 2006); Foley and Fergusson (2003) op.cit. and DfT (2004) op. cit.

effects on motorists' behaviour of road pricing on a revenue-neutral or revenue-additional basis.

Two dominant arguments tend to be employed in support of a revenue-neutral congestion charge. First, a road user charge could be an economically more efficient means of pricing road use if it raised overall welfare relative to the fuel duty and provided a sustainable source of revenues. Second, public acceptability of road pricing would be greater if the charge were seen as in place of, rather than additional to, current motoring taxes.[41]

However, this approach would not allow alternative uses of the revenues from road pricing, specifically, investing the revenue raised in public transport. This approach could improve the efficacy and equity of road pricing.[42]

The analysis in this section assumes that reducing congestion is not necessarily a sufficient condition for reducing overall traffic levels or emissions as discussed above. In addition, it assumes that road pricing in the UK should be economically and politically viable, should give appropriate priority to concerns about equity, and should allow for significant contributions to reducing greenhouse emissions.

This chapter also explores the potential for revenue-neutrality and additional spending by comparing the roles of current road transport taxation and road pricing in changing motorists' behaviour and raising revenue. We then examine some of the principal concepts, tensions and trade-offs that should be considered as part of the debate on how road pricing revenues could be used progresses.

41 DfT (2004) and MORI (2005) op.cit.

42 ibid.

43 Authors' calculations from http://www.statistics.gov.uk/STATBASE/Expodata/Spreadsheets/D5688.xls (25 January 2006).

The current structure of road transport taxation

Road transport taxation in the UK includes a variety of measures, such as fuel duty, VED, congestion charging and tolls. Fuel duty is by far the largest element, accounting for over 82% of national road taxation revenues, while VED comprises around 18%.[43] Of the two, fuel duty is the more dynamic tax, charging motorists for distance travelled, while the VED is a one-off charge, able to differentiate between vehicles, particularly heavy goods vehicles, broadly by weight and type and, consequently, can be seen as a tax on ownership, rather than on use. As we are interested in pricing road use, here we will focus primarily on fuel duty.

Fuel duty

The pump price of petrol has three components: the pre-tax price of fuel, fuel duty and value added tax (VAT). Though the duty rates for road fuel are differentiated by type of fuel – petrol, diesel, road-fuel gases and biofuels – the revenues raised from duties on ultra low sulphur petrol and diesel account for almost 99% of all fuel duty revenues.[44] As of June 2005, the UK had the highest combined fuel tax rate – duty plus VAT as a percentage of post-tax price – of any EU member state, with tax accounting for over 70% of the total pump price.[45] Yet despite this high tax rate, road congestion in the UK is worse than in any other country of the old European Union of fifteen member states.[46]

Recent history of fuel taxation in the UK

Following an increase of almost 60% in traffic levels in the UK from 1979 to 1990, the then Conservative government raised fuel duty by 10% in 1990, by 15% in 1991 and, in 1993, introduced the fuel duty escalator, whereby fuel duty increased by a set amount over annual inflation.

Originally set at three percentage points per annum above inflation in the 1993 Budget, the escalator was meant to raise revenue and discourage car use on environmental grounds.[47] In November 1993, the escalator was raised to 5% per annum above inflation, growing to 6% in 1999. The 1999 Pre-Budget Report then scrapped the escalator, leaving fuel duty to rise only with inflation. Frozen from March 2001 to October 2003, the fuel duty on both petrol and diesel was then increased in autumn 2003 by 1.28 pence per litre and remained unchanged until the 2006 Pre-Budget Report increased petrol and diesel duty by an inflationary 1.25p a litre.

With the pre-duty price of fuel relatively constant during the 1990s, increases in the pump price of petrol and diesel were entirely driven by fuel duty increases. However, since 2000, changes in the pump price of fuel have been almost entirely driven by market forces.[48]

After stagnating from 1999-2003, the revenues raised by the fuel tax have risen only slightly over inflation over the past two financial years.[49] The fall in fuel tax revenues has come about largely because the fuel duty escalator has been aban-

44 See appendix B for historical data on the level of the fuel duty and the revenues raised.

45 A Leicester, *Fuel Taxation* (The Institute for Fiscal Studies, Briefing Note No. 55, June 2005).

46 CBI (2003) op. cit.

47 http://www.publications.parliament.uk/pa/cm199899/cmhansrd/vo990706/debtext/90706-16.htm (23 January 2006).

48 Leicester (2005) op. cit.

49 Authors' calculations based on DfT statistics. See appendix B for further details on the level and revenues raised through fuel duty.

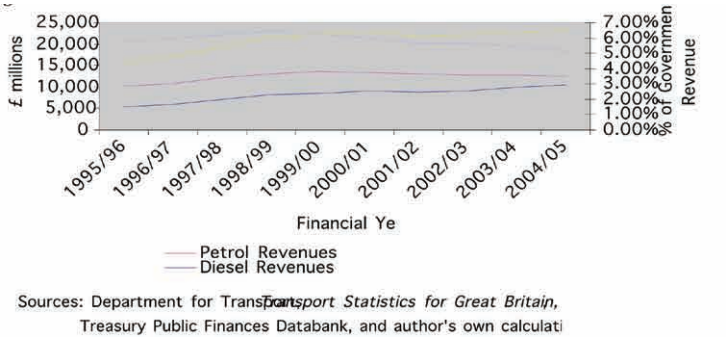
doned, but also because total consumption of petrol and diesel combined has risen by only 1.9%, despite a 6.8% increase in overall traffic since 1999.[50] The implied increase in fuel efficiency, discussed further below, has been due, in part, to a switch by cars and taxis from petrol to the more efficient diesel.

To understand the importance of the buoyancy of fuel tax revenues in perspective, it is worth looking at their contribution to the overall tax take. In the financial year 1999-2000, fuel duties, excluding VAT, raised £22.3 billion, which represented 6.32% of total government revenue. As shown in figure 3, the contribution of fuel tax revenues to total government revenue fell to just 5.20% in 2004-05.

50 DfT (2005) op. cit.

51 For example, the 15-20% reduction in greenhouse gas emissions inside the charging zone for the London congestion charge was primarily due to reduced queuing at junctions. In contrast, increasing traffic flows and speeds on motorways and trunk roads could actually increase emissions. These two effects are both independent of distance travelled, but are both directly linked to engine efficiency.

Figure 3 – Fuel revenue, by fuel type and as a percentage of total government revenues



The economics of fuel taxation

An economically efficient charge for road use would establish a direct relationship between that use (for example, distance travelled or driving on congested roads) and the total cost of motoring, including greenhouse gas emissions and congestion.

However, as noted earlier, as a distance-based pricing mechanism, fuel tax is a rather blunt instrument for reducing congestion and, perhaps, even local emissions. The costs of congestion and road transport emissions to society can vary more than differences in fuel duty. Congestion on motorways, trunk roads and dense urban roads is relatively localised, specific to location, road type and time of day. The environmental costs of greenhouse gas emissions are incurred system-wide, but could also vary by speed, type of congestion and fuel efficiency.[51]

One of the effects of the fuel tax has been that consumers have tended to mitigate the increase in fuel duty by switching to more efficient fuels. Indeed, since 1994, the consumption of petrol by cars has dropped by over 10%, while the consumption of petrol for vans has dropped by 64%.[52] By contrast, the consumption of diesel for cars and light goods vehicles more than doubled over that period. Thus there is evidence that as motorists drive more, the high price of oil – of which taxes account for around 70% of the pump price - has induced a partial switch to more efficient fuels.[53]

52 DfT (2005) op. cit.

53 Diesel fuels, on average, get over 28% more miles per gallon than the motor spirits. Table 3.4, DfT (2005) op. cit.

54 The economics of road user charging were discussed in the first draft briefing paper of this series. For more information on this seminar, please visit http://www.smf.co.uk.

Why a road user charge and not general taxation?

The likelihood that further significant increases in fuel duty are politically unfeasible suggests that there may be an important role for road pricing in changing behaviour.

The economics of road pricing indicate that a road user charge has the potential to be a more efficient means of taxing additional road use.[54] And, although in practice it would be difficult to set the charge to make explicit the full costs of road use, road pricing as a form of taxation has the potential to enhance overall economic welfare or at least not to reduce it relative to the current road tax structure.

Specifically, a road user charging scheme could see efficiency and welfare gains by:

- differentiating between groups of motorists – for example, cars from lorries – because the impact on other motorists and society in general substantially differ from group to group; and
- dynamically charging for the costs to society of congestion and, perhaps, even emissions and road wear and tear.

However, two questions arise. First, if road pricing is proven to be relatively more efficient and to raise overall welfare, then to what extent should or could it replace the fuel duty or road tax? Second, if the effectiveness of road pricing were determined, in part, by how the revenues of the charge are used, then what uses would ensure the greatest efficiency and welfare gains?

Both these issues are also critical to levels of public acceptability of road user charging. General public opposition to tax increases contrast with public demands for additional spending on specific services.

Revenue-neutrality of road user charging

There are a number of benchmarks that could be used when deciding whether a particular approach to road user charging is revenue-neutral. The charge might be revenue-neutral from the point of view of the Treasury (the total tax take from road user charging equivalent to the previous tax take from fuel duty and other forms of road user taxation), local government or the average motorist or the average journey.[55]

In most cases, when discussing revenue-neutrality, policy-makers work on the assumption of revenue-neutrality for the Exchequer. It is worth noting, however, that such an approach would be likely to raise the average cost of a journey, since the overall number of journeys would be reduced.

An alternative approach would be to seek revenue-neutrality for the average journey by estimating road pricing revenues post-charge and then reducing fuel duty or VED so as to make the charge revenue-neutral. Obviously, such an approach would mean a reduction in revenues raised by the Treasury.

Current legislation requires that all revenues raised through road pricing by local authorities must be spent on transport purposes within the area for a period of ten years. However, this does not mean that local schemes could not be locally revenue- or fiscally-neutral. Local authorities could use revenues to reduce other transport taxes and charges, for example, by lowering the prices of local public transportation or parking.

Another approach would be to make the scheme neutral for the average motorist. For instance, the cost of motoring for the average motorist could remain the same by offsetting a road user charge with adjustments, for example, to the fuel duty, insurance rates and parking charges, with higher charges for higher car usage.

Among the potential revenue uses, maintaining revenue-neutrality always ranks highly in public opinion surveys on how road pricing revenues should be used. An RAC Foundation poll suggests that 76% of motorists would find road pricing acceptable if there were an equivalent reduction in fuel duty. A survey by the DfT shows that 60% of respondents would accept a charge if the overall level of motoring tax would not increase. While in a Mori poll in August 2005, 47% of respondents said they would accept road pricing if the road tax were reduced.[56]

55 This approach is used in Glaister and Graham (Independent Transport Commission, 2006) op. cit.

56 See RAC Foundation (2002 and 2006); DfT (2004); and MORI (2005) op. cit.

The importance of revenue-neutrality for public opinion was further confirmed by a recent report that stated that the proportion of people that had a high likelihood of opposing road pricing was reduced by a third when road pricing replaced fuel duty, as compared to when it was levied on top of fuel duty.[57]

The effect on motorists' travel behaviour

A distance-based charge varied by the level of congestion on a road and implemented on a revenue-neutral basis from the point of the Treasury would be likely to reduce traffic in urban areas, but at the cost of an overall increase in traffic across the UK.[58]

This approach would produce significant benefits for some motorists. For example, for rural motorists the reduction in fuel duty would be likely to outweigh the charges they incurred. This is likely to result in an increase in their road use. Glaister and Graham estimate that traffic would actually increase anywhere from 14.4% to 26.3% in the least congested areas, while in the most heavily congested areas overall traffic would fall by up to 40%.[59]

In this scenario, 23% of the population would experience a decrease in the price of road use, which would lead to a consequent increase in road use by this group, while 77% would experience an increase in the cost of motoring and so would reduce their levels of road use.[60] While collectively the UK would be better off, such a scheme could see a redistribution of funds from drivers on congested urban roads to motorists on free-flowing ones.

This analysis raises the question of whether a decrease in congestion at the expense of increased traffic and possibly emissions or an increase in the cost of motoring for the majority at the expense of a decrease in the cost of motoring for a minority would be politically acceptable outcomes of a national road user charging scheme.

57 J Bird and J Morris, *Public Opinion and Road Pricing: Report from Primary Research* (ippr, 2006).

58 In a speech at the SMF, Rt Hon. Alistair Darling, then Secretary of State for Transport, suggested that road pricing in the UK could be distance based with variations for levels of congestion. See www.smf.co.uk for a copy of the speech.

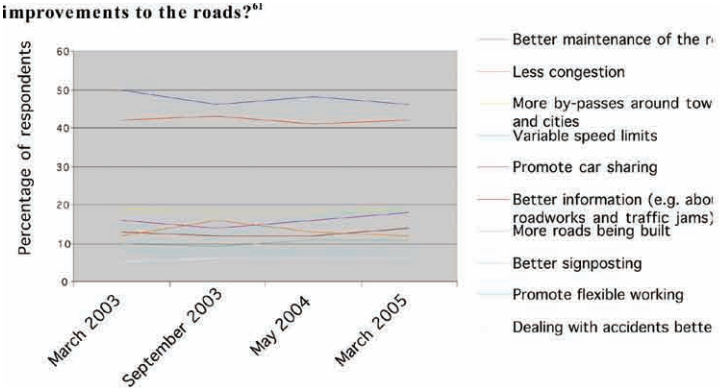
59 Glaister and Graham (ITC, 2006) op. cit.

60 ibid.

The use of road pricing revenues

The way in which revenues from road user charging were spent would also help determine how a road user charge would affect motorists' behaviour and its political popularity. The primary uses, after paying for administrative costs, could be: reducing fuel duty or vehicle excise tax; investing in public transport and/or road management and maintenance; and contributing to general revenues.

Figure 4. Which three things do you think would bring the most improvements to the roads?[61]



Hypothecation

If government sought to go down the revenue-additional route, the public's limited toleration for additional taxation or charges may be overcome by a commitment to spend the revenues on specific measures that enjoy wide support. Initial findings of public opinion on road pricing suggest that there is some demand for improving public transport, better road maintenance and management, improving and building road capacity, and minimising the welfare loss of road pricing.[62]

In other words, if surplus road pricing revenues were hypothecated to transport services, public spending may reflect public preferences and so the public would be happier paying more through a road user charge.[63]

(i) Financing public transport improvements

As noted earlier, one primary mechanism by which a road

61 *DfT Omnibus Survey* (March 2005a).

62 See RAC Foundation, *Motoring towards 2050*, May 2002, DfT (2004), and MORI (2005), Lyons *et al* (2004), and Green and Stone (2004).

63 ibid.

user charge could reduce traffic flows is by facilitating a modal switch to public transport. This switch has proved crucial to the success of the London congestion charge, where a 30% reduction in congestion and a 17% reduction in overall traffic have been complemented by a 37% increase in the number of bus passengers.[64] A DfT survey showed that 53% of respondents thought public transport spending should be the primary priority for spending the proceeds of a road user charge, while 66% said they would be prepared to accept road pricing if there were good quality alternatives to motoring.[65]

A lack of investment in public transport could blunt the impact of the charge. Expensive, inaccessible or unreliable public transport would leave the motorist with little choice but to pay. From government's perspective, the result would be higher revenues with little effect on congestion. Moreover, motorists may become frustrated at having to pay for road use which was previously free and for which they had no real alternative.

In contrast, good public transport links or relatively cheaper options could result in a greater willingness to reduce motoring in response to the charge, as has been the case in London.

Improved public transportation would also assuage some of the equity concerns associated with road pricing. There is evidence that ability to pay could be a more important determinant of who pays a road user charge than willingness to pay.[66] Poor public transport options could mean that those who do not have the ability to pay could see significant welfare losses, as their only choice would be to pay the charge or not travel.

(ii) Financing infrastructure improvements

Although it is clear that the UK cannot build its way out of its traffic and congestion problems, improving road maintenance, management and capacity are necessary as long-term investment. Lack of investment in road infrastructure would have an impact on the productivity, stability, growth and overall competitiveness of the UK economy.

Policies and technologies that improve access to motorways reduce the time it takes to clear up after accidents, and use toll roads and car pool lanes could, along with road pricing, form part of the broader, longer-term demand management approach needed to reduce traffic and lower congestion.

64 Transport for London (2005).

65 DfT (2004) op. cit.

66 A demographic breakdown of motorists who paid the road user charge on the 91 express lanes in southern California reflected the demographics of non-users. However, the frequency of use was significantly correlated with a higher economic status.

However, if road pricing increases efficiency and the productivity of existing roads, it is questionable whether there would still be a case for building new road capacity. In theory, spare capacity would render charging largely ineffective, as new capacity reduces congestion by accommodating the inefficiently high demand for motoring. In practice, this is unlikely to be the case in the UK due to the limited scope for significant expansion.

While road-user charging may have a role to play in the longer-term management of demand, the future competitiveness of the UK economy requires greater journey reliability on the road and rail networks. This requires government to deliver on its commitments in the 10 Year Transport plan and address the history of under-investment in the transport infrastructure.

The Eddington Transport Study and other recent work on road pricing suggests that a road user charge has the potential to provide very clear signals of where investment in road capacity is needed as well as providing the funds to follow through. But a national scheme is still years away. [67]

(iii) Limiting welfare losses and other measures

Although overall road pricing should increase overall welfare by improving efficiency, there could be some groups, such as local businesses, that may incur welfare losses because of the charge. Revenues could also be used to offset these welfare losses.

For example, the bid for Transport Innovation Fund (TIF) pump-priming from Tyne and Wear Local Transport Plan Partnership proposes to study the potential use of revenues to provide a rebate on business rates, thereby compensating business for loss of trade resulting from the charging scheme.[68] It also hopes to assess the feasibility of giving local residents a rebate through the council tax, while Cambridgeshire County Council will investigate means by which the congestion charging regime could be brought within the income tax system. Other measures under consideration include giving parking and public transport credits to those who pay the charge. It is worth noting, however, that mechanisms to limit the impact of the charge on residents would not be possible within a national scheme without significantly undermining the effectiveness of the charge.

67 Eddington (2006) and Glaister and Graham (2006). op. cit.

68 The Transport Innovation Fund was created by the Department for Transport to help fund and support local and regional schemes that are beneficial to productivity, that combine demand management measures to combat congestion, or that use innovative mechanisms to raise new funds.

Conclusion

Although both a road user charge and fuel duty follow the principle of 'user pays', a road user charge is likely to be the more efficient policy instrument of the two, both in terms of changing motorists' behaviour and in consistently raising revenue. While there is a growing understanding of the potential for a road user charge to help reduce congestion, this is often accompanied by the assumption that such a measure should be revenue-neutral.

This is not an obvious choice. Whether or not the charge is revenue- neutral is an important decision for a number of reasons. A road user charge without the retention of some additional measures, such as VED or fuel tax, might not alleviate sufficiently the growing pressures of traffic and road transport emissions. In part this is because it would limit the capacity for spending on improving public transport and traffic management measures. Obviously, cutting other taxes on road use and increasing spending on improved public transport, better road maintenance and management etc are not necessarily mutually exclusive. However, it is only possible to spend the revenues from road user charging once.

It is important to understand too that simply reducing congestion through a revenue-neutral scheme is not a sufficient condition for reducing either overall traffic levels or greenhouse gas emissions. There is clearly a case for making explicit an environmental objective as part of road pricing that tends to suggest at least a degree of revenue-additionality. A road pricing scheme that addressed concerns about equity through the provision of alternative modes of transport would also be one with a degree of revenue-additionality.

Chapter 3: Road pricing and the environment

In discussions about the potential for the introduction of road pricing in the UK, both the former Transport Secretary, Alistair Darling, and the current Transport Secretary, Douglas Alexander, emphasised that the primary objective is reducing congestion rather than cutting carbon emissions. However, recently environmental and climate change issues have become more prominent policy issues. The Stern Review in 2006 set out the economic case of tackling climate change sooner rather than later, while the Eddington Review of Transport stressed the effectiveness of road pricing in cutting carbon emissions. This raises the important question of whether road user charging should be designed in such a way as to incorporate the costs of environmental damage – in other words, whether environmental goals should be an explicit and primary objective of a road pricing scheme.[69]

Douglas Alexander has commented that using road pricing to reduce congestion may not be inimical to the DfT's work on reducing carbon emissions. However, if environmental objectives are incorporated into the scheme directly, questions arise as to: the mechanisms that exist for incorporating engine size and/or efficiency into the scope of the scheme; forms of taxation that should sit alongside the scheme to create incentives to reduce greenhouse gases; and the trade-off between being able to predict the cost of journeys and environmental benefits of the scheme.

This chapter considers road transport emissions generally and the DfT's policy on reducing emissions. It looks at: the potential for environmental objectives to be incorporated into a

69 Rt Hon. Douglas Alexander MP, *Reducing Carbon Emissions from Transport* (uncorrected evidence to Environmental Audit Committee, 14 June 2006).

road pricing system; schemes that have been successful in reducing emissions; issues of complexity and feasibility of incorporating environmental objectives; and the soft transport demand management efforts that could complement a road pricing scheme to achieve environmental objectives.

Road transport and emissions

Periods of economic growth are generally associated with increases in road traffic and emissions, as the increased economic activity generates more commuting, more deliveries and more leisure travel. Indeed until 1990, road traffic and emissions rose roughly in line with GDP. Reducing emissions requires severing the link between economic growth and increased traffic and emissions.

This decoupling has already begun. Although GDP grew by 35% from 1990 to 2003, traffic increased by only 19%, while carbon emissions from road transport increased by 10%, which the Department for Environment, Food and Rural Affairs (DEFRA) suggests indicates relative weakening of the link between road traffic growth and economic growth.[70]

One reason may be that, since around 1990, technological improvements, increases in fuel duty and a shift away from petrol in favour of diesel have improved the fuel efficiency of many cars and helped slow the growth in the emissions of most pollutants.

Yet, deconstructing these aggregate trends shows that for vans and lorries traffic growth was, in fact, 39% while CO2 emissions grew by 30%, roughly matching the 35% GDP growth. In contrast, CO_2 emissions from private cars grew by only 8%, while traffic grew 17%.[71] These statistics show quite clearly that although car traffic and emissions may have decoupled from economic growth, increased economic activity is still linked to a growth in the movement of freight, which is responsible for almost all of the increases in carbon emissions since 1993.

Vans and lorries have accounted for over 97.7% of the increase in road transport carbon emissions over the same period. In contrast, although the level of passenger car traffic since 1990 has risen by 18.5%, their carbon emissions have risen by only 2.1%.[72]

70 DEFRA, http://www.defra.gov.uk/environment/statistics/supp/spkf08.htm (15 September 2006).

71 DEFRA, *E-digest Statistics about the Global Atmosphere* (Table 5 January 2006) and DfT (2005) op. cit.

72 DfT (2005), DEFRA (2006) op. cit. and authors' calculations.

Figure 5 – Road traffic, economic growth and environmental impacts: 1990-2003, UK

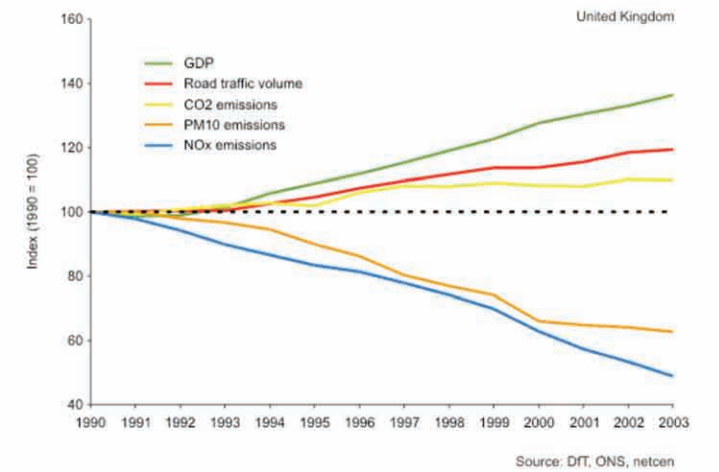
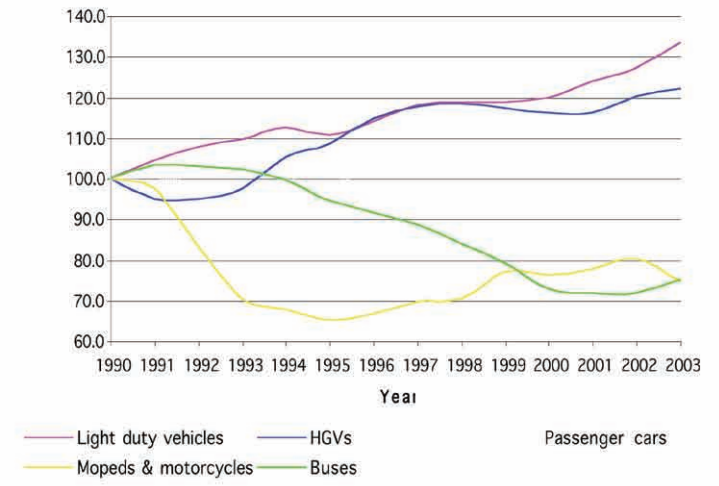


Figure 6 – Index of CO2 emissions (1990=100), by type of vehicle[73]



Looking forward to 2010, the DfT estimates an increase of 15-22% in passenger car traffic, a 19-20% increase in van traffic and a 5-6% increase in lorry traffic.[74] Undoubtedly, much of this

73 DEFRA (2006) op.cit.

74 ibid.

increased traffic may be coupled with improved energy efficiency, as the research and development of low-carbon technologies allow for improved engine and fuel efficiency. However, estimates suggest that carbon emissions from road transport are predicted to grow only slightly more slowly between 2005 and 2015 than in the previous ten years.[75]

These statistics can be broken down into two trends.

- Fuel tax has encouraged passenger car drivers to lower the fuel duty they pay without necessarily reducing mileage, by switching to more efficient fuels, primarily diesel, which, on average, gets over 28% more miles per gallon than petrol.[76]
- The increase in just-in-time and e-commerce deliveries has accelerated the growth of the number and traffic of vans, fostering increases in fuel consumption and carbon emissions.

Consequently, carbon emissions could be reduced if light and partially loaded truck travel was reduced, particularly for pick-up and delivery services. Trends suggest delivery-related traffic is on the increase, with just-in-time and e-commerce deliveries as primary leaders of this growth.[77]

As light commercial vehicles generally travel with spare capacity – almost 40% of all van traffic in 2004 used only 0-25% of capacity – one objective for demand management should be to encourage better organisation and efficiency to utilise this spare capacity, thus reducing mileage and greenhouse gas emissions.[78]

Looking at where growth in traffic may develop should not lead us to overlook carbon emissions from cars, which are responsible for almost two-thirds of all such emissions. Meeting government targets for reducing road transport carbon emissions would need to encompass emissions from both passenger and freight traffic.

One way of achieving this would be to increase fuel duty. In addition to slowing the growth in traffic in the UK, one of the effects of the fuel tax has been for motorists to switch to more efficient fuels. Indeed, since 1994, the consumption of petrol by cars and light goods vans dropped by 11% and 64% respectively, while the consumption of diesel for cars and light goods vehicles more than doubled over that period.[79]

As discussed in the preceding chapter, increases in fuel duty

75 Cambridge Econometrics (2006).

76 DfT (2005) op. cit. table 3.4.

77 In 2004, the Department for Transport revised upwards growth estimates for light delivery vans. See also, http://www.greenhouse.gov.au/local/reduction/transport/measures_freight.html (13 February 2006).

78 DfT, Survey of Van Activity: 2004 (2005a).

79 DfT (2005) op. cit.

are likely to be politically untenable, however, which suggests we might consider other measures to promote fuel efficiency. For example, tax incentives to use hybrid passenger cars and delivery vehicles, and to develop and eventually consume alternative fuels, could all reduce emissions.

Too heavy a focus on this kind of approach may have the perverse effect of increasing congestion, since the cost of motoring for those using alternative fuels would be reduced.

80 Department for Transport, *Climate change and Transport* (2006a).

81 An RTFO would require transport fuel suppliers to ensure that a percentage of their sales in the UK were from a renewable source.

82 ibid.

Government policy on road transport emissions

The DfT shares responsibility with DEFRA and the Department for Trade and Industry (DTI) for the government's climate change public service agreement targets. These require the DfT to work towards two primary targets. The first is the Kyoto target of reducing greenhouse gas emissions by 12.5% by 2008-12 over 1990 levels, and the second is a domestic target of reducing CO2 emissions by 20% by 2010 over 1990 levels.[80]

To meet these targets, the DfT is committed to promoting four policies:

- a renewable transport fuels obligation (RTFO) [81] at a level of 5% in biofuels in annual sales by 2010, which is predicted to save one million tonnes of carbon every year, the equivalent of taking one million cars off the road;
- improving technology to make cars more fuel efficient (since 1997 the average new car fuel efficiency in the UK has improved by almost 10%);
- helping people make informed and environmentally friendly journey choice; and
- working towards the inclusion of transport in emissions trading schemes.[82]

Alongside these four policies, government has several other policy levers to achieve these objectives. As discussed below, these policy levers include:

- fuel duty and VED to provide fiscal incentives for motorists to consider the environmental impact of driving;
- voluntary European agreements on engine size and efficiency;
- tax credits for research and development into low-carbon technologies; and
- soft-demand management measures to incentivise more envi-

ronmentally friendly journeys.

There are some tensions in the government's approach to road transport and emissions. A greater reliance on technology to improve fuel efficiency, as well as renewable fuels, would allow motorists to go on driving – or even increase the amount they drive – at a time when the DfT is also trying to encourage more prudent and environmentally friendly travel.

Technology

Improved technology – such as better fuel efficiency or the spread of hybrid cars – has the potential to reduce the environmental impact of motoring. The UK Petroleum Industry Association suggests that, in cities, hybrid cars could deliver fuel economy improvement in excess of 50%.[83] Meanwhile, biofuels – a mixture of bioethanol and petrol – is an option that could reduce transport carbon emissions by 50% compared to 2000 levels by 2035.[84]

In London, technological advances have led to reductions in NOx between 2003 and 2004 of 5% within the charging zone and 7% on the inner ring road.[85]

Technology, however, may not provide us with solutions quickly enough to limit climate change. A report commissioned by the DfT from the University College London Bartlett School of Planning and the Halcrow Group has suggested that technological advances are unlikely to take place in time to prevent the atmosphere becoming irreversibly damaged within the next 15 years.[86]

Concerns have been raised about the lack of incentives for manufacturers to produce more fuel-efficient cars, with actual growth in demand for more powerful, heavier models that are extremely high in carbon emissions. Research by Friends of the Earth suggests there may be a negative circle in which industry advertisements and demand for heavily polluting vehicles reinforce each other, minimising the incentives for drivers to demand, or manufacturers to market or produce, environmentally friendly cars.[87]

Many of the important decisions on fuel efficiency are taken at the European level, and so the most effective action open to the UK government may be to push for greater incen-

83 UK Petroleum Industry Association, *Future Road Fuels* (June 2004).

84 Department for Transport, *Liquid Biofuels and Renewable Hydrogen to 2050* (August 2004a).

85 Transport for London, *Central London Congestion Charging – Impacts Monitoring, Fourth Annual Report* (June 2006).

86 David Banister and Robin Hickman, *Looking Over the Horizon: Visioning and Backcasting for UK Transport Policy* (DfT, (January 2006).

87 Friends of the Earth, *Government and Industry Must Do More on Greener Cars,* http://www.foe.co.uk/resource/press_releases/government_and_industry_mu_09112005.html (14 July 2006).

tives to adapt and develop lower carbon cars. The EU target is for a vehicle efficiency of 140 grams of carbon emissions per kilometre on average across the whole of the EU, with a long-term target of 130 grams per kilometre. Average vehicle efficiency in the UK is currently about 170 grams of carbon dioxide per kilometre. The current voluntary agreements to develop low carbon cars may need to be made mandatory for the UK to reach the 140 grams per kilometre target and so reduce the contribution cars make to national carbon emissions.

88 Diesel fuels, on average, get over 28% more miles per gallon than the motor spirits. Table 3.4, DfT, *Transport Statistics of Great Britain: 2005.*

Fuel duty and VED

Both fuel duty and VED can provide fiscal incentives for motorists to use more efficient fuels and drive more efficient cars. As noted above, one of the effects of fuel duty has been that consumers have tended to mitigate the increase in fuel duty by switching to more efficient fuels.[88]

One option for ensuring environmental targets are met is to maintain a simple fuel duty alongside a road user charging scheme focused primarily on congestion. In contrast, a road user charge that prices-in the environmental costs of motoring, although adding complexity, might allow for a larger cut in fuel duty.

With no means of differentiating journeys made by motorists, for example, the speed used or distance travelled, the fuel tax is also a rather blunt policy instrument with which to make motorists aware of the environmental costs of an additional journey.

VED, on the other hand, may be better suited to making motorists more aware of the impact of their choice of car on the environment. As discussed below, steeply graduated VEDs could provide motorists with an appropriate fiscal incentive to use cars that are more environmentally friendly, while making those who choose to drive vehicles with low fuel efficiency and high levels of carbon emissions pay more. Yet VED, a fixed tax, is more closely tied to ownership of the vehicle than how it is used.

Road pricing and the environment

Several schemes, such as the Swiss lorry charge and the London congestion charge, vary charges by emissions classes as a mecha-

nism for incorporating environmental impacts into road user charges. An alternative approach would be to use technology to allow for finer variations in charging for emissions.

This would make the motorist more aware of the marginal external cost of motoring to the environment. However, using technology to dynamically price congestion and emissions could add complexity to the system, potentially lowering both public acceptability and the efficacy of the charge to change motorists' behaviour.[89] This is discussed further in chapter 6.

When asked which criteria should be used to work out how much road users should be charged in a road pricing scheme, the general public supported those relating to the environmental impact of the car: engine size, exhaust, emissions and vehicle type (see table 1).

89 See DfT (2006a) op. cit, and Deloitte Research, *Combating Gridlock: How Pricing Road Use can Ease Congestion* (Deloitte Research Public Sector Study, 2003), on the role of simplicity and clarity in road pricing systems.

90 DfT, Public Attitudes to Congestion and Road Pricing (2006c).

Table 1 – Support for different charging criteria

If there were a charging scheme for using British roads, which of the following criteria do you think should be used to work out how much road users are charged?

	Per cent
Size of vehicle's engine	33
Exhaust emissions their vehicle produces	29
Type of vehicle they used	27
Mileage, the distance they travel	26
Time of day travelled	23
Number of people in the car	17
Driving history, such as speeding fines or insurance claim records	16
Don't know	13

Source: MORI (2005).

This support for charging on environmentally based criteria may, however, be predicated on unfamiliarity with distance-based and time-based charging. As noted above, motorists are already charged or taxed based on engine size, fuel efficiency and type of vehicle. Research for the DfT suggests that motorists may view distance- and time-based charging as complex.[90] Concerns over complexity may explain why such options were less acceptable in the MORI survey.

Examples of the environmental benefits of road pricing

A relatively simple charge, such the London congestion charge, does not make any specific attempt at variation based on emissions. However, because of the nature of congestion in London, emissions in the charging zone and during charging times have lowered: carbon emissions are down by 20%, total primary emissions of NO_X and PM_{10} by 16% and fossil fuel use by 19%. Emissions on the inner ring road (the boundary for the charging zone) were predicted to rise as traffic from the centre was displaced on to these roads, but in fact have only changed by 1% from pre-charge levels.[91]

91 ibid.

Managing demand in Seattle

The city of Seattle has begun community-based demand management measures to complement the area's road pricing efforts. Way to Go, Seattle is an umbrella programme of community-based initiatives aimed at fostering smarter transportation choices. The goal is to reduce non-work automobile trips, which account for 75% of all car journeys. One of the primary initiatives is the 'one less car' demonstration, in which 41 households agreed to curb their use of a second car for six weeks and track their transport choices.

The result was to save families $70 per week, reducing driving by 25,000 miles and preventing 17,000 pounds of CO2 emissions. Another initiative is the car smart community challenge grant, which offers monthly grants to neighbourhood projects that help households use their cars less often for non-work trips.

Other projects include tools for businesses to encourage smarter transportation choices by customers and employees, and funding for schools to promote alternative transport choices for students.

Source: http://www.seattle.gov/waytogo/

Road pricing and the freight sector

As the freight haulage sector has accounted for almost all the increase in road transport carbon emissions in the UK since 1990, one solution to reducing road transport emission would be a road user charge that differentiates vans and lorries from passenger cars. However, the freight sector has a relatively

inelastic demand for motoring since there are few modal alternatives for vans (and, to a lesser extent, lorries).

As a result, an effective charging scheme aimed at reducing the traffic and greenhouse gas emissions of freight haulage would need to differ from a scheme targeting congestion. The former would ideally include charging by distance, emissions class and weight, while the latter would ideally charge by location, time of day, congestion levels and road type. All these various charges could be layered into a single scheme, but again the cost would be added complexity for both private motorists and the freight industry.

Lorry road user charging in European countries has encouraged fleet consolidation and the use of more efficient vehicles, as for example in the Swiss scheme. For the German toll collect scheme, there was approximately a 15% reduction in the number of empty runs, while the number of containers carried by rail increased by about 7%.[92]

Just as a road pricing scheme aimed at congestion may need to be implemented as part of a broader demand management package to change motorists' behaviour effectively, lorry road user charging in the UK may also need complementary measures, such as facilitating the consolidation of the delivery van sector and improving the rail network to accommodate modal switch.

92 Dr Peter Gullo, *HGV Tolls in Germany* (Federal Ministry of Transport, Building and Urban Affairs, June 2006).

93 Foley and Fergusson (2003) op. cit.

Conclusion

Road user charging has the potential to reduce CO_2 emissions significantly. Modelling suggests that a revenue-raising road user charge introduced in 2010 could save a total of two to eight million tonnes of carbon per year.[93] This would be an important contribution to the targets in the 2003 Energy White Paper for a reduction of 15-25 million tonnes of carbon by 2020, including two to four million tonnes from transport.

As road transport's contribution to greenhouse gas emissions is predicted, on current trends, to rise over the coming decades, it is important that these costs are internalised in some way. Incorporating environmental objectives into a road pricing scheme for private cars, although technically feasible, would prove to be complex. Whether it would be too complex to achieve the aims of reducing congestion should be considered.

However, if road pricing is to be revenue-neutral and is to replace either or both of the government's primary policy tools for reducing road transport emission – fuel duty and VED – then incorporating environmental objectives into the charging mechanism may be necessary to ensure road pricing does not undermine the government's climate change policies.

Two simple mechanisms identified here include scrapping the VED in favour of banded road pricing based on fuel efficiency measures and lowering the fuel duty for more efficient fuels. These two measures would give motorists incentives for greener motoring.

However, as much of the road transport emissions of the past fourteen years may have come from the freight sector, incorporating environmental objectives into a road pricing system for the freight industry may be easier and more helpful in contributing substantially to the government's climate change objectives.

Over the next decade, alternative pricing measures, such as steeper gradations in VEDs and incentives to increase fuel efficiency could facilitate the changes necessary in the freight hauling and forwarding industries to reduce carbon emissions and curtail the growth in traffic.

In addition, investment over the next decade in measures complementary to road pricing – such as fostering the consolidation of the freight industry, investment in public transportation, and improved road maintenance, management and capacity – should play a central role in reducing road transport greenhouse gas emissions and congestion.

Chapter 4: Piloting road pricing

Developing a road pricing network and the complementary packages of interventions to be sustainable in the reduction of traffic, congestion and carbon emissions will require:

- understanding the nature of congestion and traffic growth;
- assessing the current transport infrastructure;
- identifying future pressure points;
- planning the systems operations; and
- ensuring the equity of any schemes put forward.

The pilot schemes being funded at local level through the Transport Innovation Fund (TIF) should prove to be an important source for this information. It is worth noting that large-scale piloting of road user charging in the UK will have the effect of transferring to local authorities key decisions about the design, acceptability, equity and operational responsibilities typically associated with road pricing. In this way, the pilots will illustrate a range of possible approaches to road pricing and be a useful comparative study of these.

However, the development of a number of differing pilots schemes for road user charging raises questions about how road pricing might develop in the UK. It may be that we would see a transition from piloting to a single national scheme or, alternatively, a number of local schemes with good interoperability covering major conurbations and the trunk road network.

This chapter will explore the issues arising from piloting and any transition to wider implementation. The analysis will assess local, regional and national priorities, such as the use of revenues, by exploring the need to balance commonality and

coherence in national road pricing with the flexibility necessary for road pricing and any complementary measures to fit a diverse set of locations.

Piloting and road user charging in the UK

TIF congestion schemes

In 2004, the DfT announced the creation of the TIF to support two types of schemes aimed at tackling congestion, raising local revenue for transport schemes, and increasing national productivity. One would target congestion by combining hard-edged demand management tools, such as road user charging, with softer, complementary interventions, such as improved public transport services. The second type of scheme would use local, regional and inter-regional schemes to boost national productivity.

In November 2005, seven schemes were granted pre-TIF pump-priming funding to assist the development of local demand management proposals.[94] These seven authorities, along with London and Cardiff, are working with the government in the Road Pricing Local Liaison Group, which was created to share knowledge between local and national government.

TIF congestion schemes will go through four phases before implementation. Bidding for participation was open to all local authorities, either alone or in partnership with other authorities.

The first formal phase of the process is 'TIF partnership', which recognises that a proposed scheme is worthy of more detailed development and gives the authority the opportunity to engage with the DfT in preparing a detailed business case. The second phase is programme entry, where the DfT accepts the full detailed business case, indicating that it will consider funding the scheme. The third phase provides approval for the scheme, conditional on a detailed assessment of risks, scheme costs and the timetable for commencement and implementation. The fourth phase is full TIF approval in the shape of consent from the Secretary of State for Transport.[95]

In May 2006 the DfT invited authorities to bid for the second round of pump priming, and in November 2006 awarded

94 The seven authorities are the West Midlands, Tyne and Wear, Great Manchester, Bristol, Cambridge, Durham and Shropshire.

95 See DfT, *Transport Innovation Fund: Guidance* (13 March 2006) for more details on the TIF process.

pump-priming funding to nine areas to develop schemes. These included six of the seven areas already in receipt of funds from the first round, which were awarded additional funding, as well as three new areas that were also granted funding.[96]

All of the local authorities in these areas are planning to look at local road pricing. As a result, ten areas across England will be considering local road pricing schemes, which may include local pilot schemes. This would help to inform discussion on a national road pricing scheme.

The government's intention to push ahead with a road pricing scheme was further emphasised by the announcement in the Queen's speech on 16 November 2006 that a draft bill will be published to tackle road congestion and to improve public transport.

96 Additional funding awarded to West Midlands, Tyne and Wear, Great Manchester, Cambridge, Durham and Shropshire. New funding awarded to Nottingham, Derby and Leicester and the surrounding areas, Reading and Norfolk.

Potential TIF schemes

Bath and North East Somerset, Bristol, North Somerset and South Gloucestershire

This project would build upon 'demand management' work previously undertaken by Bristol and the extensive controlled parking areas and bus gate implemented in Bath. Public transport elements are to be delivered in advance of any charging scheme and will include a second generation public transport network supported by Park and Ride facilities capable of providing viable alternatives to motoring.

Cambridgeshire

This study would investigate a city centre, cordon-based charging scheme, coupled with complementary public transport and infrastructure improvements. The proposed scheme would be broadly fiscal neutral for the average driver, but would cost more for drivers with higher car use. This neutrality could be achieved in a number of ways:

- Discounts on road fund license for those living within a certain distance of Cambridge
- Incorporation of congestion charging regime within income tax system- however, need to address equity implications for those not within the tax regime
- Credits such as reduced parking costs and credits for use of public transport.

Durham

Durham propose to study alternatives to the private car, and examine the possibility for further disincentives to its use, such as expansion of Congestion Charge; traffic management measures to discourage travel in the city centre; allocation of more road space for pedestrians, cyclists and buses; re-designation of on-street parking from short stay to long stay. Proposed alternatives are to include more accessible and reliable bus services, and maximisation of the potential created by Park and Ride.

Greater Manchester Authorities

The Authorities see their strategy as focusing both on demand management and investment. They will favour hard-edged demand measures, including workplace parking levies and central parking charges (as well as wider parking measures), while investing in public infrastructure, such as developing cost effective Metrolink plans and upgrading bus ways.

Shropshire

Shropshire will study a cordon style scheme of road user charging to be supplemented by improved public services, with revenue from congestion charging to be re-invested in their development. The small cordon scheme would potentially use Automatic Number Plate Recognition (ANPR) technology. The study would also assess the impact of substantially improved bus services, walking and cycling improvements, and road space reallocation/ highway improvements.

Tyne and Wear

Tyne and Wear wish to assess distance based charging, rather than focusing solely on cordons- used by London and Durham, and will focus on both the type of charge and charging area. The study would also examine parking charges, Urban Traffic Management and Control (UTMC), and workplace parking charges.

West Midlands Metropolitan Authorities

The Authorities aim to examine the technical feasibility of 'black box' satellite navigation or other technical developments to control any form of road pricing, together with consideration of 'back room' enforcement processes. Key transport infrastructure projects could be divided into two categories. The first would focus on infrastructure - including development of the Metro Network, redevelopment and enhancement of other stations, and improvement in access to Birmingham International Airport. The second would be on operation, requiring improvement in the operating conditions of public transport.

Reading

Their proposal will comprise a balanced package of demand management measures (including variable user charging), innovative information systems and bus-based improvements in public transport.

A key element of the approach is the identification of a "tipping point" (in terms of traffic speed and journey time reliability) at which a road pricing scheme might not only be beneficial to economic performance but would also be perceived by users as socially beneficial.

Norfolk

This study will identify whether a congestion charge will actually mitigate and control traffic congestion. The study will also identify the most effective congestion charging format in terms of its impacts on transport provision. The preferred type of scheme can then be presented for consultation to assess its social impacts and its local acceptability.

Drawing on the "Pay as you drive" scheme run by Aviva, Norfolk would investigate the acceptability of GPS charging schemes as an additional choice for motorists alongside a cordon scheme and learn about the interoperability of these methods.

97 The primary European Union legislation is the *Directive on Interoperability of Charging Systems* (2004/52/EU), passed in April 2004. The directive requires road charging and toll schemes to be both technically and contractually interoperable.

98 DfT, *Transport Innovation Fund: Guidance* January 2006 (13 March 2006).

East Midlands Three-Cities Partnership

This proposal will deliver the key elements of a business case for realistic pricing options to tackle real congestion problems in the sub-area, which will reduce the constraints placed on the economy by congestion in the 3 cities sub-area. This will include a high level assessment of the macro economic and congestion impacts of particular schemes; typical development and operational costs; and an estimate of the cost of developing, managing and supporting associated interventions such as additional infrastructure, public transport service improvements and information services that would be required to enable the scheme to go ahead.

Piloting and the transition to a national scheme

Existing road pricing schemes in the UK – such as the London congestion charge, the M6 and Dartford crossing tolls, and the charge on Saddler Street in Durham's historic city centre – are localised with little or no need for coordination between them. The introduction of road pricing on a national scale would increase the need for coordination between charging schemes beyond current requirements for interoperability.[97]

Although road pricing is still in its early days in the UK, pilots will help set the stage for wider implementation and will raise questions about how to balance local, regional and national priorities in any national system. At some point, government will need to provide greater clarity on what any proposed national scheme will look like and the implications for governance and finance structures at the local and national level.

How national is 'national' road pricing?

There is a clear potential tension between the broad national goals of road pricing and the need for charging solutions to be tailored to local and regional problems. The TIF guidance encourages bids to develop demand management proposals as part of broader packages designed to tackle congestion at a local level, while also requiring proposals to take account of the potential to make a difference nationally.[98]

This raises questions about the degree of commonality and consistency in scheme design and how this can be balanced with the flexibility – and the resources – required to develop complementary measures tailored to fit the local area.

Before a national scheme could be introduced, policymakers will need to clarify the relative roles of national and local governments in:

- determining the policy objectives of road pricing;
- deciding the type of charging (time of day, which roads, the level of charging);
- choosing the appropriate technologies;
- achieving political consensus and garnering public acceptability;
- administration, collection and enforcement of the charges;
- being accountable for and spending any road pricing revenues; and
- striking the right balance between road pricing and infrastructure investments.

99 See Deloitte Research (2003) op. cit., H M Krause, *Media's Role in Value Pricing Implementation* (Paper presented at annual meeting of the Transportation Research Board, Washington, DC, January 2004), and P Jones, 'Acceptability of Road User Charging: Meeting the Challenge', in: J Schade and B Schlag (editors), *Acceptability of Transport Pricing Strategies* (Elsevier, Oxford, 2003).

But even the long-term possibility of a transition to a national scheme raises immediate questions for pilot scheme design. The purpose of the Road Pricing Local Liaison Group is to facilitate dialogue and partnership between national and local government. This dialogue could be integral to helping the government achieve this clarification as the process of piloting moves forwards.

Political leadership and public acceptability

Political leadership has been central to the introduction of schemes in London, San Diego, New York, Oslo and Trondheim, and would be essential if a national consensus on road pricing is to be forged.[99] Piloting has an important role in building a national consensus, and has the effect of transferring some of the responsibility for generating public acceptability to local and regional policymakers.

But the structure of local government in the UK militates against clear political leadership. Many of the pilot areas cover a number of local authority areas with a mix of political control. The areas also tend to lack a clear figurehead. This puts a great deal of emphasis on the need to develop local and regional political consensus.

This issue will become more significant if the approach government takes to the introduction of a national road pricing scheme is via expanding road user charging to other authorities. In this case, the primary responsibility for generating public acceptability would remain with the local and regional authorities.

If it decides to pursue a centrally operated, national road

pricing system, national government will need to take responsibility for fostering public acceptability outside the piloted areas and across a broad range of stakeholders, including citizens, businesses and the media.

Concerns for equity

A variety of factors, such as the availability, quality and price of public transport, together with socioeconomic status will have an impact on how motorists would react to road pricing. The equity implications of any scheme would vary from city to city and region to region, but the type of scheme introduced would also have an impact. For example, an area charge might hurt small businesses and have exclusionary effects on at-risk groups, such as the elderly and the disabled. In contrast, a distance-based charge might mitigate some of the effects of an area charge by dispensing with a single boundary, but it would also have consequences for equity, for example, on shift workers.

We argued earlier that improved public transport would mitigate some of the equity effects of road pricing. Poor public transport options mean that those without the ability to pay a charge, such as motorists with lower incomes, could see significant welfare losses, as their only choice would be to pay the charge or not to travel.

It is important to distinguish between seeking improvements to public transport because they facilitate modal shift and seeking such improvements because of increases to the vertical and/or horizontal equity of road user charging. The distinction is important not simply from the point of view of increasing the public acceptability of road user charging, but also because the differing motivations may result in differing priorities when considering the demand and need for complementary investment in infrastructure, such as public transportation.

Managing the transition from piloting

The transition to a national system of road pricing, although predicated on successful piloting, would necessarily require further assessment of the challenges of extending road pricing beyond any existing pilot schemes. Any piloted schemes, although designed within the context of a coherent national framework, would inevitably be individualised to fit local traffic

and congestion problems.

Introducing a road user charge in areas outside any piloted schemes would require applying the lessons learned from the experience of large-scale piloting. These lessons would include assessing the reliability and effectiveness of the piloted schemes. Such introduction would also require considering the feasibility of the schemes being folded into the national framework.

Judging the success of pilot schemes will be based on the ability to change motorists' behaviour, to foster public acceptability and their adaptability to other areas.

Conclusion

The process of piloting road user charging – from the successive rounds of proposals to the feasibility studies and eventually to testing – and ultimately the transition to a national system of road pricing will expose the tension between the desire for commonality across schemes and the need for flexibility to make the solution fit an inherently localised problem.

A highly decentralised system in which local and regional authorities have complete autonomy over their own schemes is clearly inappropriate for the UK. The most fitting and logical approach seems to be one that favours a mix of central coordination for back office functions with local and regional flexibility.

There are a number of factors that suggest a significant element of control for local authorities may be appropriate. These include the electorate's general lack of trust about government promises on taxation and charging, and the current support for a move towards devolution of powers away from Whitehall. This is certainly the spirit of the current policy of encouraging local authorities to work out pilot schemes under the TIF.

Chapter 5: The technology of road pricing

Existing road pricing schemes in the UK, while effective in reducing traffic and congestion, may not be economically optimal in the way in which they price road use. For example, congestion charging in London requires motorists to pay only one flat daily rate, regardless of how much they drive on central London roads.

While innovations in technology could allow a road pricing scheme to reflect real costs more efficiently through incorporating a broad range of variables into the price of road use, this should be balanced with an assessment of whether the technology is simple, effective and publicly acceptable.

The relevant questions in choosing a technology are, therefore, not simply about economic efficiency but should also deal with how technology can be used to support a road pricing system in the UK that delivers on the broad objectives of road pricing, including public support.

We do not attempt to identify the right set of technologies for road pricing in the UK, not least because the range of options is developing all the time. Instead this chapter will identify and discuss the criteria by which appropriate technologies could be chosen.

Whether we opt for a scheme that can be introduced in the next five years on the back of existing technologies, or for one implemented in fifteen years through a system of technologies yet defined, there are certain policy and operational objectives that any road pricing technologies should satisfy. These criteria include:

- reducing congestion;

- ensuring the system is technically and politically viable in the UK;
- giving weight to concerns about equity;
- implementing road pricing within a national framework, while maintaining the flexibility necessary to charge effectively in areas with different motoring behaviours;
- creating a system capable of adapting to developments in the nature of motoring as well as innovations in information technology; and
- reducing greenhouse gas emissions on the basis of the argument set out in chapter 3.

The differing weight given to these objectives is certain to shift as the debate over road user charging progresses. However, they do serve as a starting point in identifying simple, effective and publicly acceptable technologies.

The effectiveness and acceptability of any technology will also depend on the system within which it operates. Factors such as piggy backing, running costs, data sharing and interoperability are vital to establishing a scheme that functions effectively and efficiently and, therefore, which enjoys wide support.

Achieving a sustainable reduction in congestion and greenhouse gas emissions through road user charging and a wider package of interventions is, however, not a short-term programme. We do not know how features such as congestion, greenhouse gas emissions, motoring, planning and technology will develop in the long run. Consequently, a road pricing system, and the technologies that support it, would need the flexibility, credibility and legitimacy to operate against that background of uncertainty.

Technology and the objectives of road pricing

The primary objective of introducing road pricing on a national level is to reduce congestion across the UK. For government to achieve this, the economics of road user charging suggests that it should price roads to reflect the marginal external costs of motoring. Although the cost of congestion is the most significant negative externality of motoring, as discussed above, congestion itself is not homogenous, varying by location, road type and time of day. An optimal charge aimed at reducing congestion, therefore, would reflect this heterogeneity.

An efficient system of national road pricing as part of a broader package of interventions could, in theory, be designed to reflect motorists' response to changes in the price of a trip, trip purpose, socioeconomic characteristics and local economic competitiveness.

However, the ability of policymakers to price road use in order to reduce congestion is dependent on what is technically feasible and, ultimately, what is publicly acceptable. For example, technology could dictate whether a scheme is event-based, as in London, or rate-based, as is the German lorry scheme. The operational costs of the technology and the wider scheme would determine the level of revenues available for complementary measures, such as improved public transport.

In the case of London, the charge is a one-off, event-based charge for driving within the charging zone during specified times. Introduced in 2003, the scheme relies on technology with proven reliability at that time. While effective at reducing both congestion and traffic, the charge could be considered sub-optimal, as it is unable to account for distance travelled, time variations in congestion or location within the zone.

Developing and operating a more economically efficient road user charge could increase technical complexity for both policymakers and motorists. There is a need to examine the trade-off between this and other aims of road user charging.

Systems operation

Policymakers face practical concerns in defining and operating road pricing services, including providing the facilities to run, maintain, monitor and upgrade the technology. For example, practical questions include:

- whether the charge should be event- or distance-based;
- whether any technology should be fitted within the car or, as in the example of London, be external to it;
- whether the charge should be calculated by in-car technology or by a central system;
- how the system should account for unregistered drivers;
- how the penalties for violations should be enforced;
- which system would have a more reliable capture rate; and
- how cost-effective would the back-room operation be.

National commonality and regional flexibility

As noted above, there are important questions to be decided as to which aspects of a road pricing system should be determined locally and which nationally.

There is a strong argument for commonality and consistency within the operational aspects of road pricing, since this would assure motorists that road pricing was operating and functioning effectively across the nation. For example, having multiple technologies within a vehicle, each with a separate registration, billing and enforcement system, would create layers of complexity and be unacceptable to the average motorist.

A degree of commonality in the technology that supports the operational aspects of road pricing could give the system the simplicity that lends credibility and legitimacy to the charging regime.

On the other hand, we know that there is significant heterogeneity in the nature of motoring and price sensitivity across localities. These could be accounted for through variations in price, which would have consequences for how a road user charge affected motorists' behaviour and thus contributed to the goals of the charging system.

So a coherent and interoperable system would not necessarily imply a single, uniform or inflexible technology across the UK. It would demand a straightforward, coherent infrastructure and logic supporting the national framework. Indeed, achieving the policy objectives of road pricing would require a technology flexible enough to support the necessary local and regional variations within the charging system.

Environmental and equity concerns

It would be open to government to price other negative externalities of road transport, such as greenhouse gas emissions, in addition to congestion. While several schemes, such as the Swiss lorry charge and the London congestion charge, vary charges by emissions classes of vehicles, it would be possible to use technology, just as with congestion, to allow for finer variations in charging for emissions.

However, using technology to dynamically price congestion and emissions could add considerable complexity to the system, potentially lowering both public acceptability and the

efficacy of the charge to change motorists' behaviour.[100] High-level mechanisms for charging for emissions that are independent of technology may be more appropriate for road pricing in the UK.

Giving priority to equity concerns could also affect the decision about which technology to adopt for a road pricing system. For example, using technologies that were either cheap or ubiquitous could enhance the equitability of road pricing.

As discussed above, there is some evidence that road pricing rations road use on ability to pay, rather than willingness to pay, with motorists from lower socioeconomic levels paying the charge less frequently. So socioeconomic status is likely to determine the frequency with which users pay the charge. However, it is possible that technical complexity could further limit choice, since it may not be easy for motorists to accurately estimate the cost of journey in advance. Simplicity and transparency could provide motorists with a greater ability to select when to avoid the charge and when to pay it.

100 See DfT, *Consumer Behaviour and Pricing Structures: Final Report on Qualitative Research* (February 2006), and Deloitte Research (2003) op. cit. on the role of simplicity and clarity in road pricing systems.

Technological options

Several types of technologies are currently being used or have been considered for road pricing in the UK and internationally. For example, the London congestion charge is an event-based system that uses automated number plate recognition (ANPR) for enforcement. The new Stockholm cordon system is the largest implementation of a microwave tag and beacon system and was chosen to allow the city authority to vary the charge throughout the day. Drivers have to have direct debit accounts but they enjoy an efficient operating system. The German lorry road user charge (which charges by distance travelled, number of axles and emissions class) uses global positioning systems (GPS) to track the distance travelled, mobile technology to collect the charge, and microwave technology for enforcement.

Deciding on an operating system for a UK national road pricing scheme will involve more complex decisions than simply choosing among the various technological options. For example, technologies suitable for motorways may not be suitable for urban environments, as opportunities for evasion, obscuration and interference could all reduce the reliability of the system, while using multiple technologies in conjunction with each

other could improve the efficacy of the entire system. Delivering on the objectives of any road pricing scheme may require the use of several technologies in conjunction with each other.

Looking towards the future

Initial trials and piloting of new technologies in the UK have focused on assessing the applicability, reliability and viability of these technologies for road pricing. In May 2006, the Secretary of State for Transport, Douglas Alexander, announced £10 million in funding to help develop the technology necessary to support road pricing in the UK.

Trials of current GPS technology have had trouble in accurately locating and tracking vehicles within urban areas or on mountainous terrain, where tall buildings, narrow streets or dense forests could obscure or distort the GPS signal. Although current GPS navigation systems use 'snap to map' technology to assume a vehicle must be on a road, the assumptions may be wrong and locate vehicles on a neighbouring road, where a different road user charge may apply.

Trials in London with GPS technology have shown that charging on the boundary of the congestion charge would require, on average, a 57 metre buffer (increasing to as much as 250 metres at certain points) to ensure that a vehicle identified as being within the zone was actually located there.[101]

The demonstration of interoperable road user end-to-end charging and telematics system (DIRECTS) project in Leeds has been piloting the compatibility of dedicated short-range communications (DSRC) and mobile positioning systems (MPS) technologies side by side. The demonstration project is aimed at standardising specifications for interoperability domestically and internationally, while also supporting the local and regional road pricing schemes.[102]

The recent technology trials were more sophisticated and suggested that while the technology is not yet perfect or perhaps cost effective, TfL's assessment suggested that "the performance of the best system is probably sufficiently good enough to allow, at a later date, the introduction of a parallel distance based charge alternative to the current fixed Congestion Charge, subject to a proper assessment and appropriate consultation."[103]

101 See DfT, *Response to the Transport Committee's Report on Urban Charging Schemes* (9 July 2003) and Transport for London, *London Congestion Charging Technology Trials – Stage 1 Report* (February 2005) for a discussion of problems with GPS positioning technologies.

102 DfT (2003) op. cit.

The Norwich Union 'pay-as-you-drive' scheme uses satellite positioning to locate an on-board unit (OBU) in participating vehicles to develop an insurance premium based on when, where and how often the car is used. The trial, begun in 2003 and now complete, involved 5,000 volunteers and was designed to test the feasibility of pay-as-you-drive insurance.[104] The scheme could be applicable to road pricing more broadly, but has also been important in testing feasibility, viability and public acceptability of OBUs. It is worth noting that this system does not track people in real time, but uses journey data to set insurance premiums.

The development of intelligent mobile, positioning, radio and wireless networks, perhaps not initially designed for the transport sector, could have significant implications for what becomes technically feasible in a road pricing system. Although proof from concept trials, demonstration projects and piloting would determine whether such technologies are capable of supporting an effective system of road pricing, these innovations may offer more efficient options for implementing road pricing beyond the technologies described above.[105]

Ensuring the technologies function

The system within which the technology would sit would be as important as the technology itself in determining whether it would function effectively and affect how motorists would engage with road pricing, for example, by changing their behaviour.

Piggy backing and spin-offs

Estimates show that the cost of placing a black box in-vehicle unit and pricing under a national framework would be prohibitive.[106] However, as positioning, tracking and smart card systems become ubiquitous over the next decade, policymakers may be able to piggy back road pricing on such technologies.

Piggy backing road pricing on existing technology would not only reduce the costs of road pricing for motorists and government, but would also increase the functionality of the pricing technology.

Piggy backing on ubiquitous technologies would also assuage some of the equity concerns of road pricing. Using

103 TfL Congestion Charging, *Distance Based Charging: Report on Transport for London's (TfL) GPS OBU Trial,* (Transport for London, October 2006).

104 http://www.norwichunion.com/pay-as-you-drive/

105 P Blythe, *Congestion Charging: Technical Options for the Delivery of Future UK Policy* (Transport Research Part A 39, 2005, pp. 571-87).

106 DfT (2004) op, cit.

technologies that required motorists to pay for any on-board equipment could reinforce the effect of rationing road use on ability to pay. Piggy backing would allow motorists to gain value from technologies they may already own or plan on purchasing.

Further innovations in ITS (intelligent transport systems) would also allow for finer-grained information about road use, which could be used to support pricing and resource allocation. These innovations could also have positive implications across all modes of transport, by making transport more sophisticated, responsive and personalised.

A growing amount of real-time data on the road network, coupled with improved ITS, could allow policymakers to develop, deliver and monitor operational and policy objectives. This finer-grained real-time information could allow motorists to make more informed decisions about their motoring behaviour and increase the efficacy of technologies.

Running costs

As previously noted, the cost of the technology and systems operation would not only impact on the financial viability of any road pricing scheme, but also on the public acceptability and efficacy of road user charging. It would do this in part by limiting the amount of revenues available for other uses, such as improving public transport or reducing fuel duty and road tax.

One method of minimising the operational costs of a road pricing system would be to increase the reliance on 'zero-touch' technologies. Another could be piggy backing on commercially available ITS. Piggy backing could significantly reduce the start-up and annual operational costs of charging, while further innovations in ITS could imply a reduced reliance on manual support for road pricing technologies, such as ANPR.

Data sharing and trust in technology

Although the private sector cannot obtain data from other private transport companies, the government may have the leverage necessary to do so given its position in subsidising many transport operators (for example, obtaining information from bus operators for Transport Direct). However, if a public sector authority were to be given control of the system, current

data-sharing laws would prevent it from passing any road pricing data on to either public or private sector bodies. While the government is currently reviewing its data-sharing regulations, any reform should satisfy concerns for privacy and meet public expectations about how data should be used.[107]

In contrast, motorists need to be reassured about the security, privacy and use of information, especially as piggy backing and spin-offs have very real elements of function creep. Further ITS innovations could see increased integration of various communications networks, potentially increasing the vulnerability of road pricing systems to fraud and identity theft.

Credibility and trust in the system would be dependent on motorists' willingness to share information with private companies and, potentially, all levels of government. The security of real-time travel data and the reliability of, and therefore trust in, the technologies that support road pricing would enhance the credibility of the system.

Interoperability

Although road pricing already exists in the UK, the systems are not interoperable. This is not surprising as there is not enough of a business case to develop interoperability. However, economies of scale in introducing a national scheme in the UK and an EU directive on the interoperability of road pricing schemes have increased the need for compatible and interoperable technologies.

The European Directive 2004/52/EC covers the interoperability of electronic toll systems and proposes a European electronic toll service (EETS). The directive has staged implementation, with HGV and long-distance coaches coming within its scope in 2009 and all vehicles by mid-2011.

The directive aims to design a common system, applicable for a range of technologies, including GPS, global system for mobile (GSM) and DSRC, with a single OBU and one invoice, available on the whole of the European road network. While it would mandate commonality and interoperability, the directive would allow member states the flexibility to design road user charging systems independently.

107 Wood and Isaac, *Who Shares Wins: Transforming Public Services with Intelligent Data* (SMF, October 2006).

Public acceptability

Public acceptability of any technologies used to support road pricing would depend on: motorists' confidence that the system would work; user-friendliness and familiarity with the technology; equity concerns about the cost and complexity of the technology; and any value-added services or spin-offs of the technology. However, it should be noted that assessing the public acceptability of a given technology might not be entirely feasible until after the scheme is in place.

Indeed, public acceptability of road pricing in general tends to rise significantly after implementation once motorists have become familiar with the technology and develop confidence in the entire road pricing system.

Yet these aspects of any technology may only be determined as part of the process of specifying the operational and policy objectives and then choosing the technologies to support the system. In the short run, piloting would be likely to rely on existing, proven technologies and could foster public acceptability. However, there would still be questions about the public acceptability of more advanced, and potentially intrusive, technology.

Proliferation and ubiquity of new technologies beyond road pricing, such as navigation systems and smart cards, would ultimately improve the acceptability of their road pricing applications. Yet, motorists need to be assured that the technology is both credible and functions appropriately across the system, while also maintaining their privacy.

Technology developments and uncertainty about the future

The nature of road pricing in the UK will be shaped by innovations in technology over the coming decades. Expectations about how technology may develop and its role in road pricing, therefore, should feed back into how road pricing systems are designed and which technologies could be used to support the system.

The future of road pricing technology

Currently piloted, longer-term technological innovations include those that can: calculate traffic volumes, speed, occupancy and length classifications; calculate the percentage of cars

versus long vehicles, volume and occupancy on a single loop; use existing in-car GPS navigation technology to estimate traffic patterns and congestion to inform drivers of quickest route and estimated time of arrival; and use real-time and historical data to forecast congestion and speed patterns.[108]

Longer-term advances in communication and mobile networking technologies may require a rethink beyond the relatively simple technology described above. Integrating current and future GPS, mobile and wireless technologies innovations could increase the reliability of vehicle-to-vehicle and vehicle-to-infrastructure communications. Consequently, while current and medium-run technologies could be used to tackle congestion over the next decade, policymakers need to lay the foundation for integrating future technologies within the national road pricing framework.

Managing uncertainty

Any road pricing system, and the technologies used to support it, must be flexible enough over the long run to manage uncertainty in the pace and applicability of new technologies. For example, the piggy backing and spin-off benefits discussed above may only be achievable in the context of a system flexible enough to take advantage of such opportunities.

An initial point of inflexibility in the German lorry scheme was that the charging rate was hardwired into the initial OBUs. Although introduced only in January 2005, the initial units have already been replaced by an upgraded system, in which the price and route network are updateable through mobile networks. Since 18 July 2005, hauliers have been able to update their OBUs for automatic toll collection to the new software at any of the 1900 toll collect service partners. While the original OBU did not have to be removed, installing the new software took on average one hour.[109]

Although a system of road pricing may be limited by what is technically feasible, the system should be designed to allow for innovations in technology and policy objectives over time. Whether this implies seamless integration of new technology, an upgrade in existing systems or a complete overhaul in the technologies used to support road pricing, the systems operation and the technology chosen to support road pricing should have

108 California's Innovative Corridor Initiative (ICI), developed in spring 2003, is a multi-year project run by CalTrans, a coalition of local, regional and national authorities. The aim of ICI is to test a new approach for accelerating the deployment of intelligent transportation systems (ITS) technologies, products and services along major California corridors. The partnership has developed a call for submission (CFS) approach to solicit proposals to demonstrate motorist services that enhance mobility, convenience and safety. The ICI hopes that this demonstration process will enable private companies to use public infrastructure to demonstrate ITS technologies with no cost or risk to public agencies, who in return get to 'test drive' modern technologies. This initiative enables public-private partnerships that enhance dialogue between the two sectors. See http://www.innovativemobility.org/.

109 Ministry of Transport, Building and Urban Development, *Recent Developments in the German Heavy Goods Tolling Project* (15 November 2005).

a degree of flexibility to manage long-run uncertainty.

Conclusion

The development of communications and networking technologies would enhance the ability to monitor, sense and manage motoring behaviour, as well as communicate this information between central systems, vehicles and drivers.

The choice of technologies to support road pricing would depend on whether available technologies could function effectively, the need for commonality and flexibility within the system, and the operational and policy objectives among other factors.

Although operational objectives may require commonality, policy objectives – such as introducing road pricing within the framework of broader interventions at the local and regional level and the use of road pricing revenues – could require flexibility in how technology could support the road pricing.

Developing the compatibility and interoperability of positioning, tag and beacon, and mobile communications through trials and piloting would not only improve the efficacy of any technologies used to support road pricing, but would also allow for the flexibility required of pricing road use across a heterogeneous road network.

This process, however, would be ongoing, running in parallel to that of specifying the operational and policy objectives of road pricing, as well as integrating new innovations in technology into the road pricing system.

Chapter 6: The public acceptability and equity of road pricing

Broad public acceptance of the case for road pricing is a prerequisite of its successful introduction. There is clearly the potential for motorists to see road pricing as unfair, since it would involve asking them to pay for something that was originally free at the point of use. It may also be regarded as coercive if motorists believe they have no viable alternative to paying the charge. Understanding which issues are critical to fostering public acceptability of road pricing is an important first step, and this chapter identifies and discusses these.

But policymakers should also give weight to equity considerations above and beyond perceptions of fairness. There is a concern that where road space is effectively rationed on ability to pay, as opposed to willingness to pay, road pricing may offend against equity.

However, where fostering public acceptability for, and ensuring the equity of, a road pricing system requires concessions - for example, for drivers with disabilities - policymakers will need to balance these with the need to design an efficient and effective road pricing system.

Hence this chapter also identifies where these trade-offs may need to be made and suggests how policymakers might respond.

Public acceptability of road pricing

The design factors that are likely to influence public acceptance of road pricing, discussed below, include: the use that revenues

are put to; the form of technology used; the complexity or simplicity of the charging system; the existence of exemptions; the degree to which there is real choice over whether to pay the charge or not; and the role of political leadership and the media as opinion formers in the run-up to the introduction of a road pricing scheme.

110 DfT (2006c) op. cit.

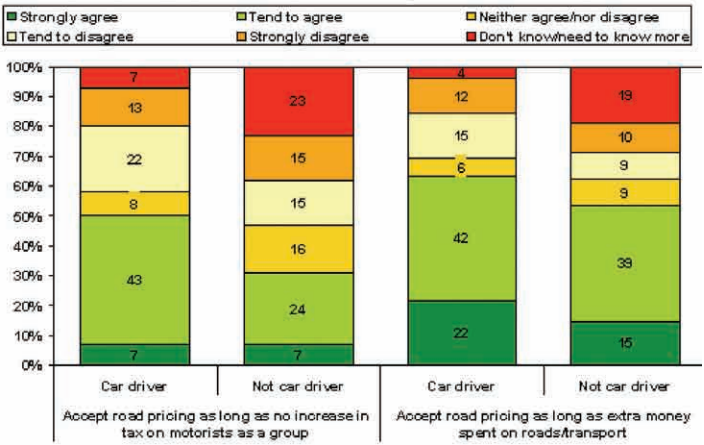
111 RAC, Report on Motoring 2006. *The Future of Motoring: A Clear Road Map or Collision Course?* (Norwich, June 2006).

112 DfT (2006c) op. cit.

Use of revenues

One of the most politically challenging questions is whether the scheme should be revenue-additional, revenue-neutral or fall somewhere between these two extremes. Polling designed to develop an understanding of road users' views on this matter have produced contradictory results. Research by the DfT suggested that just under two-thirds of motorists would accept road pricing as long as any extra money were spent on roads and public transportation, compared to 50% who would accept road pricing if there were no increase in tax on motorists as a group.[110] Yet, a similar survey by the RAC showed that while 63% of respondents would want all money raised spent on improving roads; support increased to 67% if there was a permanent reduction in road tax or fuel duty.[111]

Figure 7. Acceptability of road pricing under different scenarios.[112]



Research by BMRB Social Research suggested that motorists often viewed paying a road user charge on top of the road tax

as double taxation. This seems to suggest that while the public might want additional money to be spent on certain services they may also resent paying more for a service they already use.

Hypothecation is one response to the problem of balancing demands for lower (or at least not additional) taxation or charges with those for higher spending. If surplus road pricing revenues are hypothecated to transport services, the public may have confidence that revenues spent reflect public preferences and so may be happier to pay more through a road user charge.[113]

Even if hypothecating road pricing revenues were adopted, decisions would still have to be made as to how the revenues should be spent. A broad range of research on public opinion on road pricing suggests that there is demand for improving public transport and minimising the welfare loss of road pricing, but also for better road maintenance and management, and improving and building road capacity.[114]

This suggests that any road pricing revenues hypothecated to the road network or public transportation may need to provide visible and tangible benefits to motorists as well as the wider transport system for the improvements to foster public acceptability.

Whichever approach were to be adopted, consideration would have to be given to the impact on the effectiveness of the scheme. This in itself will have an impact on public acceptance. For example, while a revenue-neutral approach may reduce concerns about double taxation, there may not be sufficient funds available to give motorists a choice about whether or not to pay the charge, potentially limiting the effectiveness of any scheme, and so undermining public acceptability in both the short and long run.

Technology

Any road user charging system would involve the capture and storage of a certain amount of data, and is likely to involve data sharing between private companies and, potentially, all levels of government. There is clearly the potential for concern to be raised about invasion of privacy and possible misuse of information under these circumstances.

In many cases, the British public has shown itself to be remarkably tolerant of some forms of surveillance and moni-

113 ibid.

114 See RAC Foundation (2002), DfT (2004) and MORI (2005), Lyons et al (2004), and Green and Stone (2004) op. cit.

toring. For example, the huge growth in monitoring of our public spaces by CCTV has attracted very little public disquiet. However, it is important to note that monitoring by CCTV is, from the point of view of an individual, random. A person is observed if he or she happens to pass a camera. The kind of data capture involved in a road user charging scheme may be of this type, as in the London congestion charge, if a cordon or area charge is involved. However, more complex charging schemes that involve paying according to distance travelled are likely to require data relating more closely to the individual, including where he or she travelled, and at what time of day.

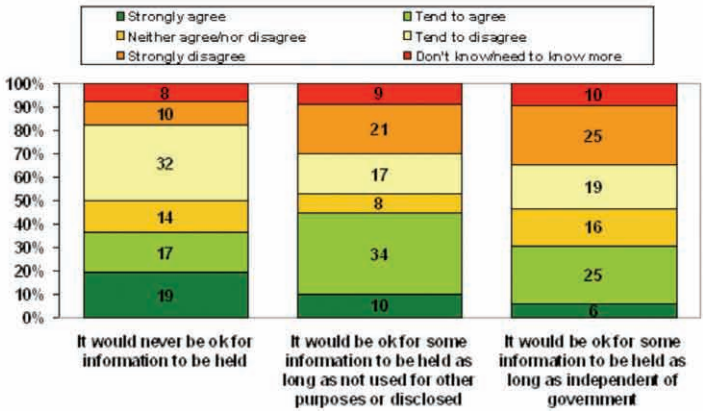
It is possible that a scheme of this latter type may meet greater objections, and objections of a different type. Certainly, it would place a greater emphasis on the need for data security if acceptance were to be given by the public.

Recent research by the DfT on public attitudes tells us relatively little, since it does not explore people's responses to different types of data being stored. It does show that the public is fairly evenly split on the general question of data storage – 44% of respondents agreed that it would be OK for some information to be held as long as it was not used for other purposes or disclosed, while 34% disagreed. Notably, when asked if some information should be held independent of government, 44% of respondents disagreed and 40% agreed, suggesting that the public has some faith in government's ability to store and manage the data. [115]

115 DfT (2006c) op. cit.

116 ibid.

Figure 8. Attitudes towards the holding of information on where drivers travel[116]



Choice

Whether drivers feel they have a choice or not about paying the charge will be critical to public acceptance. Expensive, inaccessible or unreliable public transport could leave the motorist with little choice but to pay for essential trips, no matter the level of the charge. The result would be higher revenues with little effect on congestion.

In contrast, good public transport links or relatively cheaper travel options could result in a greater willingness to reduce motoring in response to the charge, as has been the case for the London congestion charge. Similarly, where trips are not time-sensitive it would be important for motorists to be able to switch their journey to a time when the charges were lower or did not apply.

As noted earlier, poor public transport options could mean that those who do not have the ability to pay, such as motorists with lower incomes, could stand to lose, as their only choice would be to pay the charge or to not travel. Improved public transportation could provide motorists with a greater ability to choose when to avoid the charge and when to pay it: a lack of viable options may lower public acceptability as motorists may believe they are being forced to pay.

In short, improved public transport would deal with some

of the equity concerns associated with road pricing. It is important to design a system in which willingness to pay, rather than ability to pay, is the main determinant of when and whether to travel by car.[117]

Political leadership and consensus

Political leadership has been integral to the introduction of schemes in London, San Diego, New York, Oslo and Trondheim.[118] Whether through strong, individual champions or broad political consensus, political leadership provides credibility in framing the debate and addressing concerns from motorists, businesses and the media.

The media also have an important role both as reporters of public opinion and as makers of it, with the potential to shape the nature of any public debate on road pricing. Media presentation of the 'carrots' of a proposed road pricing system and the 'sticks' associated with any programme may differ and so could bias public opinion in one direction or another.

Media coverage has not always been even-handed. In the case of the failed Edinburgh scheme, research shows that the media coverage was balanced on details such as investment in new trams services but negative on the financial aspects.[119] In the run-up to the London congestion charge, a majority of the media failed to give a balanced view about the scheme.[120]

Political leadership and consensus, whether at the local and regional level or at the national level, would be important in emphasising the problems that road user charging is attempting to solve and the effectiveness of road pricing as a way of addressing these problems as well as the general benefits that a road pricing system will bring.

Complexity

Decisions about which technology to adopt will have an important impact on how a road user charging system is viewed. In general, motorists are likely to prefer a simple system because it would allow them to predict accurately the costs that they are likely to incur in making a journey.

Some motorists may perceive even a simple distance-based charge as complex. However, each additional layer of complexity in a charging structure – such as different levels of charge at

117 A demographic breakdown of motorists who paid the road user charge on the 91 express lanes in southern California reflected the demographics of non-users. However, the frequency of use was significantly correlated with a higher economic status.

118 See Deloitte Research (2003) op. cit; Krause, *Media's Role in Value Pricing Implementation* (paper presented at annual meeting of the Transportation Research Board, Washington, DC, January 2004); and Jones, in Schade and Schlag, editors (2003) op. cit.

119 Rylety and Gjersoe, *Newspaper Response to the Edinburgh Congestion Charging Proposals* (Transport Policy 13,2006).

120 I Gaber, *Driven to Distraction: An Analysis of the Media's Coverage of the Introduction of the London Congestion Charge* (Unit for Journalism Research, Goldsmiths College, University of London, 2003).

different times of day or traffic levels – are likely to decrease predictability and so incur greater opposition.

There is no quantifiable evidence on the existence of a clear tipping point at which the benefits of tailored charges are outweighed by the lack of predictability of the charge. It seems likely that the DfT is correct to suggest that this judgement will vary from individual to individual.[121]

As part of the debate about how to structure the charge, it is important to note that high levels of technical complexity in determining the charge could limit choice by reducing predictability. Simplicity and transparency could provide motorists with a greater ability to choose when to avoid the charge and when to pay it.

121 DfT (2006b) op. cit.

Perceptions of effectiveness

Congestion is recognised by both the public and government as one of the major transport problems in the UK. However, research by the DfT and RAC indicate that while motorists may support the idea of road pricing, they also have significant concerns about its effectiveness in reducing congestion.

Clearly, public opinion on the effectiveness of a scheme would be a major determinant of the degree of public support a particular proposal attracted. Motorists are likely to resent having to pay for road use if they believe that congestion is not falling or is being displaced. If this is the case, they are also likely to view the system as one with insufficient alternatives to paying the charge.

This suggests that a scheme designed to reduce overall traffic levels significantly, as opposed to reducing congestion by smoothing out traffic flow, is likely to attract greater support. Therefore, a scheme that is revenue-additional, to some degree, is likely to foster public support through its greater efficiency.

Of course, in practice, motorists are likely to be sceptical about the reported impact of any scheme before they see it working in practice, as was the case in London.

Equity of road pricing

The distributional effects of moving from free and unrationed supply to a situation of user charging are fairly obvious. While a variety of factors, such as the availability, quality and price

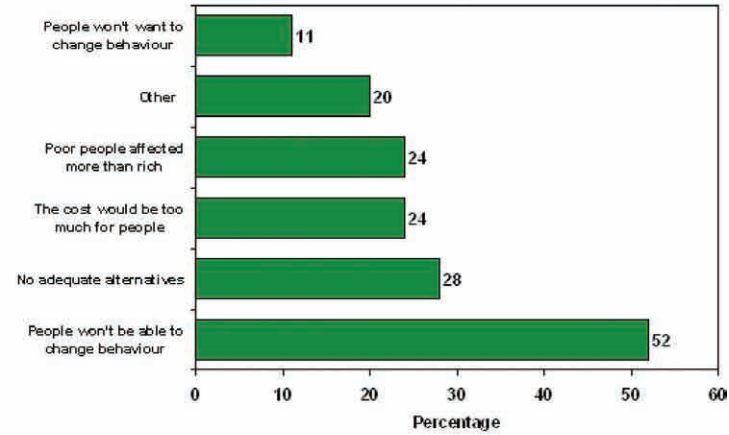
of public transport, could interact with socioeconomic status to determine the type of motorists who pay the user charge, frequency of willingness to pay is likely to be correlated with income.[122] In such cases, ability to pay, rather than willingness to pay, would determine which motorists chose to pay.

Those on lower incomes should also be given a feasible choice over when to pay the charge and when to avoid it. This choice could imply alternate means of travelling, such as public transportation, or simply altering the time of day or the route travelled. However, as the evidence base suggests, alternate modes of travel may be more effective in providing choice, not simply for those with a lower ability to pay but also across various groups of motorists.

122 A demographic breakdown of motorists who paid the road user charge on the 91 express lanes in southern California reflected the demographics of non-users. However, the frequency of use was significantly correlated with a higher economic status.

123 DfT (2006c) op. cit.

Figure 9. Views on the fairness of road pricing in reducing congestion, by levels of support for road pricing scheme[123]

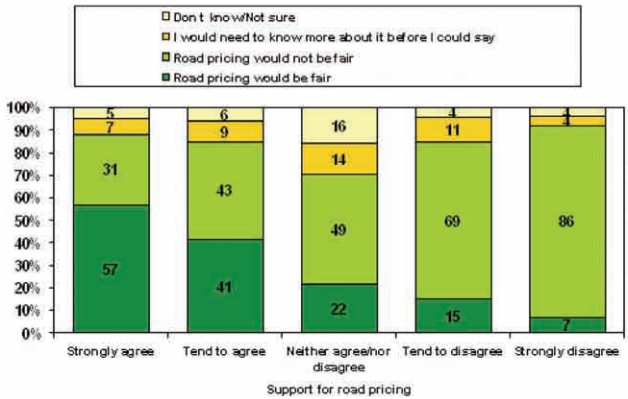


Source: November 2005 Omnibus Survey. Base number: 589.

124 ibid.

125 Glaister and Graham (SMF, 2006) op. cit.

Figure 10. Reasons why road pricing is not considered fair[124]



Equity and the use of revenues

It is worth noting though that both hypothecation of revenues from road user charging for public transport and a revenue-neutral scenario may have equity implications for motorists.

In the first case, road pricing revenues could be used to improve the alternatives available to vulnerable motorists, increasing the equitability of the scheme. Improving the availability, frequency, safety and journey reliability of public transportation could help mitigate the social exclusion effects of road pricing. However, public transportation improvements financed through hypothecated revenues may not benefit all the users of a road pricing system equally. For example, public transportation improvements may be concentrated in an urban area, leaving those travelling into a city centre from rural areas with little alternative but to pay the charge.

In the case of a revenue-neutral scheme, the equity question arises in relation to the effective transfer of resources from a majority of motorists (who drive on congested urban and inter-urban roads) to a significant minority of rural motorists.[125]

It will be important for government to consider the equity implications of a scheme whether it adopts a revenue-neutral or revenue-additional approach. It is easy to regard improving public transport as a priority because it facilitates a modal shift without considering the fact that it can also increase the vertical and horizontal equity of road user charging. The distinction is

important, not simply for generating public acceptability, but also because considering the equity implications of road pricing adds another dimension by which to gauge the demand and need for complementary investment in infrastructure, such as public transport.

Perceptions of equity are also important when it comes to generating public acceptance of any proposed scheme. It is likely that there will be a significant minority for whom road user charging will present an additional burden and may impact on decisions about work or childcare. Obviously the availability of alternative means of transport, whether in the form of public transport or of an uncharged road, will be an important consideration. But this is unlikely to provide a real alternative for all drivers.

Social exclusion

Motorists without the ability to pay could be at risk of social exclusion from the introduction of road pricing. Those on low incomes, with disabilities, the elderly, women (with potential security fears of travelling on public transport), minority ethnic communities, and those not served by public transport may be unable to avoid charges by switching modes of transport or by travelling at different times.[126]

For such motorists, paying a road user charge may be too costly and so their only option for avoiding the charge may be to stop motoring altogether. With no viable alternatives, these at-risk groups may have difficulty in continuing to participate in society.

It will be important to consider social exclusion issues when designing a scheme as the distributional impacts of road pricing on these potentially at-risk groups could differ markedly in different schemes. For example, the boundary effects of a cordon or area charge may affect fewer people but to a greater extent. By contrast, a distance-based charge could affect a broader range of at-risk motorists, but with less serious consequences relative to the cordon charge.[127]

Exemptions and better alternatives, such as improved public transportation targeted at these groups, would require a concerted effort by road pricing authorities to understand their needs and demands. Transport for London carries out social

126 Peter Bonsall, Charlotte Kelly, *Road User Charging and Social Exclusion: The Impact of Congestion Charges on At-risk Groups* (Transport Policy, 2005).

127 ibid.

impact monitoring, while the equity audits could be a means of understanding and mitigating any social exclusion effects of road pricing.[128]

Exemptions

While exemptions targeted at those who most need to use charged roads could be used to improve the equitability of a road pricing scheme, they could also lower the efficacy of the system, thereby potentially undermining public acceptability.

Policymakers need to ensure that the boundaries of any scheme do not privilege one social group over another. If the aim of congestion charging is to reduce the volume of cars using the roads, it is unclear how this objective will be achieved if, for example, residents of high car ownership areas are exempt.

Road pricing can also have significant labour market and social effects, particularly as certain disadvantaged groups and those in part-time or low-income jobs are particularly influenced by travel time and pecuniary costs.

The equity concerns raised would, in part, be determined by the type of charge instituted in the given area. An area scheme, such as in London, could see boundary effects that had significant impacts on social exclusion, accessibility and parking, while distance-based schemes may have equity implications for rural drivers who drive longer distances out of necessity.

For some people, such as medical and other essential workers, who need to be readily mobile to carry out their employment responsibilities, exemptions may be considered. Other groups, such as women and shiftworkers (whose shift covers part of the charging times), may rely on a private car because of personal security, family responsibility or because public transportation is unavailable. They may not be able to alter their travel arrangements and trip patterns in response to road user charging, and yet may fall into the low income categories who are already experiencing inequity in transport. For these people, exemptions may contribute to a fairer experience of transport.

However, any exemption scheme must not be too large if it is to reduce congestion effectively. It should be fair and opportunities for abuse minimised.[129] Although exemptions can raise public acceptability by addressing equity concerns, inappropriately targeted exemptions, as in the proposed Edinburgh

128 Raje (2004) op. cit.

129 ibid.

scheme, could foster social exclusion while undermining the effectiveness of the scheme.

Exemptions in the proposed Edinburgh scheme[130]

The abandoned Edinburgh scheme provides an interesting case study in how exemptions may cause resentment and undermine the efficacy and public acceptability of the scheme. The proposed scheme would have exempted all Edinburgh residents, whether they lived within the charging zone or not, meaning that for residents of Lothianburn on the A702 just outside of Edinburgh, those on one side of a road would have been charged to cross the cordon while their counterparts on the other side of the road would not have been.

Further examples were Danderhall (a less well-off village, with low car ownership and within the charging boundary but formally located in Midlothian) and Balerno (a well-off village with high car ownership, located outside the proposed boundary, but officially part of Edinburgh). The proposed Edinburgh scheme would have punished those within the boundary, while providing exemptions for households with high car ownership and living outside the charging zone.

130 Raje (2004) op. cit.

131 Green and Stone (2004); Raje (2004); Lyons (2004) op. cit.

Conclusion

The equity and complexity of any road pricing system are at the heart of how motorists would engage with road pricing. These, in turn, could help to determine the political viability of the system. Decisions on these questions would also have an impact on the efficacy and efficiency of a road user charge.

Introducing road pricing in the UK would require policymakers to balance careful trade-offs between public acceptability, efficiency and effectiveness, and equity. Although not necessarily mutually exclusive, policymakers should be wary of sacrificing one objective at the expense of another.

In most research concerning attitudes, the two main equity concerns are for those on low incomes and for those with no real alternative.[131] Consequently, concerns for equity may square with the need for revenue to be used to improve roads and transport.

Moreover, as motorists are concerned about effectiveness

and equity, it may be that exemptions should be granted only on those terms rather than as a means of fostering acceptability. It is clear, however, that an appropriate mix of exemptions and investment of revenues into viable and feasible options for motorists to maintain mobility without incurring the charge would foster acceptability as well as political viability in the long run.

Chapter 7: A road map for road pricing

In May 2006, the Secretary of State for Transport, Douglas Alexander, suggested that 'a personal priority will be to advance the debate about a national system of road pricing in this country – moving the debate from "why" to "how" we might make a national system work in practice.'

This report has sought to identify and explore the primary issues that are fundamental to making road pricing work in the UK, such as balancing how to use any road pricing revenues with concerns for equity and the environment.

Yet rather than explicitly set out the details of a scheme that would inevitably be outdated long before national road pricing became a reality, our analysis above provides certain principles and guideposts that, when put together, make a potential road map for road pricing in the UK.

By pushing forward the debate on how road pricing could be successfully introduced, our road map sets out the primary issues still outstanding and the steps necessary to ensure an appropriate balance between efficiency, public acceptability and concerns for equity.

The introduction of national road pricing in the UK would be on a scale not seen elsewhere, which makes comparisons with other schemes internationally difficult. However, most schemes around the world have been characterised by a level of political leadership and consensus that has enabled the promotion of the benefits, and production of a clearly defined, coherent and complete policy. Consequently, the first requirement for moving forward will be political leadership and consensus that could develop and follow a road map for road pricing.

The first stage on the road map would be for policymakers to provide clarity over the policy objectives of any potential schemes, finance and governance structures, the desired type of charging, and the technologies to be used.

The second stage would require local and national institutions to coordinate to manage the transition from a simple scheme by supplying the political leadership and consensus necessary to garner the public acceptability to move forward, along with developing the appropriate technologies, realigning (if necessary) the finance and governance structures with road pricing and, ultimately, piloting schemes across the UK. The third and last stage would involve incorporating the lessons from any pilot schemes and pushing the consensus forward for implementing road pricing on a wider scale.

Providing clarity

Step 1: Determine the policy objectives

Road pricing has the potential to make motorists pay the real costs of driving, which at the moment they may not typically face, such as congestion and carbon emissions. Although congestion in the UK seems to be the overwhelming economic problem, there are going to be fundamental trade-offs between efficiency, public acceptability and equity.

Consequently, any focus on congestion should be balanced with a concern for road transport carbon emissions – road pricing in the UK should not make emissions worse nor should it conflict with governmental priorities and commitments on climate change.

Policy objectives for road pricing in the UK

- Road pricing in the UK should be designed to make significant reductions to traffic congestion. Any scheme should:
- be technically and politically workable for the UK;
- give appropriate priority to concerns about equity; and
- allow for significant contributions to reducing road transport carbon emissions.

Whether reducing road transport carbon emissions is addressed as part of the tax system or through road pricing would depend

critically on the design of any road pricing system. As noted, fuel duty is the primary means of taxing motorists for their carbon emissions, with motorists paying more in fuel duty the more they drive. Graduated bands for the VED make motorists who own less fuel-efficient cars pay more.

Yet if road pricing were to be introduced on a revenue-neutral basis from the Treasury's perspective, with offsets in fuel duty and/or VED, then either an alternative mechanism has to be found to reduce carbon emissions or reducing carbon emissions should be made an explicit policy objective of any road pricing system. If fuel duty or VED were lowered or abolished as a consequence of any road pricing system, policymakers would need to ensure that the goal of reducing emissions is not sacrificed for reducing congestion.

As noted in chapter 3, there are two specific areas of concern about road transport carbon emissions - the rapid growth of carbon emission from vans and lorries, and the already high level of carbon emissions from private cars. Consequently, vans and lorries may have different demands for motoring and so would respond differently to the same road pricing system.

Road pricing policy can constrain the growth in carbon emissions by differentiating freight traffic from passenger traffic. Reducing congestion of passenger cars (and white vans) will help, but a significant contribution to cutting carbon emissions would require complementary investment – public transport, better transport infrastructure, green soft-demand management measures.

Step 2: Determine how the revenues will be used

The issue of how revenues would be spent is perhaps most crucial, integral to securing public support as well as determining the design of any scheme. As stated in this report as well as other research, road pricing could be revenue-neutral or it could, from the viewpoint of the Treasury, be completely revenue-additional or it could fall in-between these two poles.

Surveys and polls of public opinion show that there is no clear winner, in terms of public opinion, between reinvesting road pricing revenues in public transportation and roads or returning the revenues to motorists through lower fuel duty or VED.

132 This approach is used in Glaister and Graham (SMF, 2006) op. cit.

How to use the revenues

Option 1: Revenue-neutral road pricing with explicit environmental objective

Road pricing on a revenue-neutral basis is a complex concept with a number of potential approaches. One would be for road pricing to be revenue-neutral from the viewpoint of the Treasury, with a reduction in fuel duty or VED to offset any road pricing charges.[132] Another possibility would be to estimate road pricing revenues post-charge and then reduce fuel duty or VED so as to make the charge revenue-neutral.

However, we believe that a revenue-neutral scheme that returned revenues to motorists through fuel duty or VED would need to be accompanied by a more explicit environmental objective. For example, any reductions in fuel duty should favour cleaner fuels (diesel and biofuels) so that any increase in traffic due to lower fuel duty would not be counterproductive to environmental goals. Another option would be to remove the VED in favour of banded road pricing, whereby more fuel-efficient cars pay a lower charge.

Option 2: Revenue-additional (with hypothecation)

A revenue-additional scheme would make significant sums of money available for use on complementary measures – including improved public transportation or better road maintenance – that would make road pricing more efficient, publicly acceptable and equitable.

We believe that these positive features would be enhanced if the revenues were then hypothecated.

Option 3: A degree of additionality with hypothecation

Full additionality may not be optimal, however. Motorists are likely to regard road pricing as double taxation on top of fuel duty and VED. Some mitigation through a reduction in other forms of taxation may help them view road user charging positively.

An important argument is also often made in favour of using the VED to incentivise drivers to own more fuel-efficient cars. However, VED is a tax on ownership; it treats an SUV parked on the street the same as one used for the daily commute, even though the latter makes a more significant contribution to carbon emissions.

Removing the VED in favour of banded charging would partly address concerns of double taxation, incorporate the publicly and politically acceptable environmental objective, and replace an inefficient tax with a welfare-enhancing charge.

By not reducing the fuel duty, there would potentially be enough revenues to make the complementary investments in public transportation and roads.

Irrespective of how revenues were used, significant questions would remain about the governance and finance structures that would support road pricing. These include:

- Which authority would collect the funds?
- Which would be responsible for distributing them?
- Which bodies would be responsible for spending them?
- Would local governments want to be bound/told by the Treasury to spend the money on transport when they have other pressing needs?

Although road pricing in the UK would undoubtedly exist under a coherent and consistent national framework, there would still be the requirement to decide whether it was completely run and operated by a central authority nationally or by a mix of local and national authorities. As there are pros and cons to either structure, and as both would require close cooperation between local and national authorities, the choice between the two would come down to:

- existing policy or proposals for reforming local government;
- the ease and fairness of reinvesting road pricing revenues into complementary measures, such as public transportation; and
- benefits/relative simplicity for motorists in either option.

Step 3: Define the type of charging

Despite a statement on the policy objectives, we still need to know the type of charge to be used. Will it be like congestion charging in London, with drivers charged for driving in a specified area, or will it be distance-based, with drivers charged by the mile? Will the charge change by time of day or by levels of congestion? How will addressing carbon emissions explicitly affect the charging mechanism?

International schemes provide a range of options. Lorry

133 Gullo (2006) op. cit.

charging in Germany is distance-based, but varies by weight and emissions class. Toll roads in California charge not only by time of day but also change the charge to reflect the level of congestion on the road.

Option 1: Simplicity is key
Road pricing could be made fairly simple and straightforward. Whether a distance-based charge, an area charge (such as congestion charging in London) or a simple event-based charge, simplicity would provide clear signals to motorists about the cost of driving.

Option 2: Layering the charge
Road pricing could be built on the simple charge by adding layers or other specifications on to the basic charge. For example, a distance-based charge could form the basis for varying the charge by location, time of day, levels of traffic or vehicle type.

Option 3: Maintain flexibility
As suggested by the differing nature of the proposals of the seven areas receiving TIF money, there may not be a single type of charge that works well across the UK. Rather, much as with the technology used, flexibility might be the key. Yet flexibility should not, and does not, necessarily mean added complexity.

One solution to make flexibility work could be for a UK system to piggy back off the existing technology at the heart of the German lorry-charging scheme. Germany has 12,000 km of motorways that are divided up into more than 5,000 segments, each with a length prescribed by the government and effectively with a fixed charge.[133]

Each segment is designated by virtual gantries/nodes – the GPS system is able to tell when a lorry has passed through a virtual gantry and only charges when it is sure that the lorry has completed the segment. If the on-board unit (OBU) is not sure, the lorry is not charged.

This method of charging would allow for two important scheme variations. The first would be the ability to cluster or group segments, turning the charge, for practical purposes, into

an area scheme. Such a system would address one of the criticisms of the London scheme by allowing for distance-based charging within areas, as well as for the charge to vary by area.

The second benefit is that different stakeholders can 'own' different segments. If schemes are to be locally managed, while fitting into a coherent and consistent national system, local and regional authorities could have 'ownership' over the segments relevant to their areas. If roads were to be treated as other infrastructure utilities, such as gas, electricity or water, private companies would own various segments. Or, if road pricing is to be truly national and run by a central authority, then that body could own the entire system.

Such segment-based charging would also allow for flexibility in allocating revenues – a particularly thorny issue when considering hypothecation or revenue-neutrality. For example, London could maintain its scheme within a larger framework while receiving the revenues raised in its area. However, mixed ownership of segments would require consensus on the full rights and responsibilities of owning a segment of road pricing. Transport for London's technology trial on a segment-based GPS system found that "the performance of the best system is probably sufficiently good enough to allow, at a later date, the introduction of a parallel distance-based charge alternative to the current fixed Congestion Charge, subject to a proper assessment and appropriate consultation."[134]

This, however, is only one potential answer, as the charging mechanism would form only part of the solution needed to deliver on the policy and operational objectives. Issues such as enforcement and accuracy in urban environments would need to be addressed.

Other options

As mentioned above, there are two additional options for varying the type of charge. The first is to differentiate the road pricing scheme for passenger cars from the one for vans and lorries. The other is scrapping the VED in favour of a high-level environmental mechanism, such as banded road pricing based on fuel efficiency. These mechanisms would not complicate the technology necessary for pricing but would provide clear incentives to use roads more efficiently, in the former case, and to

134 TfL (2006) op. cit.

own more fuel-efficient cars in the latter.

Step 4: Define technology
The choice of technologies is not simply about the differing merits of technologies, such as GPS, tag and beacon or roadside cameras, but rather which technologies can deliver the policy and operational objectives set out by government. Indeed the effectiveness of any one of these technologies may be improved or better suited for different aspects of the value chain.

Although government has said it is in favour of piggy backing on proven technologies, there might be a role for it to be a 'first mover' in determining road pricing technology.

If road pricing in the UK piggy backs on the GPS technology of mass market navigational systems, there is no guarantee that such technology will have the accuracy necessary for road pricing nor will these systems be designed to deliver on operational goals. Government would still have to determine the pricing mechanisms that set the charge as well as define and develop the technology necessary for accurate enforcement.

This approach would also see government clarifying the data to be collected and how it would be used – by making privacy concerns central to introducing road pricing, government could frame the debate and manage public trust.

Yet being a 'first mover' should not necessarily imply government designing or developing the technology itself, but rather clarifying what it wants from road pricing and how it sees technology helping to deliver those objectives.

By either clarifying the end objectives (as with the digital switchover), or using existing road pricing technology to develop the core system on which spin-offs and value-added service can be added, government could be a first mover and ensure that its own policy and operational objectives determine the technologies rather than vice versa.

Managing the transition

Step 5: Public acceptability and equity
Introducing road pricing in the UK would require policymakers to balance careful trade-offs between public acceptability, efficiency and effectiveness, and equity. Although not necessarily

mutually exclusive, policymakers should be wary of sacrificing one objective at the expense of another.

In most research on attitudes, the two main equity concerns are for those on low incomes and for those with no real alternative.[135] Consequently, concerns for equity may square with the need for revenue to be used to improve roads and public transport.

Moreover, as motorists are concerned about effectiveness and equity, it may be that exemptions should be granted only on those terms rather than as a means of fostering acceptability.

An appropriate mix of exemptions and investment of revenues into viable and feasible options for motorists to maintain mobility without incurring the charge would foster long-term acceptability as well as political viability.

Whichever approach is used to determine exemptions and discounts, the objective should be to maintain integrity of the scheme. For example, while resident discounts may work in central London, in a national scheme they would greatly limit the ability to reduce congestion or carbon emissions.

Garnering public acceptability will depend on achieving the political leadership and consensus necessary to advocate the 'carrots' of road pricing alongside the 'stick' of paying for a trip that was previously free. However, it is precisely because the benefits of road pricing depend on the details of any scheme that policymakers should provide a road map of road pricing.

135 Green and Stone (2004); Raje (2004); Lyons (2004) op. cit.

Step 6: Developing the technology

Setting out a road map for road pricing would allow policymakers to better manage the process of developing the technologies necessary to deliver the policy and operational objectives of road pricing.

Although there could be significant benefits from being a technology 'first mover' it would not be necessary for government to develop the technology itself. Rather, piggy backing on proven road pricing technologies could lower costs while speeding up the timetable for road pricing.

Indeed, clarifying the core technologies of road pricing would open up the possibility of a road pricing system being at the core of any additional services, such as real-time traffic information, or potentially lower insurance premiums could give

drivers extra incentives to fit an OBU into their car.

In addition, this phase of the road map would see policy-makers ensuring that road pricing technologies meet the appropriate standards for privacy, and developing a framework for data sharing that not only meets standards of public trust, but also provides value-added for the motorist.

This phase would also allow public and private sectors to work together to resolve the details of road pricing technology, such as:

- how to treat infrequent or occasional users;
- how to achieve the accuracy necessary for any system;
- developing accurate and credible charging and enforcement systems; and
- ensuring any on-board technology is cost-effective, not only for government but for motorists as well.

Step 7: Aligning finance and governance structures with road pricing

Concerns about double taxation and the potentially large amounts of revenues involved in road pricing, coupled with some current bitterness from motorists about the discrepancy between what they currently pay to drive and government's investment in roads, will tend to reinforce the public's lack of trust towards government promises on the new forms of taxation and charging.

As the current trend in governance structures is towards devolution of powers away from Whitehall, it seems more likely that considerable powers and discretion would be left with local government. That is certainly the spirit of the current policy of encouraging local authorities to work out pilot schemes funded under the TIF. Consequently, any road pricing system favoured by the government would need to fit reforms to local government's powers.

Option 1: A fully national scheme
A fully national scheme managed and operated by a central authority. Reforms to local government would be largely independent of any road pricing system.

Option 2: Replicate the London system in other areas
Government is currently discussing the possibility of replicating in certain areas the London system of a directly elected mayor held accountable for charges, budgeting and reinvesting revenues.

Option 3: Maintain flexibility
The default option could be that road pricing is the responsibility of a central authority, but as local and regional governments demonstrate interest in establishing road pricing schemes in their own areas, responsibility for road pricing could devolve to these authorities by progressing through a modified TIF process.

Step 8: Piloting
The question is not whether or how road pricing could be piloted better, or what aspects of road pricing should be piloted, but rather what aspects of road pricing should be addressed before piloting progresses. In our road map, piloting is the last step before wider implementation of the national scheme. Piloting would be more informative and relevant for introducing road pricing on a national scale if much of the clarification came upfront. Indeed, the TIF and Road Pricing Local Liaison Group are designed to do just that.

Transition to national road pricing
By advocating a road map for road pricing, we note that there is neither a single preferred route nor a single preferred destination. Nor do we suggest that government necessarily commits upfront to a singular concept of road pricing. Rather, we argue that by setting out a more detailed notion of where and how road pricing in the UK would be implemented, we would be better positioned to garner public acceptability and to ensure the successful introduction of any scheme.

Road pricing is no miracle cure for all transport policy issues. Road pricing works best when it provides clear and sim-

ple, yet strong signals to motorists about the costs of driving. As such, it can be an effective policy tool for tackling congestion and reducing carbon emissions.

Nor is the road map intended to be a simple and linear policy checklist. As lessons learned and feedback from public consultations are incorporated, the proposals will need to be developed and refined.

Our research suggests that a road pricing scheme could primarily target congestion but could also: be economically and politically viable; give priority to concerns about equity; enable reductions in greenhouse gas emissions; and favour significant levels of hypothecation. Consequently, we favour a road pricing system with:

- a significant degree of additionality;
- VED scrapped in favour of a high-level fuel environmental objective;
- banded road pricing based on fuel efficiency and emissions output;
- any additional revenues hypothecated for reinvestment in, among other uses, roads and public transportation; and
- a distance-based charge that forms the basis for charges that vary by time of day and traffic levels.

This could be developed by working within the consistent and coherent framework already in place with the TIF and the Road Pricing Local Liaison Group. This approach would see local and regional authorities taking on a degree of responsibility or ownership over road pricing in their areas.

We also suggest implementation of road pricing progress at a clearly defined pace. This might be via a 'big-bang' approach with charging introduced on a specified date, or a more measured approach in which road pricing is implemented in stages, for example, by proceeding from piloting to charging in urban areas and the strategic road network to potentially charging for driving on all UK roads.

A road map for road pricing – the alternatives

		Option 1	Option 2	Option 3
Provide clarity	**Policy objective**	**Road pricing in the UK should be designed to make significant reductions to traffic congestion, as well as:** • being technically and politically sound; • giving appropriate priority to concerns about equity; and • allowing for significant contributions to reducing road transport carbon emissions.		
	What happens to the revenues	**Revenue-neutral, with explicit environmental objective** • Banded road pricing based on fuel efficiency and emissions category • Fuel duty reductions favour more efficient fuels, such as diesel or biofuels • Central authority responsible for collecting revenue	**Completely revenue-additional, with hypothecation** • Additional money spent on roads and public transportation • Emphasis on promoting alternatives to driving, such as walking and cycling	**A degree of additionality, with hypothecation** • VED scrapped for high-level environmental target • Banded road pricing based on fuel efficiency and emissions category • Any fuel duty reductions favour more efficient fuels, such as diesel or biofuels
	Type of charging	**Maintain flexibility** Distance-based charging as a foundation for layered charging or segment-based system		
	Clarify technology	**Be a 'first mover' on technology** Make privacy central to road pricing and help frame debate on public trust Place road pricing at the core of any additional services		
		Option 1	Option 2	Option 3
Manage transition	**Public acceptability and equity**	National political leadership fosters national consensus on road pricing	National and local political leadership work in partnership to develop national consensus	
	Develop technology	**Resolve the details of road pricing technology, such as:** • how to treat infrequent or occasional users; • how to achieve the accuracy necessary for any system; • developing accurate and credible charging and enforcement systems: and • ensuring any on-board technology is cost-effective, not only for government but for motorists as well.		
	Align finance and governance structures	**Maintain flexibility** Any road pricing system should incorporate a certain amount of flexibility to adapt to changing local government finance and governance structures.		
	Piloting	**Pilot road pricing through the TIF process**		
National road pricing	**Wider roll-out**	A measured approach A more measured approach in which road pricing is implemented in stages, for example, by proceeding from piloting to charging in urban areas and the strategic road network to potentially charging for driving on all UK roads		

Conclusions

As congestion on the UK's roads worsens and as climate change becomes an even greater priority, transport policy needs to be realigned so as to better manage traffic growth. A market-based solution to tackling congestion and reducing emissions, road pricing has the potential to provide clear and transparent, yet strong signals to drivers about the true costs of motoring. Using road pricing to change motorists' behaviour requires striking an appropriate balance between the multi-layered priorities of improving the efficiency of the UK's road network, garnering the public acceptability necessary to implement road pricing and minimising the exclusionary aspects of any scheme.

How local and national authorities would spend any road user charging revenues is of particular importance to the effectiveness of the scheme in changing motorists' behaviour, and is ultimately tied to public acceptability.

Consequently, it is not only important to consider whether environmental objectives should or could be included into a road pricing scheme, but also the environmental impact of the various options for how revenues were used.

Revenue-neutrality could enhance the public acceptability of a road pricing system, yet it could also create tensions with other policy objectives, such as improving public transport and reducing road transport emissions, and would only be possible after covering administrative costs of the scheme. As such, an environmental objective would need to be made explicit in any revenue-neutral road pricing scheme.

Revenue-additional road pricing with hypothecation could provide the level of trust necessary to convince the public that current and future road pricing revenues would be spent on public transport and improving roads. Yet a road user charge

on top of fuel duty and vehicle excise duty (VED) is often perceived as double, if not triple, taxation.

By settling on a level of additionality between these two polar choices, policymakers may be able to remove the double taxation stigma. A degree of additionality would also ensure that enough funds would be available to invest in the complementary measures, such as public transportation improvements that are not only desperately needed around the country but would also increase the equity and efficiency of any road user charge. Simple variations in the charges and exemptions based on engine efficiency would be possible without generating the complexity inherent in a system that charges for distance travelled as well as the level of greenhouse gas emissions per journey.

By placing these policy and operational objectives side-by-side, policymakers could assess the efficacy, reliability and credibility of various technologies in delivering on the practical aspects of road pricing, such as collecting and administering revenues, data sharing and enforcement. It is through this process that policymakers could identify a simple and effective, yet publicly acceptable technology.

It is important to note, however, that road user charging, either for passenger cars or for vans and lorries, is more than likely not a short-term solution. Other pricing mechanisms could consequently be as important as road pricing in encouraging more efficient uses of delivery infrastructures. These include: steeper gradations in the VED and tax incentives to use hybrid technologies and consume bio/alternative fuels; a reconsideration of trip planning and transport patterns; enhancing bundling of consignments; and improving the efficiency of transport business.

As the debate on road pricing progresses from asking 'why' to exploring 'how', the road map set out above is meant to provide policymakers with a set of options in managing the trade-offs between efficiency, public acceptability and equity. While we have indicated a preferred road map, it is by no means meant to provide a comprehensive solution to road pricing in the UK.

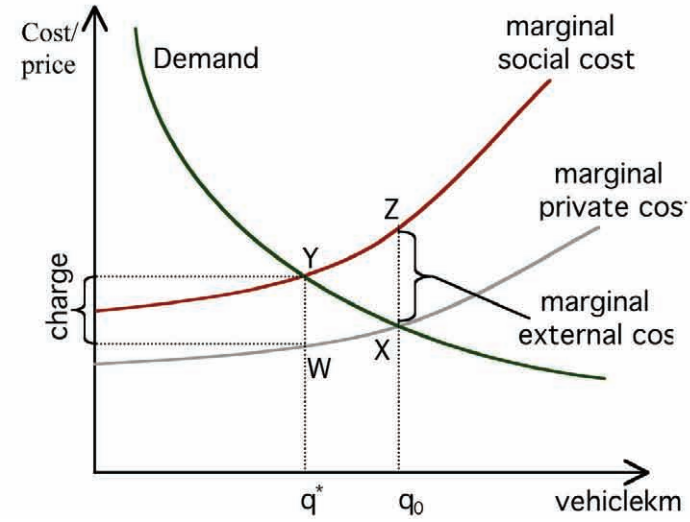
By advocating a road map for road pricing, we note that there is neither a single preferred route nor a single preferred destination. Nor would we suggest that government necessarily commits upfront to a single concept of road pricing. Rather, we

argue that by setting out a more detailed notion of where and how road pricing in the UK would be implemented, we would be better positioned to garner public acceptability and ensure a successful introduction of any scheme.

Road pricing, however, is not a miracle cure for all land and transport policy issues. Road pricing works best when it provides clear and simple, yet strong, signals to motorists about the costs of driving. As such, road pricing can be an effective policy tool for tackling congestion and reducing carbon emissions.

Appendix A – The economics of road pricing

Figure A1 – The economic case for road user charging – a simplified model



Given their demand for road transport, motorists will travel until the point where their marginal private cost is equal to their marginal private benefit, or their demand, shown in figure 3 as point X.

However, this travel imposes costs on other motorists and the general population. By travelling an extra mile, the motorist will increase traffic flows over that mile, slowing down existing traffic, emitting more greenhouse gases and adding to road wear

136 Sansom et al, *Surface Transport Costs and Charges* (Institute for Transport Studies, University of Leeds: 2001).

137 ibid.

and tear. This marginal external cost is shown as the difference between the points Z and X.

The equilibrium level of vehicle-kilometres per hour, shown as q0, is inefficient because it creates a welfare loss of XYZ, relative to the social optimum level q*. At the social optimum, demand equals the marginal social cost of travel, creating an efficient level of road transport.

Economic theory states that road user charging works by making the marginal external costs explicit to the motorist. Thus the charge should be set so that the sum of the charge (shown as the distance between points Y and W) and the motorists' marginal private costs is equal to their marginal private benefit. The charge, which reflects the added infrastructure and external costs, is a signal for the true price (here the marginal social cost) of motoring.

Table A1 provides low and high estimates of the cost (pence per vehicle kilometre) of major types of marginal external cost. Even on conservative estimates, the marginal cost of congestion is the highest at 9.71 pence per vehicle kilometre.

Table A1 – Road costs (pence per vehicle kilometre)[136]

Cost category	Low	High
Infrastructure operating costs and depreciation	0.42	0.54
External accident costs	0.82	1.40
Air pollution	0.34	1.70
Noise	0.02	0.05
Climate change	0.15	0.62
Congestion	9.71	11.16

Table A2 – National elasticity values[137]

Elasticity	Value	Source
Car traffic with respect to fuel price	−0.310	Graham and Glaister (2002b)
Bus (passenger km) with respect to bus fare	−0.900	Dargay and Hanly (1999)
Rail (passenger km) with respect to rail fare	−0.500	ATOC (2001)
Freight traffic with respect to fuel price	−1.070	Graham and Glaister (2004b)
Bus (passenger km) with respect to fuel price	0.035	Calculated
Rail (passenger km) with respect to fuel price	0.112	Calculated
Traffic (car km) with respect to bus fare	0.005	Calculated
Traffic (car km) with respect to rail fare	0.016	Calculated
Bus (passenger km) with respect to rail fare	0.340	Grayling and Glaister (2000)
Rail (passenger km) with respect to bus fare	0.918	Grayling and Glaister (2000)

Table A2 lists the own and cross-price elasticity of car, bus, rail and freight traffic. Predictably, the own-price elasticities show that, as the price of travel rises, the level of traffic drops. For example, if petrol prices rose by 10%, car and freight traffic would fall by 3.1% and 10.7%, respectively; bus and rail passenger-kilometre would fall by 9% and 5%, respectively, with a 10% rise in bus and rail fares. The cross-price elasticities estimate the tendency of, for example, a rise in petrol prices to induce a modal switch to bus or rail.

Appendix B – Historical fuel duty rates and receipts

Figure A3 – Selected fuel tax duties since 1989

Date of Budget change	Motor Spirit (pence per litre)					Diesel (pence per litre)			
	Leaded Petrol and other light oils	Unleaded Petrol	Ultra Low Sulphur Petrol	Sulphur Free Petrol	Super Unleaded Petrol/ LRP[2]	Diesel	Bio Diesel/ Blended	Ultra Low Sulphur Diesel	Sulphur Free Diesel
14.03.89	20.44	17.72	-	-	-	17.29	-	-	-
20.03.90	22.48	19.49	-	-	-	19.02	-	-	-
19.03.91	25.85	22.41	-	-	-	21.87	-	-	-
10.03.92	27.79	23.42	-	-	-	22.85	-	-	-
16.03.93	30.58	25.76	-	-	-	25.14	-	-	-
30.11.93	33.14	28.32	-	-	-	27.70	-	-	-
29.11.94	35.26	30.44	-	-	-	30.44	-	-	-
01.01.95	36.14	31.32	-	-	-	31.32	-	-	-
28.11.95	39.12	34.30	-	-	-	34.30	-	-	-
15.05.96	39.12	34.30	-	-	37.62 [4]	34.30	-	-	-
26.11.96	41.68	36.86	-	-	40.18	36.86	-	-	-
02.07.97	45.10	40.28	-	-	43.60	40.28	-	-	-
15.08.97	45.10	40.28	-	-	43.60	40.28	-	39.28 [5]	-
17.03.98	49.26	43.99	-	-	48.76	44.99	-	42.99	-
09.03.99	52.88	47.21	-	-	52.33	50.21	-	47.21	-
21.03.00	54.68	48.82	-	-	50.89	51.82	-	48.82	-
01.10.00	54.68	48.82	47.82	-	50.89	51.82	-	48.82	-
07.03.01	54.68	46.82	45.82	-	- [6]	51.82	-	45.82	-
15.06.01	54.68	48.82	45.82	-	-	51.82	-	45.82	-
17.04.02	54.68	48.82	45.82	-	-	51.82	25.82 [7]	45.82	-
09.04.03	54.68	48.82	45.82	-	-	51.82	25.82	45.82	-
01.10.03	56.20	50.19	47.10	47.10	-	53.27	27.10	47.10	47.10
03.12.04	56.20	50.19	47.10	47.10	-	53.27	27.10	47.10	47.10
01.01.05	56.20	50.19	47.10	47.10	-	53.27	27.10	47.10	47.10
06.12.05	56.20	50.19	47.10	47.10	-	53.27	27.10	47.10	47.10
01.09.06	57.68	51.52	48.35	48.35	-	54.68	28.35	48.35	48.35

1. Kerosene and other heavy oils (including aviation kerosene and lubricating oil) have been at nil rates of duty since 1984 and 1986 respectively.
2. Lead Replacement Petrol (LRP) was introduced on 1 October 1999 and had the same rate of duty as super unleaded petrol.
3. Duty on road fuel gas was previously at the same rate as aviation gasoline.
4. Duty on super unleaded petrol was previously at the same rate as other unleaded petrol.
5. Duty on Ultra Low Sulphur Diesel (ULSD) was previously at the same rate as other diesel fuel for road vehicles (DERV).
6. Separate rate abolished 7 March 2001. Duty now charged on this fuel at the rate appropriate to unleaded petrol or ultra low sulphur petrol dependent upon the sulphur and aromatics content of fuel.
7. Biodiesel duty rate took effect on 26/07/02. This will apply to pure biodiesel and the proportions of biodiesel blended or mixed with heavy oils
8. With effect from 3 December 2004 the road fuel gas duty rate is separated into two categories, 'natural gas' and 'all other gases'.

Source: Department for Transport

Figure A4 – Historic Receipts

	Motor Spirit						Diesel					Other Selected Fuels				All Oils
	Ultra Low Sulphur Petrol	Sulphur Free Petrol	Unleaded Petrol	Super Unleaded Petrol/LRP [1]	Leaded Petrol	Total Petrol	Ultra low Sulphur Diesel [2]	Sulphur Free Diesel	Diesel	Biodiesel and Bioblended [3]	Total Diesel	Fuel Oil	Gas Oil	Gas for Road Fuel/LPG [4]	Bioethanol	Total
Financial Year																
1995/96	-	-	19,174	0	10,843	30,017	0	-	16,479	-	16,479	4,943	7,608	0	-	59,023
1996/97	-	-	19,845	712	9,198	29,756	0	-	17,308	-	17,308	4,306	7,583	1	-	58,892
1997/98	-	-	21,320	769	7,870	29,959	930	-	17,204	-	18,134	2,665	6,838	4	-	57,584
1998/99	-	-	22,916	543	5,678	29,137	3,876	-	14,531	-	18,407	2,390	7,133	8	-	57,042
1999/00	-	-	24,907	1,890	1,844	28,640	17,912	-	384	-	18,295	2,211	6,965	19	-	56,093
2000/01	6,050	-	19,275	2,207	-0 *	27,532	18,442	-	51	-	18,493	1,691	6,879	59	-	54,596
2001/02	26,969	-	1,247	11	2	28,229	19,062	-	51	-	19,113	1,654	6,798	124	-	55,786
2002/03	27,812	-	22	0	3	27,837	20,067	-	30	5	20,102	1,119	6,602	179	-	55,760
2003/04	27,372	-	34	-0 *	1	27,407	21,141	-	68	22	21,230	1,056	6,246	211	-	56,029
2004/05 p	26,561	-	-20 *	0	-1 *	26,540	22,304	-	69	21	22,395	877	6,303	225	14	56,267
Calendar Year																
1995	-	-	18,805	-	11,298	30,103	-	-	16,339	-	16,339	5,231	7,199	-	-	58,879
1996	-	-	19,870	543	9,471	29,884	-	-	17,111	-	17,111	4,490	7,858	-	-	59,269
1997	-	-	20,182	767	7,874	28,824	372	-	17,019	-	17,391	2,982	7,056	3	-	56,253
1998	-	-	22,381	572	6,224	29,177	1,929	-	16,212	-	18,141	2,563	7,025	7	-	56,882
1999	-	-	24,402	1,256	3,171	28,829	15,775	-	2,784	-	18,559	2,202	7,015	15	-	56,576
2000	2,429	-	23,278	2,593	14	28,313	18,738	-	62	-	18,800	1,803	6,991	43	-	55,909
2001	23,962	-	3,669	399	6	28,036	18,852	-	113	-	18,965	1,646	6,883	108	-	55,530
2002	27,856	-	145	2	0	28,002	19,779	-	-14 *	3	19,767	1,324	6,572	170	-	55,722
2003	27,368	-	24	-1 *	2	27,393	20,818	-	69	19	20,906	1,047	6,416	206	-	55,870
2004	27,030	-	-4 *	0	-1 *	27,025	22,088	-	72	21	22,181	929	6,277	220	-	56,530

1. Includes lead replacement petrol (LRP) which became widely available from October 1999 and is liable to duty at the same rate as super unleaded petrol.
2. From 15 August 1997 ultra low sulphur diesel became liable to duty at a lower rate; prior to this figures were included in those for diesel.
3. Data shows only that proportion of the fuel liable at the biodiesel duty rate.
4. A separate rate of duty for gas for use as road fuel was introduced on 29 November 1994, but separate data on quantities are not available prior to January 1997. Since January 2005 data are for liquified petroleum gas only.

p = Provisional
r = Revised
* = Negative quantities may occur when claims for repayments exceed clearances for consumption.

Source: HMRC

Appendix C – Road pricing technology

138 Central London Congestion Charge (2006).

139 TfL (2005) op. cit.

Automatic number plate recognition (ANPR)

ANPR and other video-based systems rely on the accurate reading of vehicles' number plates as the primary means of identifying, charging and enforcing road pricing. ANPR systems process the video image via a roadside camera or gantry and convert it into the appropriate alphanumeric characters. However, several problems with the technology, such as low accuracy in poor weather and similarities between letters and numbers, have increased the need for manual interpretation and checking of ANPR data. The roadside cameras and human support increase the cost of deploying ANPR technology.

The London congestion charge uses ANPR technology at 203 points in the central London charging zone to capture images of vehicles entering and exiting the zone during charging hours. Penalty charge notices are issued the following day to motorists who have failed to pay the charge. Before the notices are sent out, however, trained staff compare over 5,500 daily digitised number-plate readings with the actual camera image.[138]

As ANPR systems are still developing, they require manual checking to minimise the number of false positives (motorists who have paid the charge yet are still fined) and the number of false negatives (motorists who failed to pay the charge yet are not fined). The accuracy rate of current technologies is 70-80%, compared with over 90% for newer generations.[139]

Two-way communications

Dedicated short-range communications (DSRC) systems are

used for two-way communication between a roadside or gantry beacons and in-vehicle tags or transponders, the most flexible of which are smart cards.[140] There are currently two types of DSRC technology, microwave and infrared. Typically, infrared DSRC allows detection of in-vehicle tags at a greater distance than microwave DSRC.

While previous generations of DSRC technologies were only reliable for low-speed, single-lane operation, current innovations in DSRC technologies are aimed at operating in a high-speed, multi-lane situation. Alone, DSRC systems could be used for motorway tolling, area and cordon charging and, as in the Swiss and German systems, for enforcement.

Although DSRC technologies could be used for both vehicle-to-vehicle and vehicle-to-infrastructure communication, the latter requires the vehicle to pass within a certain distance of roadside infrastructure, such as overhead sensors or gantries. For example, the Stockholm congestion charge uses gantries at each of the 18 entry points to the city centre. Implementing such a scheme in London, for example, could require installing gantries at the 203 ANPR camera sites.

Global system for mobile (GSM) networks could be used for two-way communication between the on-board unit (OBU) and the central system, allowing for a range of payment options, software updates and potentially positioning information.

Initial proof of concept trials in London have shown that GSM technology is inadequate for positioning, but has proved useful as a channel for delivering information to motorists, communicating as a beacon or as a means of updating the charging system.[141]

Mobile positioning systems (MPS)

Mobile positioning, or wide area, systems are the most recent innovations in charging and tolling technology. These systems rely on two existing types of technology – the American global positioning system (GPS) and either of the two-way communication technologies described above. MPS systems would also use either of these two-way communications to facilitate charging, enforcement and updating the system.

GPS systems do not actually report a single location but

140 Blythe (2005) op. cit.

141 ibid.

use a system of satellites to provide an ellipse within which the location may lie. Accuracy (the size of the ellipse) depends on the number of GPS satellites visible to the OBU. The European satellite positioning system, GALILEO, has been designed to improve the accuracy and integrity of the positioning signal. The system is planned to be operational between 2008-10.[142]

142 See above and http://www.intelligentroads.org/section/road_applications (22 March 2003).