Funding Strategic Roads

Stephen Glaister & Luca Lytton;
David Bayliss
November 2011

RAC Foundation

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About the authors

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He was a member of the Board of Transport for London 2000 to 2008, and a non-executive director of London Regional Transport from 1984 until 1993. In 2009–10 he was Partnership Director of Tube Lines. He was a member of the Steering Group for the Department for Transport's 2004 Road Pricing Feasibility Study and was a member of the 'Friends' group advising Sir Rod Eddington on his Transport Study. He is a member of the Analytical Challenge Panel for High Speed 2 (HS2). Between 1993 and spring of 2001 he was an economic advisor to the rail regulator.

He has published widely on transport policy and also on regulation in the telecommunications, water and gas industries. He is the principal author of a series of three studies into national road pricing for the Independent Transport Commission, and of the RAC Foundation's study *Governing and Paying for England's Roads*.

Luca Lytton

Luca Lytton is Research Manager at the RAC Foundation, where he is responsible for the environmental research brief. He has written and project-managed reports on low-carbon vehicles, and has been involved in the Foundation's ongoing work on road pricing. He previously worked for a member of the European Parliament in Brussels on the EU's CO_2 emissions from cars regulation, as well as a policy think tank in Berlin, where he researched the EU's energy and climate change policy. Luca holds an MSc in Environmental Policy and Regulation from the London School of Economics and a BA in European Studies from the University of Maastricht.

David Bayliss

David Bayliss is a transport planner with over forty years of experience. He has long had an interest in road pricing and was involved in the Supplementary Licensing study which was the forerunner of the London Congestion Charging scheme; he co-authored, with Banks and Glaister, the RAC Foundation's report *Roads and Reality* on pricing and investment for the national road system. He is a trustee of the RAC Foundation, a visiting professor at Imperial College, and Chairman of the Rees Jeffreys Road Fund.

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Foreword

I am old enough to know that there is very little new under the sun when it comes to the subject of pay-as-you-go (PAYG) driving or, if you will, road pricing. The intellectual debate goes back as far as I can remember. In theoretical terms the case for a system of charging which reflects a motorist's use of the road is hard to argue with. Long before we became used to today's sophisticated variable pricing mechanisms for energy, telecoms and forms of transport such as rail and air travel, there were those who said PAYG was the best and fairest form of driving taxation.

And yet despite this intellectual endorsement, little has happened except the implementation of the London Congestion Charging scheme. Public distrust, a fear of paying even more to use our roads, and a widespread belief that it wouldn't work anyway have led successive governments to do nothing. Instead they have remained loyal to fuel duty and vehicle excise duty (VED – the tax disc), blunt instruments which effectively hide what the taxation is actually for, and fail to create any substantive link between what is paid into the Exchequer and what is spent on roads and road maintenance.

So why raise it all again? Because never before have there been such compelling reasons for a change.

Things are different now. In fact there are several looming imperatives which mean that the concept of PAYG driving should be considered very seriously. They come as no surprise to anyone: congestion, lack of investment in road capacity and maintenance, falling fuel duty revenue, and the need to tackle carbon emissions.

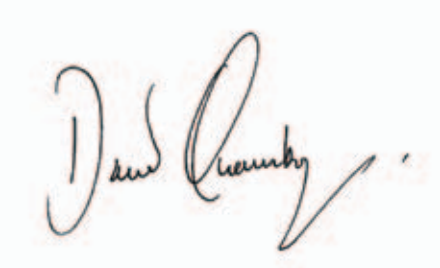
As the main paper by Glaister and Lytton illustrates, PAYG offers a real chance to help manage demand for increasingly scarce road space, cut carbon emissions and maintain a steady revenue flow for the Exchequer, even as income from fossil fuel duty falls away because of the take-up of ultra-low carbon methods of propulsion.

Most importantly, as Glaister and Lytton outline in what follows, drivers would finally be subject to a transparent and reasonable charging system which recognises, and where appropriate rewards, individual driving habits. The Appendix by Bayliss presents some of the theoretical analysis on which the main paper draws.

What this paper also does is put flesh on the theoretical skeletons. It contains real numbers and not just fanciful equations. Crucially, it shows that there are

many ways in which a PAYG system can be tailored depending on what the network coverage is to be – motorways, all strategic roads, every road – and what the desired outcome is in terms of tax revenue, be it a net increase or decrease. There are real choices to be made: PAYG does not automatically mean higher payments for the majority of motorists.

If ever there was a time to think of PAYG driving, it is now. The complex set of challenges that lie not far ahead are unlikely to be solved by tinkering at the edges. There are many who are instinctively opposed to PAYG – though, as the reports explain, not necessarily so after careful explanation – but it is incumbent on the opponents to say what they would do as an alternative.



David Quarmby
Chairman, RAC Foundation

Executive Summary

Introduction

A healthy transport system is vital for any country's prosperity. As in most European nations, the vast majority of transport activity in Britain takes place on the roads: nine out of ten passenger miles are travelled on asphalt, as is the majority of freight movement. Ensuring that road transport operates effectively through sound policy should therefore be regarded as one of government's highest priorities.

The Difficulty

The UK is facing a problem. Transport demand, not only for roads but also for rail and aviation, has been rising for decades and is expected to continue to do so over the coming years as the economy recovers and the population increases. Yet government policy does not seem to reflect this: the provision of new road capacity has declined in recent years, a trend which is already causing gridlock in many parts of the country and risks slowing economic growth.

Part of the trouble is the Exchequer's inability – or unwillingness – to find an adequate sum of money to spend on the road network, even though tax receipts from motoring actually exceed investment in roads by a ratio of four to one. This is a situation which is set to worsen as improved vehicle fuel efficiency, and a shift to alternative fuels driven by European legislation, erode the tax take from road transport, a situation which will be offset only partially by the expected rise in vehicle numbers.

In the short term, more efficient or fuller use of the existing facilities – for example through the Managed Motorways programme, which includes hard-shoulder running and variable speed limits – can in part alleviate congestion. In principle, the capacity of the road network is more than enough to cater for the traffic that wishes to use it over any 24-hour period. Unfortunately, demand is not uniform. Instead it is heavily peaked, with huge spikes in traffic at particular times of the day, notably the morning and evening rush hours. Congestion and unreliable journey times are the inevitable result.

An Answer

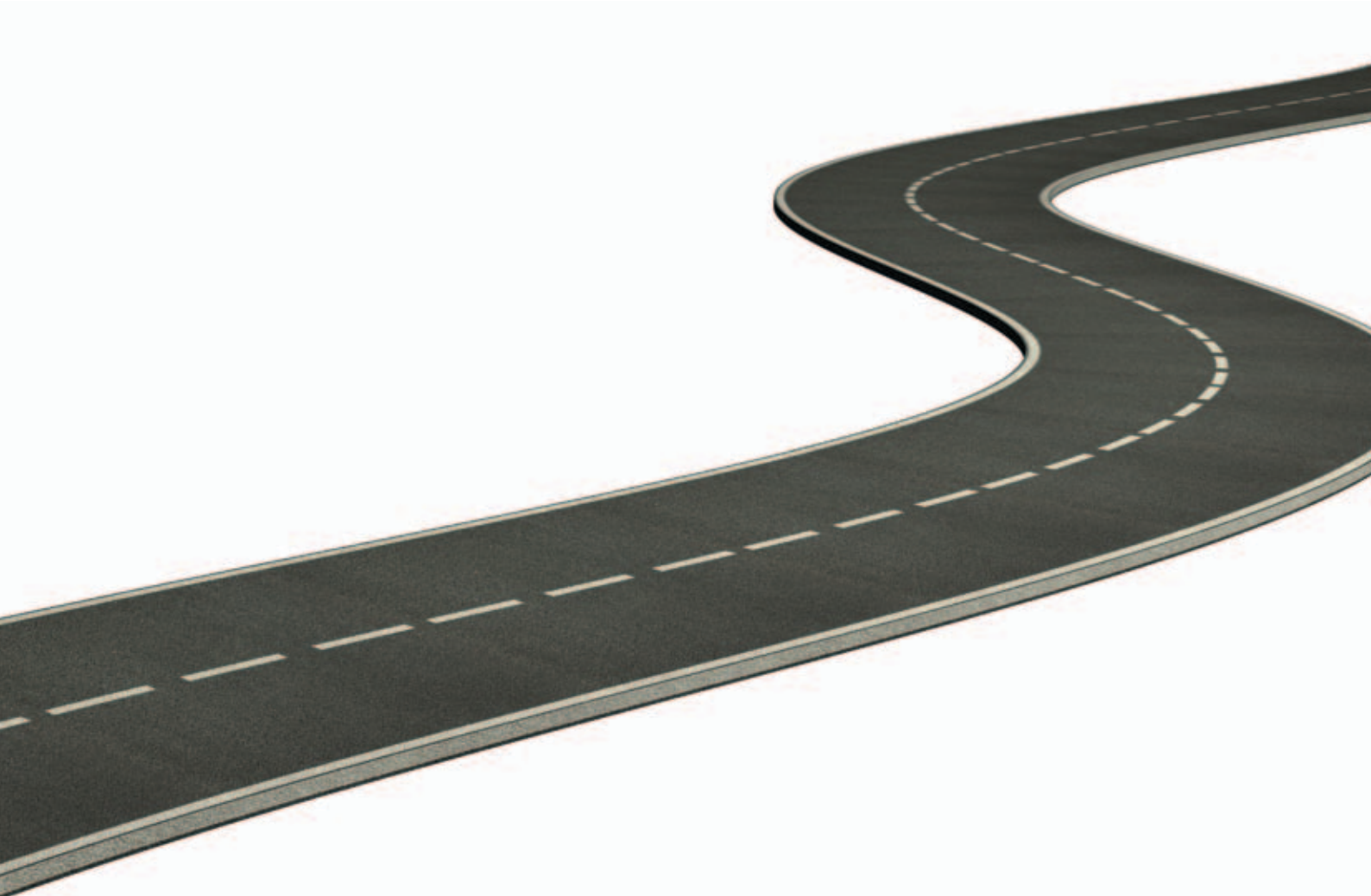
Pay-as-you-go (PAYG) driving has long been recognised as a potentially effective way of squaring the circle between the need to increase capacity and the finite nature of the resources necessary for doing so. Indeed, as the 2006 Eddington Transport Study put it, a well-designed large-scale PAYG system is 'unrivalled by any other intervention' (DfT, 2006: 39). PAYG charging, coupled with reform of governance, offers the opportunity to adjust the balance between taxes, duties and the revenues from PAYG charges. This balance can

be adjusted so as to yield a net increase in revenues or a net reduction, or to leave them unchanged. It is crucial that any additional revenue is guaranteed to be used in improving road management and enhancing the network.

The RAC Foundation has created a 'ready reckoner' to estimate where this balance could lie. This paper reports an illustrative selection of results. Although there are a number of simplifications, the model allows for an estimation of the effects of *replacing* a proportion of fuel duty and vehicle excise duty (VED) with PAYG charges on various types of road. The different scenarios discussed in this report – ranging from an introduction of motorway-only charges with relatively minor tax concessions, through to charges on most roads, with major reductions in fuel duty and VED – illustrate the many ways in which government could relieve congestion while also generating revenue to spend on road maintenance and management.

Today, drivers of cars and vans pay on average 9.2p per mile in fuel duty and VED (considering the cost of the tax disc as spread across the miles travelled); heavy goods vehicles (HGV) pay 32.7p per mile.

The first option mentioned above might see an introduction of a 10p per mile charge for cars and vans, and a 30p charge for HGVs, but on motorways only. This would allow for an across-the-board cut in fuel duty of 20% but no reduction in VED. Such a scenario would generate an additional £1.1



billion each year in government revenue, for example for reinvestment in road maintenance and management, while decreasing traffic and hence carbon dioxide (CO_2) emissions by around 0.6%.

Alternatively, a similar additional annual revenue could be secured by a 5p per mile charge for cars and vans, and a 15p charge for HGVs on motorways and trunk roads alone, whilst allowing a 17% reduction in fuel duty.

A more broadly-based PAYG system could result in a charge of 9.5p per mile for cars and vans, and 28.5p for HGVs, on all except minor roads, with a commensurate fuel duty cut of some 50% and the abolition of VED. This would provide a net increase in government revenue of around £120 million a year, and a decrease in both traffic and CO_2 emissions of around 4% each.

One way to rebalance the tax and charge regime in favour of road users, at a net cost to the Exchequer of about £3 billion a year, would be to halve VED and reduce fuel duty by 25%, whilst imposing a PAYG charge of 2.7p per mile for cars and vans and 8.1p for HGVs, for all traffic except rural principal and rural minor roads. This would leave all road users facing lower overall charges – for most only slightly lower, but for those of cars and LGVs on rural roads a drop of 31%. Carbon emissions would be broadly unaffected.

The paper discusses the issue of diversion from charged roads onto less suitable, local roads. Whilst this is certainly a problem, it is suggested that this could be mitigated by careful physical design and by judicious choice of the sections of road to which the PAYG charges would apply.

Options for a transition are discussed. One option would be to prove the principles by selecting one particularly congested motorway, or part of a motorway, in need of improvement. A simple automatic number plate recognition system could be used to levy PAYG charges, as in London and other parts of the world. This could be let to the private sector as a time-limited, regulated concession (like High Speed 1, HS1, the high-speed rail link between London and the Channel Tunnel), or held in a public trust, or managed by a distinct division of the Highways Agency.

A possibility worthy of investigation would be to create a package consisting of the right to extend the M6 Toll Road from north of Birmingham to Manchester, together with the (time-limited and regulated) concession to operate and charge for the existing M6 on that alignment.

A less cautious start would be to define one or more portfolios of motorways (possibly including some other major trunk roads) and create a body or bodies to manage, improve and charge for them, under a regulated, time-limited concession. This would be close to the current model for the *autoroutes* in France.

Conclusion

Although PAYG remains a sensitive issue, research by the Department for Transport and others suggests that it is technically feasible and can be made acceptable to the public, something evidenced by the fact that PAYG systems are now in operation all across the world. While it is true that people are initially sceptical, mainly because the purpose and design of such schemes are often not communicated clearly, the evidence shows that once charges are enacted, public opinion changes to favouring them, when improvements that could not otherwise be enjoyed are experienced. This is especially true when drivers understand that the new system is a *replacement* for the existing motoring tax regime, not an *addition* to it.

The figures presented in this report are only estimates, and should not be regarded as definitive; rather, they illustrate the effects of introducing a charge in different ways. A more detailed account of what the level of charges might be on the different types of road can be found in the appended paper by David Bayliss. Ultimately, of course, all these decisions will be made by the politicians.

1. Introduction

This paper offers solutions to a major shortcoming in public policy in England that has been unresolved for decades. It is this: we have underinvested in maintaining and enhancing the Strategic Road Network. Traffic growth tends to match economic growth, and if this growth is constrained it risks impeding the economic recovery. More traffic will also follow from a growth in population. Yet there is inadequate Exchequer money available for increasing the capacity of the roads, and changing vehicle technologies will eventually lead to a dilution of the revenues from fuel duty.

Meanwhile, copious experience in London and overseas demonstrates that pay-as-you-go (PAYG) charging for roads is technically feasible, is accepted by the public, can work as a tool to manage congestion, and can generate new income flows. The way we treat our roads is inconsistent with our management of other network utilities, which have mechanisms in place to enable funding of the massive investment that they require. We should consider the lessons for our roads that we can learn from these other utilities.

These arguments are not new. We have discussed the principles elsewhere. But it is difficult to have a meaningful discussion in the abstract; we need some numbers. How much will people have to pay on what types of road, and how much revenue might charges raise? This paper offers some estimates.

Recognising the reality that the Exchequer is unable (or unwilling) to find adequate public funds to operate and improve the Strategic Road Network, this paper discusses alternative funding solutions. We concentrate on improving the level of service delivered by our major, strategic roads, rather than on addressing urban traffic congestion.

This paper is not primarily about privatising the Strategic Road Network. It is about estimating the orders of magnitude of the extent to which fuel duty and vehicle excise duty (VED) could be reduced by means of the introduction of PAYG charges. Optionally, these charges could be set so as to raise some additional net funds to pay for better management and enhancement of the strategic roads. Privatisation is not necessary to achieve this, although it is another option.

Part of the attractiveness of PAYG charging is that it can be tailored to achieve a variety of outcomes. This paper envisages some extra money being raised overall to fund the huge gap between the demands placed on the road network and the level of actual investment in it; the system could, however, equally easily be designed so as to make it revenue-neutral (or indeed to raise less cash than at present), with the primary focus then being on achieving a different outcome, such as alleviating congestion and all the adverse societal impacts – not least carbon emissions – associated with it.

2. The Problem

The Department for Transport (DfT) stated in its Spending Review Press Notice:

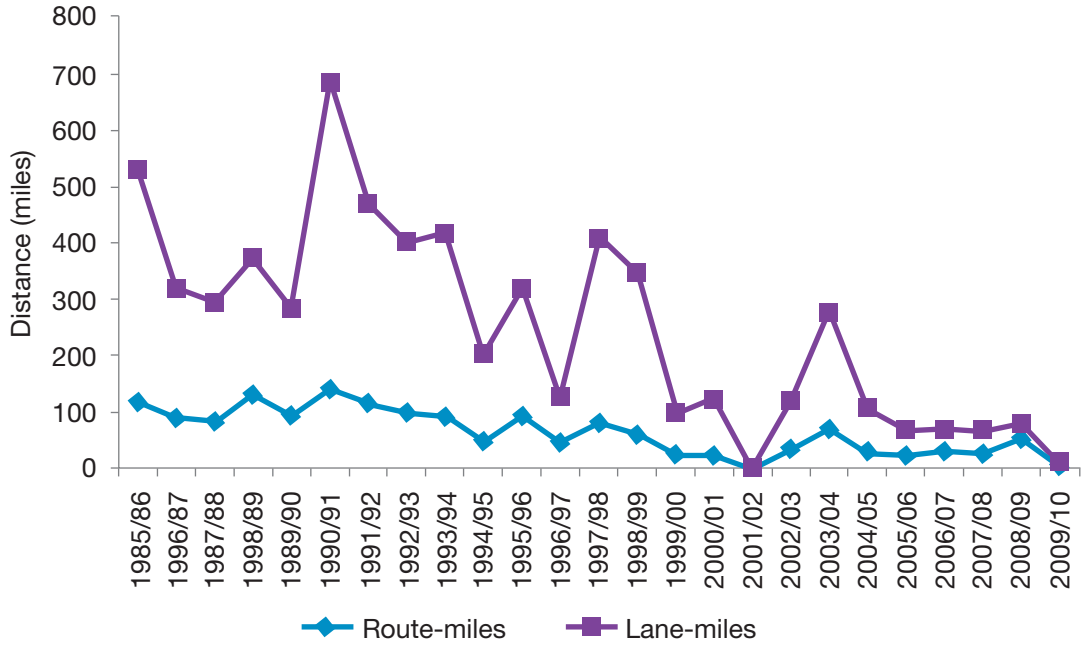
> 'In the Budget, the Chancellor pledged to make the tough choices that will allow us to maintain investment in new and existing infrastructure that will support a growing economy, while eliminating the structural deficit over the lifetime of the Parliament… taking hard decisions about priorities that have allowed us to secure the investment in vital transport infrastructure that will support the national economic recovery…' (DfT, 2010c).

The Spending Review did indeed protect public spending on investment in railways. But railways only carry 9% of freight tonne-miles and 8% of passenger miles – of which the greater part is in the London area (DfT, 2010d). The roads carry the remainder, and good-quality roads are essential to a recovering economy. It is therefore hard to square the government's stated objectives with the Spending Review's 34% cut in the Highways Agency's capital budget (averaged over the four years and not inflation-adjusted), a 9% cut in its resource budget (DfT, 2010c), and the severe cuts in road funding that will result from the demise of the Regional Development Agencies and the cuts in local government expenditure.

Failure to develop the road network is a continuation of a trend which started in the last years of the Conservative Government of 1992–7 and was continued to varying degrees under the Labour administrations of 1997–2010. Throughout this period, provision of new road capacity – either by the building of new roads or the improvement and better operation of existing ones – fell far behind the growing demands upon them. This is illustrated by Figure 1, showing the decline in completions of motorways and trunk roads since 1985, a period during which traffic grew by over 60% (DfT, 2010d).

Since 2007, traffic has fallen to a level slightly below the 2006 levels. The recorded levels of reliability have improved accordingly (DfT, 2011b). This is to be expected as a consequence of what has happened to the general economy over this period, and it is likely to be reversed as the economy's health recovers.

Figure 1: New road construction and improvement: motorways and all-purpose trunk roads: England, 1985/6–2009/10 (miles)



Source: DfT (2010c), supplemented by a Freedom of Information request by David Bayliss

The Commission for Integrated Transport (2001), Bayliss (2008b), McKinsey (2011) and the British Chambers of Commerce (2011) document the extent to which England has fallen behind the rest of Europe in the provision of strategic road capacity. That alone is not a persuasive argument, but in his seminal Transport Study for HM Treasury and the DfT, Sir Rod Eddington (DfT, 2006) noted that shortage of transport capacity in general, and road capacity in particular, risked damaging the nation's competitiveness and ability to grow. He documented the extraordinarily high economic returns to expanding road capacity which are a consequence of the shortage. These were further confirmed by the then Secretary of State Philip Hammond when he announced the 14 Highways Agency schemes that were approved in the Spending Review 2010 (DfT, 2010a: 14): 'For every pound invested, there will be over six pounds worth of public benefits. On some schemes this figure will be higher than ten.'

The Office of Population, Census and Surveys expects the English population to increase overall, and in some regions by as much as 10% per decade (see Glaister, 2010, for detail), due largely to increasing fertility and longevity, and migration from less economically successful parts of the country.

While individuals might be travelling less, the growth in population and economic recovery will mean greater overall traffic. Although there is room for debate about how much growth we can expect, an additional 10 million people over the next 25 years would undoubtedly result in higher levels of demand for road use. The most recent DfT National Traffic Forecast (2009) predicts

an increase in interurban traffic of 41% on 2003 levels by 2035, with a 54% worsening of average delay.

In the short term it is plain that the only way forward is to get better use from the existing facilities. The Managed Motorway programme, in which hard shoulders are made available at peak times and variable speed limits are enforced (as on the M42), has demonstrated that throughput can be increased, safety improved and carbon emissions reduced (Highways Agency, 2009). But Managed Motorway schemes only represent a partial solution for various reasons: many strategic roads do not have hard shoulders; the current programme relates to less than 2% of the English trunk road network; the scheme can do little to increase the capacities of motorway junctions and of the roads used to access motorways, which are where many difficulties occur.

The Managed Motorways programme is important in that it eases conditions whilst a physical expansion programme gets underway. However, it would be an adequate long-term solution only if capacity and demand were close to an efficient balance, in which case it would 'polish' the system to improve the match.

Although they are not sufficient, Managed Motorways have been demonstrated to be good value for money. Like all proactive management, they do cost money, and the programme of new installations announced by the Labour Government has been reduced under the Coalition Government's Spending Review 2010.

Many other things can be done with more funding: the presence of Traffic Officers and improved procedures by the police to speed up the clearing up of incidents can make a valuable contribution at a cost – see Yass (2010) and the experience on the A12 following the Rowlands Inquiry (2008). The DfT's May 2011 preliminary *Review of Investigation and Closure Procedures for Motorway Incidents* (DfT, 2011a) is a welcome recognition of this.

The 24-hour capacity of the road network is more than enough to cater for the traffic that wishes to use it over the 24 hours. The problem is that the demand is heavily peaked – we all try to travel at once – and congestion and unreliability result. This is because the costs faced by the individual when choosing to use a road do not reflect costs imposed on other users through increased congestion. Many authors have argued that this is a characteristic of public service utility networks that can be successfully overcome by giving sufficient incentive for a few users to switch their demand to quieter periods by variation of price by time of day. In the case of roads, Eddington (DfT, 2006, paragraph 1.108) said that '…the potential for benefits from a well-designed, large-scale road pricing scheme is unrivalled by any other intervention.' He noted that by managing the peakiness of the demand, such a scheme would greatly reduce the need to provide new road capacity.

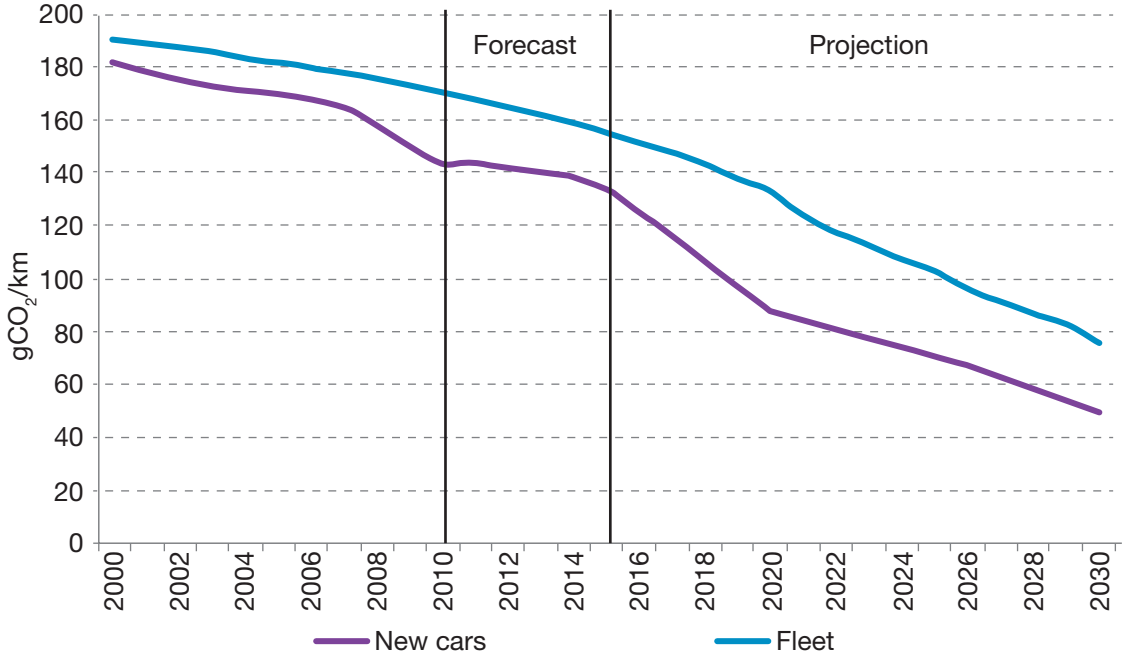
It is right that fuel should carry a tax to reflect the social cost of the carbon contained in it, valued at a common rate used across government departments: if carbon is the problem, then carbon should be taxed directly. This will reflect differing rates of carbon emissions due to different vehicle efficiencies, driving styles and so on. But current fuel duty is much higher than the appropriate carbon tax, the extra effectively being a tax to fund general government expenditures with no attempt to relate it to costs of provision, congestion or environmental considerations. We propose replacement of some – or the entire non-carbon tax portion – of fuel duty, and VED, by a PAYG system of charges on these roads.

Glaister (2010) discussed the reforms to the administration and governance of strategic roads that would be necessary to render this reform acceptable to the public. PAYG charging, coupled with reform of governance, offers the opportunity to adjust the balance between taxes, duties and the revenues from the charges so as to yield a net increase in revenues and – crucially – to *guarantee* that the extra funds are applied to improved management and enhancement of the network. This offers a route to a solution for the problem outlined above: the need to fund new capacity despite the Exchequer's inability to provide additional taxpayer funds.

The proposal to consider PAYG charging for strategic roads bears on two other policy areas. First, the fuel efficiency of modern cars and vans has been improving rapidly and will continue to do so. It is European (and hence UK) policy that it should (see Figure 2). The EU's regulation on carbon dioxide (CO_2) emissions from cars requires that the current figure of 144.2 gCO_2/km for the average new UK car (SMMT, 2011) be reduced to 95g by 2020; the Committee on Climate Change recommends a target of 50g by 2030. These targets imply a corresponding improvement in fuel efficiency. A similar regulation was recently adopted for vans, setting a target of 147 gCO_2/km for new vehicles by 2020.

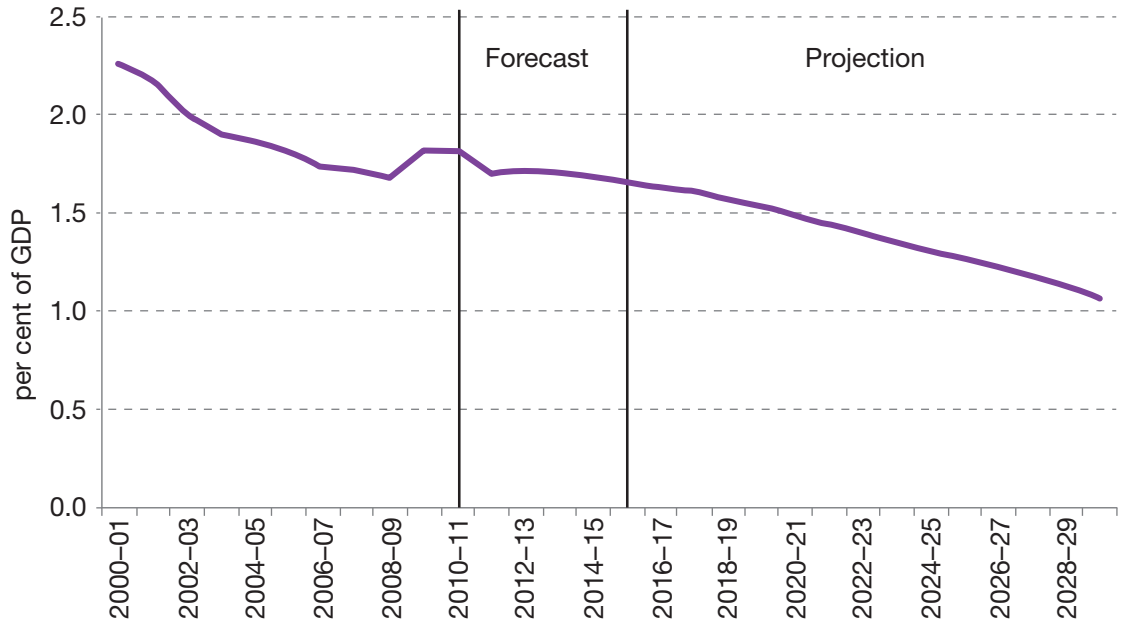
The implication is that the expected increase in traffic – and hence potential increase in tax intake from fuel duties – will be more than offset by improvements in fuel efficiency of the entire UK vehicle parc (the number of UK-registered vehicles on the roads), as recognised by the Office for Budget Responsibility (OBR) in its *Fiscal sustainability report* of July 2011 – see Figure 3. In order to preserve the revenue base under the existing tax regime, one of the few options for government would be to increase the rate of fuel duty to compensate for the forgone revenue.

Figure 2: CO_2 emissions from all cars and new cars, 2000–30



Source: OBR (2011)

Figure 3: Fuel duty receipts, 2000/01 – 2028/28



Source: OBR (2011)

It is widely accepted that the fuel efficiency targets for 2020 will be met through the continuous improvement of the internal combustion engine, but increasingly also through the take-up of currently available and proven hybrid technologies. Government is, however, keen to encourage the mass-market

adoption of electric vehicles and, surprisingly, through the Spending Review 2010 it maintained the £5,000 grant offered to buyers of ultra-low carbon vehicles emitting less than 75 gCO_2/km, as well as the funding for public charging infrastructure available to regions and local authorities. To meet the UK's legally binding greenhouse gas reduction targets – 34% by 2020 and 80% by 2050, both relative to 1990 levels – the Committee on Climate Change, the government's advisory body set up under the Climate Change Act 2008, recommends that 1.7 million plug-in electric vehicles should be on the road by 2020.

Whether the government's ambitions for electric vehicles are achievable in this timescale is questionable, but it is clear that in the longer term this arm of public policy carries the implication that, if successful, the existing base for fuel duty will eventually be significantly diluted. If, as seems likely, HM Treasury wishes to preserve this source of revenues to fund general government expenditure, then something will have to change.

Finally, HM Treasury's Infrastructure UK (IUK) has published an important *Infrastructure Plan* (IUK, 2010) which points out the need to create a long-term strategy for maintenance and enhancement of important infrastructure networks, including: power; gas; water; telecommunications; railways; airports; seaports and strategic roads. IUK points out that in many of these industries

the need for renewal, technical change, the effects of climate change, and the changing demands of population and industry imply substantial new investment, which will need to be funded. In all cases except roads there is a mechanism for making a comprehensive and independently verified assessment of the physical needs and of how much it might cost to meet these needs, and – crucially – a mechanism to fund these costs out of charges to end users. This is the Regulated Asset Base (RAB), with economic and efficient prices to service it being set by an independent economic regulator.

In 1979 all these utilities were state-owned and funded in a way similar to roads. The programme of utility privatisation has effectively meant that the charges to users have been ring-fenced – or isolated from taxes and government expenditures – for the express purpose of paying operating costs and funding investment.

But roads, remaining under direct public ownership, administration and funding, have no properly valued asset base, and no explicit charges to end users. Whilst private capital can, and does, invest in roads, it is only through the halfway-house of the PFI (Private Finance Initiative) and shadow tolls (per-vehicle tolls paid by government rather than by users), with the exception of the M6 Toll Road and some tolled bridges. There is no connection between the charges paid by users, in the form of fuel duties and VED, and the provision of service. Funding for investment is determined in a purely administrative fashion by government departments. If government wishes to put roads on a similar footing to the other network utilities, so that the end users who benefit from investment can be charged for it, then the creation of some form of valued asset base, together with independently regulated PAYG charges, is the way to achieve this.

A reform of this kind for the Strategic Road Network could go so far as a sale of the asset base to private owners – 'privatisation'. If it were to be sold, the cash proceeds could be tens of billions of pounds sterling. But it is not necessary to privatise the enterprise in order to achieve the required isolation of a legally competent body with the (vital) capacity to borrow and be accountable for its debt: there are other forms of public benefit ownership available as alternatives (see Glaister, 2010, for a discussion). Smith et al. (2011) document the concessions and sales of roads that have been successfully concluded around the world.

An interesting form of agreement between the state and the private sector is the long-term concession – exemplified by the way in which HS1 (the 'High Speed 1' concession for operating the Channel Tunnel Rail Link) has recently been sold as a thirty-year concession to a two Canadian pension funds for £2 billion.

The public trust (or 'public benefit corporation' in US parlance) has a long tradition (see Bayliss, 2008a, from which the next paragraphs are taken, for

more detail). In the 18th and 19th centuries, the Turnpike Trusts were largely instrumental in creating and maintaining the main roads in Great Britain, using revenues from tolls. By 1830 the Trusts, created by Acts of Parliament, provided about 20,000 miles of road for which users (not always willingly) paid a toll. They were used by hauliers of goods, passenger coaches and postal services. The turnpikes allowed the time taken for a journey between London and Edinburgh to be reduced from 12 days to 4 between 1750 and 1800.

At the height of the turnpike era in the 1860s there were about 125,000 miles of roads, of which almost 21,000 miles were turnpikes when Great Britain had a population of 22 million. On a population basis this amounted to 925 miles per million population, which compares with 540 miles per million population of the current primary road network.

The first effects of competition from canals, and then railways, were curtailment of investment in the turnpikes, and then the gradual neglect of maintenance: consequently many roads were progressively 'disturnpiked' and returned to the local parish for their care.

2.1 The technical feasibility and public acceptability of pay-as-you-go charging

In 2004 the Department for Transport (DfT, 2004) carried out a large study of charging people as they use roads and concluded that it was technically feasible. Walker's (2011) paper surveys a number of schemes from around the world that are now in successful operation. They include: the tolled motorways in France, Spain, Portugal and Italy; the urban road charging schemes in London, Singapore and Stockholm; the several schemes in Norway; the lorry-charging schemes in Germany, Austria and the Czech Republic; and the privately provided highways in Australia.

In some cases the primary objective of the scheme is to raise revenue, and in others it is to control congestion. Typically they succeed in doing both. The technologies work. It is apparent that, so long as the objective of the policy is clear and the requirements are not unduly complex or unnecessarily demanding, the costs of operation can be reasonable. It is likely that for many of our strategic roads an adequate system could be constructed using automatic number plate recognition (ANPR), thus obviating any need for toll booths or equipment to be installed in vehicles. This technology has worked well enough in London, and now that ten years have passed since the London scheme was designed, the costs would be much less.

Walker recounts the fairly common experience that when schemes are first proposed, the population has difficulty understanding the policy or what the benefit might be to them (or others). But once it is enacted, public opinion changes to favouring the scheme because people have experienced the improvements that they could not otherwise have enjoyed. This is why it is so

important to have some orders of magnitude to help with the debate at proposal stage: it can help to make the ideas a little less abstract. It was crucial to Mayor Livingstone's success in introducing the London Congestion Charge that, even before the start of the election campaign there had been a careful study of the scheme that he proposed to adopt (Government Office for London, 2000); in consequence there was an informed debate, he could be clear about what he was proposing to introduce, and he was subsequently able to defeat two attempts at Judicial Review which were aimed at stopping the scheme.

It is apparent from Walker (2011) that PAYG schemes for roads are common and successful across the globe. At one stage it was Labour government policy that they should be introduced as soon as practicable. An Ipsos MORI survey for the RAC Foundation (RAC Foundation, 2010) shows that an instinctive nervousness amongst the British public about PAYG motoring is significantly eased when people understand that the system should be considered a *replacement* for the existing motoring tax regime, not an *addition* to it.

The unwillingness of the Coalition Government to even consider such a scheme means that there is a risk of the UK falling behind much of the developed world in this matter.

3. How Might Charges Look, and Who Would Gain and Lose?

In the companion paper appended to this document, Bayliss sets out the implications of a set of PAYG charges constructed on one particular set of principles: that every vehicle should pay the full costs imposed on other vehicles, and other interested parties, of each kilometre travelled – known as marginal social cost pricing. Of course, these costs vary a great deal, depending on a number of factors such as time of day, type of vehicle, and, notably, whether or not the road in question is heavily congested (so that an extra vehicle slows down other vehicles).

The charges, he estimates, in addition to VED, shown in his Table 6[1], vary from 16p per vehicle mile (p/vm) (10p per vehicle km (p/vkm)) on congested single carriageway main roads to

1 Bayliss's figures in the Appendix, expressed in pence per vehicle kilometre, have been converted into pence per vehicle mile for the purpose of this paper.

4 p/vm (2.5 p/vkm) on rural dual carriageways, compared to an average tax rate in 2008/9 equating to about 10.2 p/vm (6.3 p/vkm). Average charges in lightly populated Wales of 5.8 p/vm (3.6 p/vkm) would contrast with 30.6 p/vm (19.0 p/vkm) in congested London.

Bayliss analyses the gainers and losers under this scheme by household income and by type of residential area. In interpreting his results, it is important to bear in mind that (neglecting the costs of scheme administration) the overall economic benefits considerably exceed the disbenefits: that is, there is a net increase in overall economic welfare. But some of the benefits are captured in the form of additional revenues: total money costs to users increase by about 16%. This additional revenue is available to compensate those who lose out, by improving the road network, improving public transport, or some other means.

Having said this, full compensation of losers would not in practice be achieved; as with almost any change in public policy, there would be some that lose out in the end.

As he notes, his scheme is derived from one particular set of principles: it is the one that would generate the greatest economic benefit without regard to the distributional effects across users. In particular, Bayliss's estimates include 'full-blown' charges for congestion in urban areas (subject to a maximum cap), and it is in these areas that the most severe losses would occur unless compensation was actually achieved.

The particular policy which Bayliss has analysed may well be deemed politically unacceptable, so we present in the next section the results from approximate estimates of net revenues from some alternative sets of PAYG charges, along with offsetting reductions in fuel duties and VED. By their nature, these would not yield as much overall economic benefit, but they have other attractive features.

4. Pay-As-You-Go Charges for Parts of the Network

We have set up a 'ready reckoner' to allow us to estimate the revenues that would be generated from PAYG charges at various rates on different types of road. This allows us to estimate the orders of magnitude of the consequences for traffic volumes and net revenues of changing the following variables: the rate of PAYG charge (which does not vary by road type); the types of road to which it applies; the level of VED; and the rate of fuel duty.

Note that in some of the scenarios we report below these charges do not apply in urban areas; therefore, unlike the Bayliss estimates, they are not tightly targeted towards the most congested parts of the system. PAYG charges are more complex to implement in urban areas than on motorways and principal roads, and arguably more controversial. That is a good reason to consider urban charging separately. Therefore, this paper is less about alleviating urban road congestion than about improving the level of service delivered by our strategic roads.

We do not claim that this analysis is precise – there are a number of simplifications, the objective being to calculate rough orders of magnitude in a transparent way.

We do not attempt to estimate the economic welfare benefits generated by these proposals – that would require a much more sophisticated model such as that used in Banks et al. (2007). For this purpose we neglect the transfer from road to other modes; whilst these are important in some contexts (particularly for transport policy in big urban areas), they are unlikely to be material to the present calculations. Neither do we attempt to model the changes in congestion and average traffic speeds. If these were taken into account, they would change these results somewhat (see Banks et al., 2007, for detailed estimates of these effects). We make no allowance either for the differences in fuel consumption rates which occur in reality between different types of road (in practice there is an important difference between rural roads and urban roads).

The method crudely averages fuel duty and VED per vehicle mile. Under the current set of charges, a car or light goods vehicle (LGV – a van) is assumed to cost 7.3 p/vm for fuel duty and 1.9 p/vm for VED, making a total of 9.2 p/vm. For a heavy goods vehicle (HGV) the figures are 31.0 + 1.6 = 32.7 p/vm. We use DfT traffic flow data which relate to 2010.

Table 1: PAYG on motorways and rural trunk roads, halving VED, 10% off fuel duty

Key

BASE
WORSE
BETTER

Inputs for this scenario	Cars & LGVs	HGVs
Toll per mile	5.0p	15.0p
Reduction in VED	50%	50%
Reduction in fuel duty	10%	10%

Summary of outputs	This scenario	Difference from base	% change from base
Average cost per veh-mile, cars & LGVs	8.9p	-0.3p	-3.0%
Average cost per veh-mile, HGVs	38.0p	5.3p	16.3%
Total traffic volume (distance travelled, billion miles)	298.0	-4.1	-1.3%
Total government revenue (£ billion)	£31.17	-£0.42	-1.3%

'Worse': worse off, whether applied to drivers or government, and also indicating more traffic and therefore CO_2 emissions.

Road type		Toll?	Toll per mile		Total cost per vehicle-mile (toll + VED + fuel duty)				Distance travelled (billion miles)						Government revenue (£ billion)					
					This scenario		Diff / % change		This scenario			Difference			This scenario			Difference		
									Base case			and % change			Base case			and % change		
			Car & LGV	HGV	Car & LGV	HGV	Car & LGV	HGV	Car & LGV	HGV	All vehs	Car & LGV	HGV	All vehs	Car & LGV	HGV	All vehs	Car & LGV	HGV	All vehs
Motorways		Yes	5.0p	15.0p	12.6p	43.8p	3.4p	11.1p	49.5	6.7	56.3	-3.8	-0.4	-4.2	£6.22	£2.95	£9.17	£1.32	£0.62	£1.94
							36.9%	34.1%	53.4	7.1	60.5	-7.2%	-5.6%	-7.0%	£4.90	£2.33	£7.23	27.0%	26.6%	26.9%
Rural A	Trunk	Yes	5.0p	15.0p	12.6p	43.8p	3.4p	11.1p	29.5	3.1	32.6	-2.3	-0.2	-2.5	£3.71	£1.34	£5.05	£0.79	£0.28	£1.07
							36.9%	34.1%	31.8	3.2	35.0	-7.2%	-5.6%	-7.0%	£2.92	£1.06	£3.98	27.0%	26.6%	26.9%
	Principal	No	0.0p	0.0p	7.5p	28.7p	-1.7p	-3.9p	48.6	2.6	51.2	0.6	0.0	0.6	£3.64	£0.75	£4.38	-£0.77	-£0.09	-£0.86
							-18.5%	-12.1%	48.0	2.6	50.6	1.3%	1.5%	1.3%	£4.41	£0.84	£5.24	-17.5%	-10.7%	-16.4%
Urban A	Trunk	No	0.0p	0.0p	7.5p	28.7p	-1.7p	-3.9p	3.1	0.2	3.3	0.0	0.0	0.0	£0.23	£0.06	£0.29	-£0.05	-£0.01	-£0.06
							-18.5%	-12.1%	3.1	0.2	3.3	1.3%	1.5%	1.3%	£0.28	£0.07	£0.35	-17.5%	-10.7%	-16.2%
	Principal	No	0.0p	0.0p	7.5p	28.7p	-1.7p	-3.9p	44.1	1.4	45.5	0.6	0.0	0.6	£3.30	£0.41	£3.70	-£0.70	-£0.05	-£0.75
							-18.5%	-12.1%	43.5	1.4	44.9	1.3%	1.5%	1.3%	£4.00	£0.45	£4.45	-17.5%	-10.7%	-16.8%
Minor	Rural	No	0.0p	0.0p	7.5p	28.7p	-1.7p	-3.9p	42.2	1.0	43.2	0.5	0.0	0.5	£3.15	£0.30	£3.45	-£0.67	-£0.04	-£0.70
							-18.5%	-12.1%	41.6	1.0	42.6	1.3%	1.5%	1.3%	£3.82	£0.33	£4.16	-17.5%	-10.7%	-17.0%
	Urban	No	0.0p	0.0p	7.5p	28.7p	-1.7p	-3.9p	65.0	0.9	65.9	0.8	0.0	0.8	£4.86	£0.25	£5.11	-£1.03	-£0.03	-£1.06
							-18.5%	-12.1%	64.2	0.9	65.1	1.3%	1.5%	1.3%	£5.89	£0.28	£6.18	-17.5%	-10.7%	-17.2%
Total / weighted average / difference					8.9p	38.0p	-0.3p	5.3p	282.0	15.9	298.0	-3.6	-0.5	-3.8	£25.11	£6.06	£31.17	-£1.11	£0.69	-£0.42
Base case totals / % change on base case					9.2p	32.7p	-3.0%	16.3%	285.6	16.4	302.0	-1.2%	-3.0%	-7.2%	£26.22	£5.37	£31.59	-4.2%	12.8%	-1.3%

Source: Authors' own

Table 1 illustrates **Scenario 1**, a change that is approximately revenue-neutral. The table shows the various categories of road, and the volumes of traffic for cars and vans, and for heavy goods vehicles. A 5 p/vm PAYG charge ('toll' in the table) is made for cars and LGVs on motorways and rural trunk roads. We assume that HGVs pay three times the charge for cars and LGVs: in this case 15 p/vm. Note that this charge is assumed to apply at all times of day, so there is no attempt to vary the PAYG charge to reflect congested conditions. In this scenario VED for all vehicle owners is halved. Fuel duty for all users in the country is reduced by 10%. The net effect on government revenues is a fall of £0.42 billion.

For car users of the roads with the PAYG charge, the cost per mile has risen from 9.2 p/vm to 12.6 p/vm. For all other car users, the cost has fallen to 7.5 p/vm because of the cheaper fuel. All traffic volumes have changed: they have reduced on the PAYG-charged roads and increased on the others. These changes are computed by assuming that a 10% increase in the money cost per mile (fuel and PAYG charge, but not VED) will lead to a 3% reduction in traffic. This is the kind of response observed in the long run (after about five years) in past experience in the UK and around the world (see Graham & Glaister, 2002) and it is the kind of figure commonly used by the DfT and others in modelling the effects of fuel price changes. Overall in Scenario 1 there is a reduction of about 1.2% in national car and LGV traffic and 3.0% in HGV traffic, and therefore a small reduction in total carbon emissions of 1.3%. Car traffic on the motorways falls by 7.2%.

Table 2: Effects of PAYG charges with reductions in fuel duty and VED

Scenario	Reduction in VED (%)	Reduction in fuel duty (%)	PAYG rate for cars/HGVs (p per mile)	Type of road to which PAYG charge applies *	Change in traffic/CO_2 emissions (%)	Change in net revenue (£ billion p.a.)
1	50	10	5/15	A, B	-1.3	-0.42
2	100	50	9.5/28.5	A, B, C, D, E	-3.8	0.12
3	0	20	10/30	A	-0.6	1.14
4	0	17	5/15	A, B, D	-0.5	1.09
5	100	25	5/15	A, B, C, D, E, G	-4.1	0.78
6	50	25	5/15	A, B, D, E, G	-2.7	1.30
7	50	25	2.7/8.1	A, B, D, E, G	0.0	-3.07
8	50	25	5/5	A, B, D, E, G	-2.5	0.23
9	50	25	6/6	A, B, D, E, G	-3.5	1.83

Source: Authors' own

* A – Motorways; B – Rural A trunk; C – Rural A principal; D – Urban A trunk; E – Urban A principal; F – Minor rural; G – Minor urban

Table 2 summarises the results for some other scenarios. The first row is the one just discussed.

Scenario 2 summarises a more radical, broadly revenue-neutral option. VED is abolished. Fuel duties are reduced by 50%, leaving an element of fuel duty that is closer to (but still higher than) the cost of the carbon content of the fuel – in other words, what remains is closer to a pure carbon tax. The PAYG charges to recover the government revenues are set at 9.5 p/vm for cars and LGVs on all motorways, trunk roads and principal roads. This implies a 43.0% increase in the per-mile cost for cars on those roads with PAYG charges, but a 60.5% reduction on the others. Total car and LGV traffic falls by 3.7%.

Scenario 3 sets PAYG charges on motorways only, at a rate of 10 p/vm for cars (and therefore 30 p/vm for HGVs). Were this to be the only change (i.e. unaccompanied by any reduction in fuel duty or VED), this would yield about £5.4 billion annual additional revenue. This scenario shows such a scheme but combined with a 20% reduction in fuel duty for all users in the country, while leaving VED unchanged. The net result is an increase in revenues of £1.14 billion a year.

Scenario 4 shows how similar net revenue could be generated by charging 5 p/vm for cars and vans on all motorways and trunk roads, and reducing all fuel duty by 17%, again leaving VED unchanged. This would increase car motoring costs by about 42.5% on the trunk roads (30.0% for HGVs), but reduce them by 13.9% on all other roads. It would reduce car and LGV traffic on the motorways and trunk roads by 6.4% and increase it elsewhere by 1.8%, slightly reducing total national traffic and carbon emissions. Of course, this pricing structure is very different from that discussed in the Appendix by Bayliss: charges are reduced rather than increased in the urban areas, where congestion is the most severe.

In **Scenario 5** VED is abolished, fuel duty is reduced by one quarter, and a 5 p/vm PAYG charge (15 p/vm for HGVs) is applied to six of the seven road types – all roads except minor rural roads. This would avoid the need to implement PAYG charges on a large proportion of the nation's roads as measured by length. This yields a net revenue increase of £0.78 billion a year. Per-mile costs for cars increase by 13.7% (17.1% for HGVs) except on minor roads in rural areas, where they reduce by 40.8%. National car and LGV traffic falls by 4.2%.

In **Scenario 6** the same charges are applied as in Scenario 5, except that rural principal roads are exempted as well as minor rural roads. Then PAYG charges would apply to only 5% of the national road network by length. VED is halved rather than abolished, and fuel duty again reduced by one quarter. Total national traffic falls by 2.7%. Net revenue increases by £1.30 billion per year. This option reduces per-mile charges for cars and LGVs on rural minor and rural principal roads by 30.6%, but increases them by 24.8% elsewhere. This option might be considered as broadly consistent with stated Coalition Government policy on rural road costs.

Scenario 7 is one in which the balance between conventional road taxes and PAYG charges is adjusted in such a way as to reduce the total revenues. It is

the same as Scenario 6 except that the PAYG charges are reduced to 2.7 p/vm (8.1 p/vm for HGVs). This would be at a net cost to the Exchequer of about £3.1 billion per year. All road users are made at least slightly better off, with cars on rural principal and rural minor roads enjoying a 30.6% reduction in costs. Overall, carbon emissions are unchanged.

Scenario 8 is the same as Scenario 6, except that HGVs are charged the same as cars (rather than three times their rate) on the argument that this would encourage them to stay on the major roads. In this case all HGVs would enjoy a reduction in costs, ranging from 11.0% to 26.4%. The increase in revenue is now only £0.23 billion, making this scenario almost revenue-neutral.

In **Scenario 9** the increase in revenue is more than restored by increasing the PAYG rate for all vehicles by just 1 p/vm to 6 p/vm. The revenue increases by £1.83 billion a year.

In practice all the scenarios discussed in this section could be considerably refined by applying the PAYG charges only during the congested times – say, during the working day, as with the current London Congestion Charge. This would, of course, somewhat change the traffic levels and revenue yields.

The cost of installing and operating a PAYG system is an important issue. More work is required to derive firm estimates, but Walker (2011: 95) suggests that, with 2,500 links on the Strategic Road Network at a cost of £50,000 a link, the capital costs would be £125 million, with annual maintenance costs of £73 million. To this would have to be added the 'back office' costs.

4.1 The possibility of sale of a concession

With all other taxes and charges unchanged, a PAYG charge of 1p per mile (3p for heavy lorries) on all motorways would yield about £0.6 billion a year – say £0.5 billion after maintenance and administration costs. Assuming a private sector cost of capital of 10% (rather high for a secure, regulated utility) this could be capitalised to approximately £5 billion. As a sale price this would have to be reduced to the extent that a new owner would be required under the terms of the concession to carry out renewals and maintenance additional to that already being funded at present.

It should be noted that this price would be in addition to the sale price of the existing asset base: that would depend upon what value was initially set for the RAB on which a fair market rate of return would subsequently be available. And if this annual return were to be recovered from charges, there would have to be a corresponding, further reduction in fuel duty or VED to reflect the fact that the Treasury would have the benefit of the sale proceeds and therefore would be paying less to service the national debt: otherwise the sale would increase net charges to road users, even if no new net funds were created for improvements.

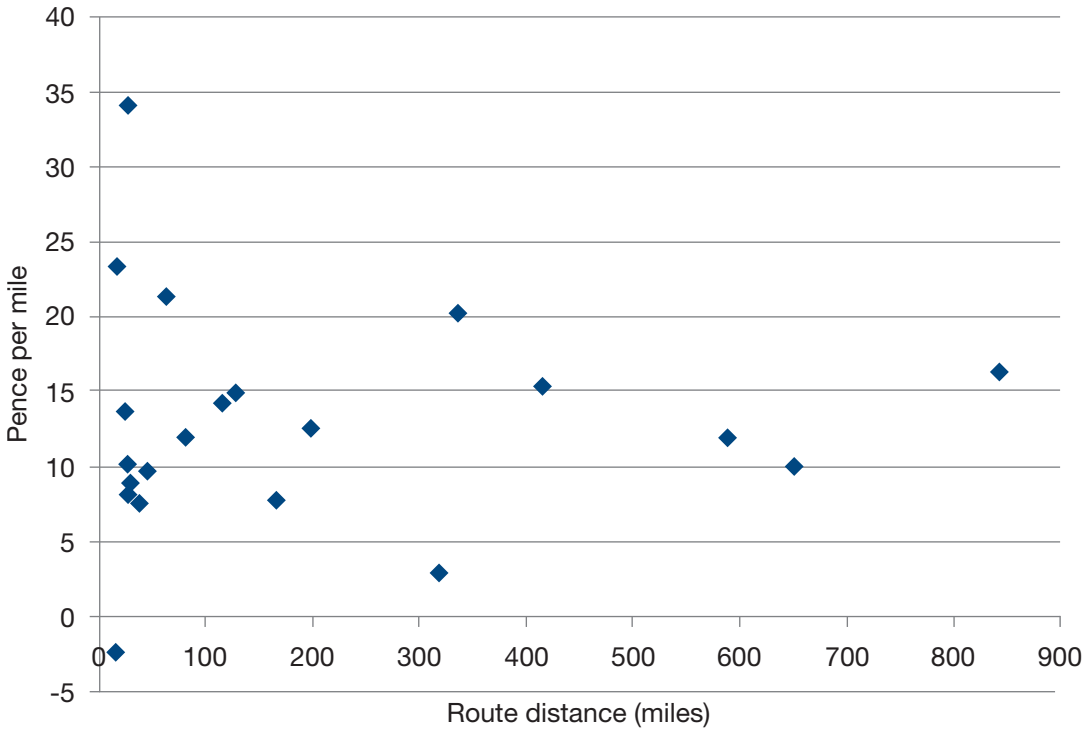
5. Diversion of Traffic

One real concern is that a PAYG charge on a major road would cause diversion of traffic, particularly HGVs, onto local, slower and less suitable roads. The extent to which this would happen plainly depends on the rate of charge and exact local circumstances – in particular, the time taken on the best available alternative route.

In practice, careful design would be necessary to manage this problem. However, some indicative calculations are possible using times and distances between a selection of start–finish locations from a route planner, comparing routes using motorways with those avoiding them.

In Figure 4 we plot, for a selection of start and finish points, the sum of estimated money-cost and time-cost advantage (using DfT-recommended values of time) per mile of using motorways rather than avoiding them, against the length of the route.

Figure 4: Cost and time advantage per vehicle mile of using motorways against route miles



Source: RAC Foundation calculations by David Bayliss

The figure shows that for journeys over about 400 miles, using the motorway offers an advantage of 8p or more per vehicle mile. This is also the case for many of the shorter trips. So, on the basis of this rough-and-ready calculation it appears that there will be many situations where there would be sufficient leeway to make a PAYG charge without causing too much diversion; and that is before accounting for the possible deterrent effect of congestion delay and increased accident risk on the diversionary routes.

6. Transition

If a government were to decide to explore the opportunities offered by PAYG charging, the question would arise as to how to proceed – what steps should be taken in what order?

One option, and an attractive one, would be to prove the principles by selecting one particularly congested motorway, or part of a motorway, in need of improvement. The candidate road would need a suitable junction layout, and alternative routes that would not make undesirable traffic diversion onto local roads too great a risk. A simple ANPR system could be used to levy PAYG charges, as in London and other parts of the world (as suggested by Walker, 2011). This could be let to the private sector as a time-limited, regulated concession (like HS1), or held in a public trust, or managed by a distinct division of the Highways Agency. In some ways this would be similar to the long-standing PFI schemes with shadow tolls, such as the one operated at present on the M40.

A possibility worthy of investigation would be to create a package consisting of the right to extend the M6 Toll Road from north of Birmingham to Manchester together with the (time-limited and regulated) concession to operate and charge for the existing M6 on that alignment. A similar model might work on the alignment of the A14, a road greatly in need of an improvement scheme but without one in preparation since the October 2010 Spending Review.

On account of its small scale, a considerable disadvantage of this cautious start would be that a reduction in motoring taxes could not be offered because the revenues would be, for the most part, consumed in improving the charged road and, if sold, to paying a return on investors' capital investment. The charges would be additional to existing taxes, but the revenues would be transparently ring-fenced – as is the case with the London Congestion Charge.

A less cautious start would be to define one or more portfolios of motorways (possibly including some other major trunk roads) and create a body or bodies to manage, improve and charge for them, under a regulated, time-limited concession. This would be close to the current model for the *autoroutes* in France. This approach might result in only a part of the revenues being consumed by maintenance and enhancement of the relevant network, and, if sold, by funding a return on investors' capital (that is, a return on the RAB). Then surplus revenue could be generated, and applied to reducing motoring taxes as part of the policy package.

7. Conclusions

We already have an overstressed road system, and whilst there is room for debate about how much growth we can expect, an additional 10 million more people added to the population of the UK over the next 25 years will undoubtedly result in higher levels of demand for road use. To fail to recognise this would be to plan for economic stagnation: although dissatisfaction with the level of service – both to people and industry – has lessened, this is temporary and it will mount again. Since improvements take years to bring to fruition, it is necessary to act in anticipation.

The need to manage growing demand and worsening congestion; the need to generate new income with which to operate and enhance our roads; the need to accommodate low carbon technologies – these all point towards reform in the way in which we pay for our roads. This paper offers some alternatives to continuing with the historically accepted means.

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A Speculative Estimation of Direct Road User Charging Impacts

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1. Introduction

The introduction of a more rational pay-as-you-go (PAYG) means of charging road users for the use of public highways would significantly increase the efficiency of use of roads – as has been demonstrated by a series of studies over the last half century. Given sufficient will, the technical complexities can almost certainly be overcome with the technologies of today, and there are a number of organisational and administrative arrangements that could make this feasible. However, doubts remain about what the impacts would be of replacing the existing system of fuel duty and annual vehicle excise duty (VED) with a PAYG system. This paper explores that issue, making a range of assumptions about what an efficient PAYG regime might look like.

The effects of introducing a PAYG system will depend on a range of factors, including:

- the level of charges and the tariff structure;
- other motoring costs;
- the types of road users;
- the levels of road congestion and how these change with PAYG pricing; and
- how users respond to a novel way of paying for the use of the road network.

Assumptions have to be made about each of these factors, and a wide range of outcomes is possible depending on what these assumptions are. Indeed, one of the desirable features of a PAYG scheme is that the key variable – the level of charges and the tariff structure – is subject to public policy control; consequently, there is considerable scope for varying the charging regime to promote desired outcomes and minimise unwanted impacts.

In the estimates made below it has been necessary to make a series of assumptions on which the findings depend. This is therefore a speculative exercise, and as such is not intended to be definitive. If it stimulates others to carry out their own assessments, that will be all to the good. The assumptions are set out in some detail to help understand the estimates of impacts and to give a feel for how these could change if the assumptions themselves change.

The effects of a PAYG scheme would be more than financial. An efficient PAYG regime would reduce congestion, pollution, traffic noise and greenhouse gas (GHG) emissions. For this reason it would be short-sighted to judge PAYG simply on the basis of its financial impacts. An indication of the traffic and GHG effects of efficient pricing is given in *Roads and Reality* (Banks et al., 2007a; 2007b).

2. The Basic Approach

The approach adopted is that specific road use taxes (fuel duty and VED) are replaced by a distance-based charge which varies according to the marginal social cost of road use. These charges vary by time of day, degree of congestion, amounts of pollution and accidents, and type of vehicle. To gauge the pecuniary impacts it is therefore necessary to estimate existing taxes and these 'external' costs of motoring.

3. Existing Motoring Taxes

Road users currently pay the normal taxes on expenditure, i.e. value added tax (VAT) and insurance premium taxes, but also pay an annual charge for access to the road system (the VED) and a tax – the fuel duty – on road transport fuels (on top of which VAT is levied, making this VAT a tax on a tax).

Table 1: Road taxation revenue in 2008/09

VED by vehicle type		Number of vehicles (thousands)	Road taxes (£ million)
Private and light goods vehicles (LGVs)		30403	5091
Motorcycles, mopeds etc.		1181	52
Buses and coaches		111	29
Heavy goods vehicles (HGVs)		438	250
Other vehicles*		2173	19
All vehicles		34305	5441
Fuel tax by fuel type			
Fuel tax by fuel type	Petrol **	20493	11315
	Diesel	13759	12689
	All ***	34305	24615
All motoring taxes			30056

Source: DfT (2010b), Tables 7.15, VEH0203, VEH0301, VEH0453, VEH0504 & VEH0604.

* 'Other vehicles' include Crown vehicles, emergency vehicles, vehicles adapted for disabled persons, vehicles manufactured before 1973 (amounting to 2.091 million in 2008), works and showmen's vehicles, general haulage vehicles, recovery vehicles and three-wheeled vehicles.

** 'Petrol' includes petrol-electric hybrids.

*** 'Diesel' includes gas- and electric-powered vehicles.

It is assumed for the purpose of this paper that road users will continue to pay the two general taxes with a new PAYG scheme, meaning that the taxes that would be replaced are VED and fuel duty.

Table 1 shows the amount of road use taxes paid in 2008/09 (which, it should be noted, does not include monies lost through VED evasion – an estimated £46 million in 2010/11 – DfT, 2010d). The amount of VAT paid in addition is not known with certainty, but has been estimated for households to be £12.2 billion in 2007 (IAM, 2011: Table 1.2.), which was at a rate of 17.5%: today the figure will be higher as VAT has increased to 20%. This works out as an average of tax due (including VED evaded) under the existing regime of 6.1 pence per vehicle kilometre (p/vkm). If this figure is updated to reflect a fuel duty rate of 57.95p per litre it increases to 6.3 p/vkm, which breaks down into 5.26p for cars, 6.74p for vans/LGVs and 19.64p for HGVs.

VED rates vary between different types of vehicle and have become quite complex in recent years with the move to a carbon dioxide (CO_2)-based system.

4. The Level of PAYG Charges

The level of PAYG taxes is proposed to be equal to the external costs of road use alluded to in Section 2. These include wear and tear of the road system, harm caused by noise and air pollution, contributions to climate change from GHG emissions, and congestion of the road network itself. Estimating these costs is very difficult and for the purposes of this exercise the estimates carried out for the then Department of Environment, Transport and the Regions (DETR) by the Institute of Transport Studies of Leeds University in conjunction with AEA Technology have been taken as the basis. Table 2 sets out the marginal social costs by type and class of vehicle for Great Britain in 1998. This is the average of the 'high' and 'low' figures estimated in that report.

The source of the range of costs in the study varied between the different parameters. For example carbon prices were 'given' to the analysts by the client (DETR). The health effects were based on the results of epidemiological studies on the impacts of dosages and exposure. Different studies found different dose-response rates and attributed different values to the resulting effects – this typically yielded a wide range of values. The authors did not carry out these estimates themselves, but relied on the findings of other research projects by specialists in the relevant fields. In the case of road infrastructure costs the authors took the findings of a study by NERA et al. (1999) and, to get the upper estimate, added 30% as an allowance for the deteriorating physical condition of the road network.

Table 2: Marginal cost analysis by vehicle class (average at 1998 price levels, p/vkm)

Vehicle	Infrastructure operation cost & depreciation	Vehicle operating cost	Congestion	Möhring effect	External accidents	Air pollution	Noise	Climate Change	Unpaid VAT	Total
Car	0.06	-	9.70	-	1.09	0.53	0.27	0.30	-	12.0
LDV *	0.07	-	9.94	-	0.71	2.03	0.51	0.45	-	13.7
HGV – rigid	4.36	-	17.62	-	1.68	5.00	1.48	1.09	-	31.2
HGV – artic	8.69	-	24.52	-	1.20	4.52	2.22	1.79	-	43.0
PSV **	6.02	79.61	16.71	–14.70	5.16	9.26	2.10	1.40	13.44	119.0

Source: Sansom et al., 2001.

* Light duty vehicle

** Public service vehicle

If public service vehicles (PSVs) are ignored, either on the basis that they could be exempt from PAYG user charges or that they are a barely significant fraction of the traffic stream (amounting, as they do, to 5.1 billion vehicle km out of a total of 503.9 billion in 2009 (DfT, 2010c: Table 7.1), the table can be simplified considerably as follows:

Table 3: Marginal cost analysis by vehicle class (average at 1998 price levels, p/vkm)

Vehicle types	Infrastructure operation cost & depreciation	Congestion	External accidents	Air pollution	Noise	Climate change	Total
Car	0.06	9.70	1.09	0.53	0.27	0.30	12.0
LDV	0.07	9.94	0.71	2.03	0.51	0.45	13.7
HGV – rigid	4.36	17.62	1.68	5.00	1.48	1.09	31.2
HGV – artic	8.69	24.52	1.20	4.52	2.22	1.79	43.0

Source: Sansom et al. (2001)

These values are adjusted in Table 4 to reflect the changes in prices between 1998 and 2009. The adjustment factor used is 1.312 (based on the retail price index, RPI) (ONS, 2010).

Table 4: Marginal cost analysis by vehicle class (average at 2009 price levels, p/vkm)

Vehicle types	Infrastructure operation & depreciation	Congestion	External accidents	Air pollution	Noise	Climate change	Total
Car	0.08	12.72	1.43	0.70	0.35	0.39	15.74
LDV	0.09	13.04	0.93	2.66	0.67	0.59	17.97
HGV – rigid	5.72	23.12	2.20	6.56	1.94	1.43	40.93
HGV – artic	11.40	32.17	1.57	5.93	2.91	2.35	56.42

Source: Sansom et al. (2001)

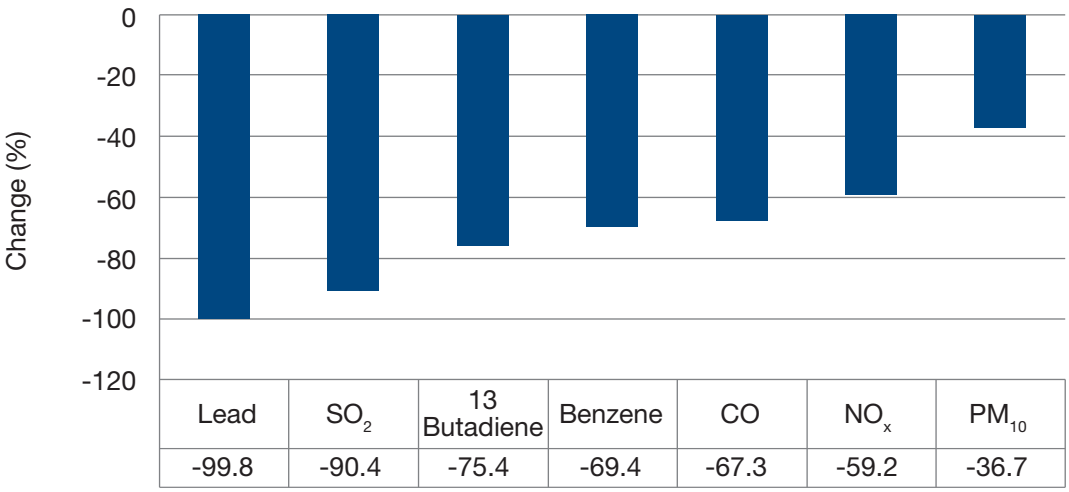
Some of these cost rates will have changed in real terms between 1998 and 2009. Highway maintenance expenditure grew by about 50%[2] – implying a

2 Estimated from DfT (2001: Table 1.18) and DfT (2010c: Table 0115). The local authority current expenditure for 2008/09 is not broken down by category, so £3.6 billion has been taken compared with £3.3 billion in 2007/08.

real increase of about 14%. However, traffic grew by 11% over that period, so spending per vehicle km has barely changed.

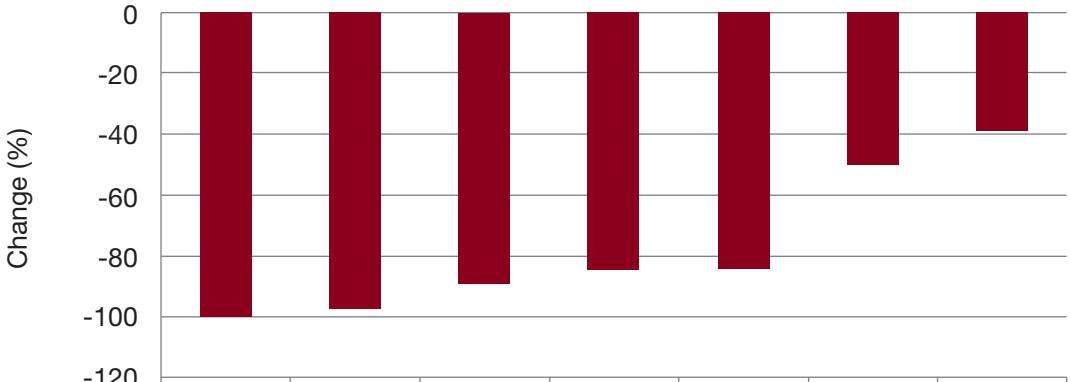
Road traffic air pollution has also fallen during this period. Figures 1 to 4 show the extent to which noxious emissions from road transport are estimated to have fallen between 1998 and 2008. It is clear that whilst there have been large reductions in emissions, progress with HGV reductions have been slower than with cars and vans. It has not been possible to weight the contribution of the individual pollutants to the overall cost of air pollution. These changes also reflect an increase in traffic.

Figure 1: Change in noxious pollutants from cars, 1998–2008



Source: DfT (2010c), Table ENV0301

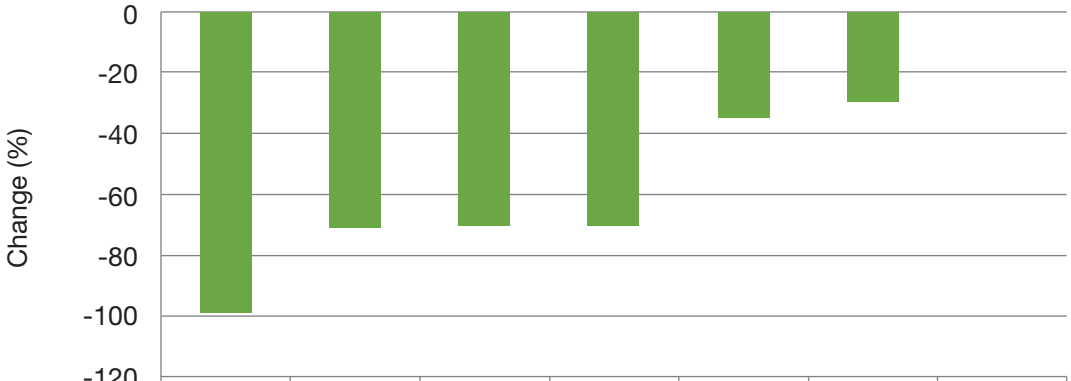
Figure 2: Change in noxious pollutants from vans 1998–2008



Lead	SO_2	Benzene	13 Butadiene	CO	PM_{10}	NO_x
-99.4	-96.6	-90.0	-85.7	-84.8	-50.0	-38.9

Source: DfT (2010c), Table ENV0301

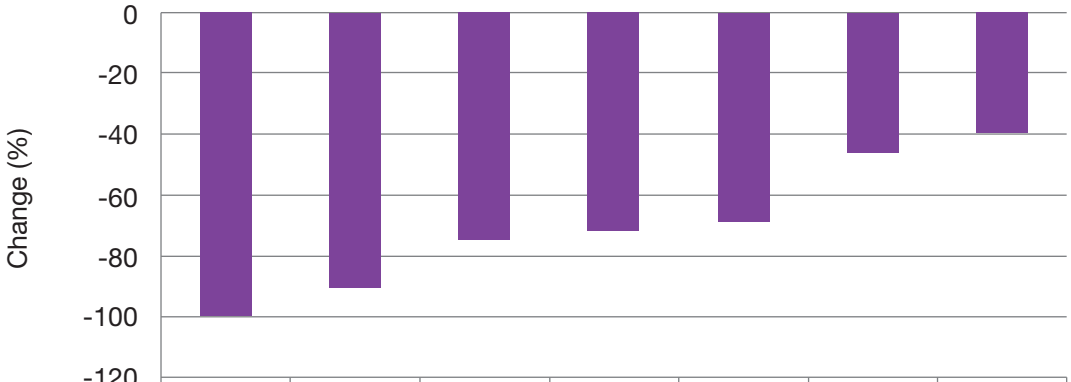
Figure 3: Change in noxious pollutants from HGVs 1998–2008



SO_2	PM_{10}	Benzene	13 Butadiene	CO	NO_x	Lead
-98.4	-68.6	-66.7	-66.7	-35.7	-30.7	0.0

Source: DfT (2010c), Table ENV0301

Figure 4: Change in noxious pollutants from all road vehicles 1998–2008



Lead	SO_2	13 Butadiene	Benzene	CO	NO_x	PM_{10}
-99.7	-93.6	-75.0	-71.1	-67.8	-46.2	-39.8

Source: DfT (2010c), Table ENV0301

Between 1997 and 2009 car traffic grew by 9.5% and van traffic by 37%, whereas HGV traffic fell by 1.8%; all motorised traffic increased by 11.9% (DfT, 2010b: Table 7.1), so the percentage reductions in these pollutants per vehicle km will have been correspondingly greater. In the absence of a more refined estimate, the overall emission rates are taken to have fallen by the averages shown above for cars and HGVs. This implies that a possible underestimate from using the average is offset by the traffic growth and the continuation of the trend for a further two years. To do this in respect of vans would be inconsistent, as the growth in van traffic has been so large over this period. It has not been possible to weight the relative damaging effects of the different pollutants shown above. To minimise the risk of overestimating the reductions in the costs of traffic pollution, a figure has been taken which is the average for all pollutants – reduced by a third of the difference between this average and the least improved pollutant. This gives a 65% improvement for cars, 71% for vans and 27.5% for HGVs.[3]

On this basis the reductions in atmospheric pollution cost rates (i.e. reflecting the growth in traffic volumes over this period) are assumed to be 80% for cars, 30% for HGVs and 85% for vans.

Road traffic accident rates have also fallen substantially over this period, from 50 per 10^8vkm in 1999 to 33 per 10^8vkm in 2009 – a 38% reduction (DfT, 2010c). Whilst it is possible to disaggregate casualties by vehicle occupant type (DfT, 2010a: Table 1), the data for cause by vehicle type is not available. This figure therefore has to be applied equally to all classes of vehicle.

Road vehicles have also been getting quieter, but it seems not by much – and increasing traffic volumes have offset this, so noise nuisance from traffic does not appear to have changed much in recent years. Whilst rates for both light

3 Benzene and lead are not included in the calculation because the amounts involved are so small.

and heavy vehicles have fallen a little, it appears that the greatest success has been with heavy vehicles. For this reason no allowance is made for improvements in cars and vans, but a 10% reduction in HGV rates is assumed.

Since *Surface Transport Costs and Charges: Great Britain 1998* (Sansom et al., 2001 – hereafter abbreviated STC&CGB), was published, there has been a good deal of work on the impacts of GHG emissions. The most recent Guidance from the Department for Environment, Food and Rural Affairs (Defra) is that CO_2 should be valued for 2009 at £26.5 per tonne at 2007 prices (Price et al., 2007). Adjusting to 2009 prices, this comes to £27.4 per tonne. In 2008, it is estimated that cars emitted on average 191 gCO_2/km, vans 213 grams and HGVs 830 grams. At 0.0027p per gram, this gives the figures shown in Table 5 (i.e. under the column 'Climate change').

Measures of congestion do not allow meaningful overall comparisons to be made between 1998 and 2009, and there are no official estimates of the current costs of congestion. However:

- NERA estimated congestion costs in 1996 at £7 billion per year (£10.2 billion at today's prices);
- the UNITE project (Mayeres et al., 2001) put the costs of congestion at £15 billion at 1998 prices (£20.5 billion at today's prices);
- the Department for Transport (DfT) study of road pricing gave the value of congestion and unreliability as £12 billion in 2010 at 2004 prices (£13.8 billion at 2020 prices);
- Eddington (2006) concluded that the increase of congestion between 2003 and 2025 would cost £24 billion a year; and
- the British Chambers of Commerce (2008) estimated congestion to be costing businesses £23.8 billion in 2008.

If a (probably low) estimate of the cost of road congestion is made, of £20 billion in 2009, then the average cost per vehicle km amounts to 4p – much lower than the estimates in STC&CGB which are consistent with a total cost of congestion in 1998 of £44 billion. It would seem appropriate therefore to reduce the values in Table 4 accordingly. This also gives an average charge rate a little higher than existing taxes, which is a realistic scenario in that it:

- protects Treasury revenues;
- provides funds for the higher costs of collecting dues in a PAYG scheme; and
- provides funds for road and other transport improvements.

In the DfT's road pricing study, the estimate of average charges came out at 1.9 p/vkm higher than under the prevailing tax regime (DfT, 2004a: Annex B, Figure B11) compared with 1.7 p/vkm in this estimate, so this seems to be broadly in line with DfT findings.

Whilst the pecuniary costs of the PAYG scheme exemplified in Table 5 would be higher than under the existing taxation system, road users would be better off: congestion would be reduced in the short term, and in the longer term there would also be steady improvements to the road system.

Table 5: Updated marginal cost analysis by vehicle class (average at 2009 price levels, p/vkm)

Vehicle types	Infrastructure operation & depreciation	Congestion	External accidents	Air pollution	Noise	Climate change	Total
Car	0.08	3.91	0.9	0.25	0.35	0.52	6.01
LDV	0.09	4.45	0.6	0.77	0.67	0.58	7.16
HGV – rigid	5.72	8.0	1.4	4.75	1.75	1.86	23.48
HGV – artic	11.40	11.18	1.0	4.30	2.62	3.06	33.56
All vehicles	0.57	4.6	0.88	0.57	0.50	0.64	7.76

5. What Would the Rate Structure Look Like?

To estimate the impacts of direct charging, a tariff structure has to be created. Relative prices from the road pricing rates estimated in *Roads and Reality* (R&R) have been used and factored to give the average charging levels shown in Table 5; the R&R rates were significantly higher than these, reflecting both greater congestion and higher values of time in 2041. As well as being scaled back, overall regional rates were adjusted to take account of the differences in traffic growth between 2005 and 2041 assumed in R&R.

The differences between regions (including Scotland and Wales) are shown in Figure 5.

Figure 5: Estimated PAYG charge rates by region (car traffic, p/vkm)

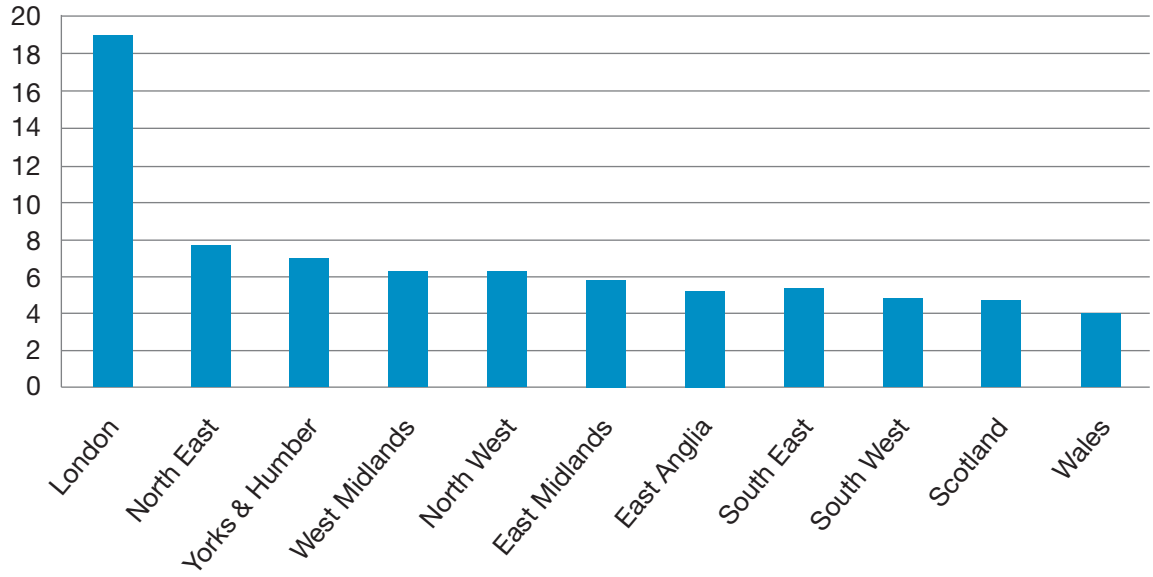
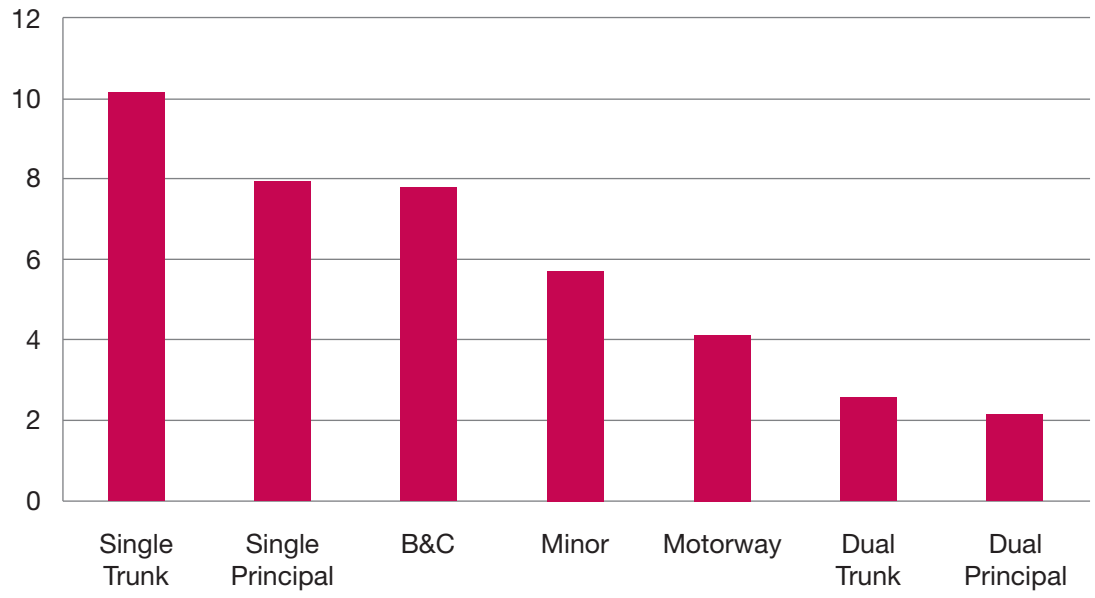


Figure 6: Estimated charge rates by type of road (car traffic, p/vkm)



It is notable, as illustrated in Figure 6, that the highest charge rates on this basis would not be on motorways but on single carriageway main roads, which form some of the least satisfactory sections of the inter-urban road network and the main distribution networks of the major towns and cities.

Regions are large heterogeneous areas and, as such, regional averages do not mean a great deal. A more useful spatial categorisation would be by settlement type. It is not possible to derive charge rates directly by settlement type for the R&R analysis, so estimates have been made by interpolation between the extremes of London at one end of the scale and rural Wales at the other.

Table 6 gives an estimate of how charges could vary by type of settlement. As is to be expected, charges would be highest in London, at around treble the national average and double those in the other large metropolitan areas. As the size of settlements reduces, average charges fall; this is primarily because of the much lower levels of congestion occurring on single carriageway roads – both major and minor – than on dual carriageways.

Table 6: Charge rates for cars by type of area and type of road (p/vkm)

Road Type	London	Met. areas	>250k	>25k	>10k	>3k	Rural	All
Motorway	5.1	5.0	4.1	3.2	2.3	1.8	1.6	4.1
Dual trunk			3.5	3.2	2.9	2.7	2.5	2.6
Dual principal			3.3	3.2	2.9	2.7	2.5	2.1
Single trunk	30.3	9.9	8.5	7.1	5.7	4.2	3.9	10.2
Single principal	21.5	11.5	10.2	8.9	7.5	6.2	5.7	8.0
B and C roads	23.8	10.6	9.0	7.4	5.8	4.2	3.8	7.7
Minor	12.1	9.2	7.9	6.6	5.3	3.9	3.6	5.7
All	19.0	8.7	7.5	6.3	5.1	4.0	3.6	6.1

Source: ONS (2009a)

To derive this table, information was taken directly from R&R in respect of London and the Metropolitan areas. Information for Wales as a whole was taken to represent the >3k settlements, and the remainder were interpolated/ extrapolated from these numbers.


EXCEPT
BUSES
BUS
STOP
BUS
BUS
STOP
TURN
LEFT

6. What Would Be the Effects on Road Users?

To get a feel for the possible impacts of a PAYG system on different types of household, estimates have been made by income quintile and type of area. There are many other ways in which users could be characterised, but these are two of the most important discriminators and deriving estimates for these broad categorisations has required a number of quite bold assumptions. These are explained at the appropriate points in the text.

The most obvious impacts of a PAYG scheme would be on car owners; however, there will also be consequences for people in households without cars. Less road congestion will make for more reliable bus services, and there would be some increased use of rail – and possibly rail crowding. Some car travel would be diverted to buses, and this – in conjunction with a reduction in congestion – would generally mean that bus services would be more frequent and reliable. Increased ridership should also increase fare revenues, thus reducing the demand on taxpayers for subsidies.

Table 7: Average annual distance travelled by income (2002–2006) – non-car-owners (km)

	Lowest quintile	Second quintile	Third quintile	Fourth quintile	Highest quintile
Walk	422	383	338	510	372
Bicycle	35	74	74	134	352
Car/van driver	104	72	249	441	292
Car/van passenger	1097	1334	1594	1539	1098
Other private	213	127	442	232	267
Bus	1175	1214	1173	1046	946
Underground	79	105	225	465	1844
Surface rail	588	517	804	1845	3712
Other public	402	288	716	343	1301
All travel	4114	4115	5614	6554	10184

Source: ONS (2009b)

Table 7 shows travel by income range for people in households without cars. For these people, use of the bus, at 412 km per capita per year in 2004 (DfT, 2005: Table 3.1) is three times higher than average, and even more so than for people in car-owning households, which means they would benefit substantially from a better bus service. Similarly, they walk about a third more than average, and cycle over twice as much, so they would benefit disproportionately from the impacts of less congestion on these forms of transport. These benefits do not vary much by income range in the case of buses. When it comes to walking, the most benefits would accrue to people in the upper and lower income ranges, but for cycling it is clearly the better off that would benefit most, although the low use of bicycles by members of low-income households might well change with the introduction on PAYG as the cost savings from cycling would be that much greater.

It is noteworthy that travel by car is the most important means of transport, even for people in non-car-owning households – especially for those in lower-income groups (for 30% in the lowest-income quintile, compared with less than half of those in the highest). For the wealthiest group of non-car-owners, rail travel dominates – carrying over a half of all travel; so it is the wealthier non-car-owners that would suffer most from any increase in rail overcrowding. It is in London that this phenomenon would have the greatest effect. However, here road journeys to the centre already have to pay the £10-per-day congestion charge, which would logically disappear with PAYG.

Table 8: Average non-car distance travelled (kilometres) by income 2002

	Lowest quintile	Second quintile	Third quintile	Fourth quintile	Upper quintile
Walk	353	334	288	284	272
Bicycle	29	33	61	71	68
Bus and coach	793	577	432	422	340
Rail	349	374	407	705	1673
Taxi and minicab	91	85	66	79	128
Other public transport	16	30	89	71	239

Source: DfT (2004b), Table 5.6.

Table 8 shows how the use of public transport varies with income for members of all households, whether car-owning or non-car-owning, and a picture similar to that for non-car-owning households alone emerges, except that the contrasts between the wealthier and poorer groups are less marked because of the moderating effects of car ownership.

The transport effects of PAYG would be felt most strongly in the busy urban areas, and especially at peak times. It is at these times and places that the benefits of improved bus services and better conditions for pedestrians and cyclists will be most evident. It is also at these same times and places that rail crowding is most evident, and this must be a concern for the introduction of an effective PAYG scheme.

Car users are a large and diverse community, and it is impossible to answer all the questions about the type of impacts that a road pricing system might have. For the purpose of this analysis, car users are classified by income level and the type of area in which they live. The analysis focuses on the financial impacts – which are usually the aspect of greatest concern – although the improvements in traffic conditions can be of a similar order of magnitude. The following estimates do not assume any change in road use – a premise that is clearly unrealistic. Indeed an efficient PAYG scheme would be designed to alter

behaviour to change the modes and times of transport, to reduce congestion, and to discourage some car use from taking place at all. However, by not allowing for behavioural change, the estimates present the worst possible case. Car users will almost always be able to avoid some of the charges levied, by limited alterations to how they use the transport system, thereby reducing the volume of high-cost road use and consequently moderating the level of charges.

Table 9: Illustrative cost of PAYG road use by type of area and income range (£/car-owning household per year) – no behavioural change

Area type	London	Met. areas	>250k	>25k	>10k	>3k	Rural	All
Lowest quintile	2073	1095	837	736	764	643	540	830
Second quintile	2939	1580	980	843	880	736	656	992
Third quintile	3780	1724	1236	1064	1114	1038	940	1237
Fourth quintile	3923	1802	1550	1349	1414	1266	1135	1587
Highest quintile	3706	2052	1810	1575	1651	1478	1326	1853
All incomes	2756	1505	1319	1150	1203	1064	909	1371

To derive this table it has had to be assumed that income distributions are independent of type of area. This is almost certainly not the case, but all settlement types do have a significant spread of household incomes.

The introduction of substantial differentials in road use pricing would mean that some would pay more and others less – even when charges are set to provide a net increase in receipts. Car-owning households would pay more in busy congested cities and less in quiet rural areas. Charges would also be lower in off-peak periods than at the busiest of times. Table 9 shows average annual charges for households in a range of different types of areas by income range. Londoners would pay about twice the national average and rural dwellers about two thirds. As under the present tax arrangements, wealthier people would pay more than the less well-off car-owning households, with the lowest-income quintile paying about 60% of the average and the wealthiest paying about a third more than the average.

Table 10: Illustrative costs of road taxes by type of area and income range (£/car-owning household per year)

Area type	London	Met. areas	>250k	>25k	>10k	>3k	Rural	All
Lowest quintile	728	752	683	696	759	721	734	661
Second quintile	1041	1081	806	783	911	854	919	827
Third quintile	1378	1239	1038	1013	1191	1254	1368	1050
Fourth quintile	1696	1505	1432	1340	1526	1607	1765	1470
Highest quintile	1993	2018	1917	2025	2084	2011	2209	1851
All incomes	1101	1152	1133	1119	1307	1321	1393	1182

These spending levels can be compared with the estimated costs under the existing tax regime as estimated in Table 10. In neither table is VAT or insurance premium tax included as these are assumed to remain unchanged with the introduction of a PAYG system. Overall, the annual costs of using the road network would, on the basis of the charges used, be about 16% higher. This difference has two rationales. Firstly, it is at about the level that covers estimated road users' 'externalities', and so is economically efficient; and secondly, it would protect contributions to the Consolidated Fund whilst leaving a surplus to meet the costs of operating the new charging scheme and providing additional funds to improve roads and other components of the transport system – thus relieving congestion and reducing other unwanted effects of overcrowded roads. To give road users confidence in a new charging system of this kind, the governance of the road system would need to be overhauled; the choices for doing this are explored in Glaister (2010).

If these two patterns of road user costs are compared directly (see Table 11), it is possible to get an idea of how households in different areas and income levels would be affected. Households in small towns and rural areas would be no worse or better off financially under the PAYG scheme, whilst those in large towns and cities – and especially London – would pay more than under the present tax regime. Car-owning households in the highest-income quintile would pay about the same as currently, whilst those in the lowest would pay about a quarter more – the equivalent of £170 per year. This is because of the very high amounts of fuel duty paid currently by wealthy car-owning households who make more and longer car journeys than poorer car users and so would also benefit more from improved road conditions (about a £1,000 per year for the top quintile compared with under £500 per year for the bottom quintile) (ONS, 2009a).

Table 11: Illustrative ratios of PAYG charges to road taxes by type of area and income range for car-owning households, assuming no behavioural change

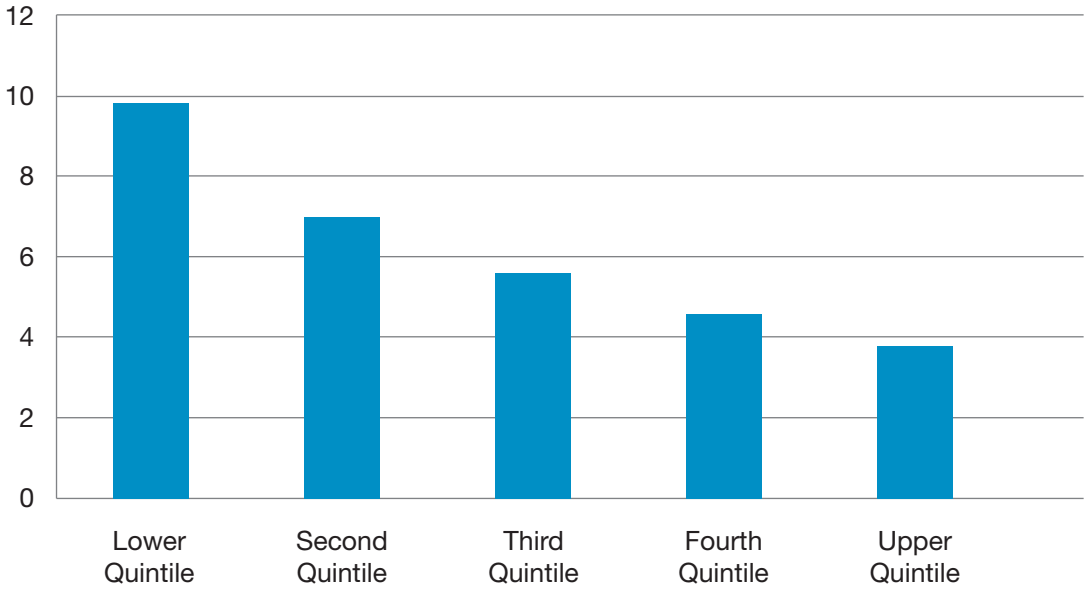
Area type	London	Met. areas	>250k	>25k	>10k	>3k	Rural	All
Lowest quintile	2.85	1.46	1.23	1.06	1.01	0.89	0.74	1.26
Second quintile	2.82	1.46	1.21	1.08	0.97	0.86	0.71	1.20
Third quintile	2.74	1.39	1.19	1.05	0.94	0.83	0.69	1.18
Fourth quintile	2.31	1.20	1.08	1.01	0.93	0.79	0.64	1.08
Highest quintile	1.86	1.02	0.94	0.78	0.79	0.74	0.60	1.00
All incomes	2.50	1.31	1.16	1.03	0.92	0.81	0.65	1.16

Much higher cost	Higher cost	Similar cost	Lower cost	Much lower cost

It could be argued that low-income motorists are the most price-sensitive, and that consequently they will be the most prepared to change behaviour and reduce their costs. However, some low-income motorists are in routine employment and the scope for changing their journey to work – which is likely to attract peak rates – will be the most constrained. The journey to work, however, makes up only 9% of trips by lowest-income car owners, compared with 19% for the highest, so it would appear that by not allowing for behavioural change the financial impact on low-income car owners is overestimated.

Estimates have been made of how these numbers might change if there are behavioural responses. These have been calculated be changing traffic levels to reflect the higher costs of some roads (e.g. single trunk roads) and using different elasticities by income range. The overall changes in car use resulting from these are as shown in Figure 7, with an overall average reduction in traffic of just over 5%. This compares with a forecast of just over 10% on the Strategic Road Network in R&R; but substantially higher average charges (13 p/vkm at 2009 price levels) were used in that study.

Figure 7: Reduction in car traffic from PAYG by income quintile (%)



Tables 12 and 13 are derivatives of Tables 9 and 11, taking account of possible behavioural effects of PAYG charging. This is only a crude representation, as a network model that reassigns traffic between different routes, modes and times of day would be needed to get a realistic picture, and such a model is not available for the whole of Great Britain. The estimates are based on calculating traffic changes by road type and area in relation to the difference between the average tax cost and the charge rates in Table 6, constrained to prevent unrealistic suppression on roads with very high charge rates (mainly in London).

Table 12: Illustrative cost of PAYG road use by type of area and income range (£/car-owning household per year), with behavioural change

Area type	London	Met. areas	>250k	>25k	>10k	>3k	Rural	All
Lowest quintile	1338	846	738	699	773	689	613	749
Second quintile	1963	1324	897	813	888	773	720	923
Third quintile	2580	1502	1153	1034	1122	1080	1012	1168
Fourth quintile	2723	1616	1466	1318	1422	1307	1205	1516
Highest quintile	2598	1873	1727	1545	1659	1519	1395	1783
All incomes	1894	1324	1236	1120	1211	1105	975	1300

From Table 12 it is evident that the effects of restraint are greatest in London and the metropolitan areas. Whilst charge revenues are reduced overall, they (and traffic levels) are *greater* in rural areas and small towns, where costs under the new regime would be less. This effect also applies to road types, as motorways would become more attractive, but to try and be specific about this would be foolish in the absence of a network model. Overall the yield from

PAYG with restraint is estimated to be about 5% less than without restraint. However, because of the greater reductions assumed for lower-income groups, car users in the lower quintile would experience greater reductions in their payments as a result of restraint, and this is illustrated in Table 13 in respect of the impacts in relation to the costs of the existing tax regime. The differentials in effects between income ranges are significantly reduced, with the advantage experienced by the two highest quintiles being relatively modest.

Table 13: Illustrative ratios of PAYG charges to road taxes by type of area and income range for car-owning households, with behavioural change

Area type	London	Met. areas	>250k	>25k	>10k	>3k	Rural	All
Lowest quintile	1.84	1.13	1.08	1.00	1.02	0.96	0.83	1.13
Second quintile	1.89	1.22	1.11	1.04	0.97	0.91	0.78	1.12
Third quintile	1.87	1.21	1.11	1.02	0.94	0.86	0.74	1.11
Fourth quintile	1.61	1.07	1.02	0.98	0.93	0.81	0.68	1.03
Highest quintile	1.30	0.93	0.90	0.76	0.80	0.76	0.63	0.96
All incomes	1.72	1.15	1.09	1.00	0.93	0.84	0.70	1.10

Much higher cost	Higher cost	Similar cost	Lower cost	Much lower cost

Overall this would mean that about three quarters of car-owning households would pay more, about 8% pay a similar amount, and about 17% pay less. The remaining 25% of households that do not own cars would be better off by virtue of improvements to public transport services consequent on a boost in demand. The costs by income range under the current and the PAYG regimes are illustrated in Figures 8 and 9.

Figures 8 and 9: Road use costs by income quintile with existing taxes and PAYG

7. Heavy Goods Vehicles

In Table 5 the charges calculated for HGVs are 23.46 p/vkm for rigid vehicles and 33.56 p/vkm for articulated lorries. Applying these rates to current HGV travel gives the figures in Table 14.

Table 14: HGV charges calculated using marginal social cost (MSC) rates

Type of HGV	Km/year (billion)	Charge rate (p/vkm)	Total charges (£ billion)
Rigid	13.5	24.2	3.27
Articulated	12.9	34.9	4.50
All HGVs	26.4	29.5	7.79

Source: Traffic flows from DfT (2010c), Table TRA 9909.

Under the existing taxation regime the VED paid by HGVs was £250 million in 2008/09 (DfT, 2010c: Table 7.15). Moreover, the amount of fuel used by HGVs in Great Britain in 2008 was 7,420.2 thousand tonnes (DECC, 2010). At a duty rate of 57.95p per litre and 1,192 litres of fuel per tonne (BP, 2010: Annex), the duty on this fuel would be £4.73 billion. If added to VED, the resulting total of £4.98 billion is two thirds of the PAYG charges. The high PAYG charges for HGVs are strongly driven by the infrastructure element. Whilst all other components of external costs of HGVs are within an order of magnitude higher than cars or vans, this charge is of three orders of magnitude greater. This is not reflected in the current taxation regime, with fuel duty being at the same rate irrespective of type of vehicle. This means that, based on their fuel consumption, HGVs pay about 19 p/vkm[4] whilst cars and vans pay just under 4p and 5p respectively.[5] It should also be borne in mind that most of the road network is made up of minor roads with little HGV traffic on them, and where the most important factor in maintenance needs and degradation is the environment.[6]

Average VED rates are £167.5 for cars and vans and £665 for HGVs, but HGVs travel more than four times the distance of cars and vans, so the VED tax rate is similar for both classes of vehicle (0.96 p/vkm for HGVs and 0.93 p/vkm for cars and vans). Using the charge rates implied in Table 14 would therefore result in a large increase in the differentials between light and heavy road vehicle taxation, and also a large increase in HGV taxes over the existing ones. It is suggested therefore that the existing differential should be used – of 3.75 times the rate for cars, or 22.5 p/vkm average for all HGVs. This gives a yield of £5.94 billion, or 19% higher than current taxes. There would be some suppression of HGV traffic as a result of the higher average charges and the greater differentials. If this suppression factor were 5%, the yield from PAYG would be £5.64 billion, which is 13% higher than the present revenue.

4 This assumes a fuel consumption of 3.03 km per litre, equivalent to 8.56 mpg.

5 This assumes fuel consumption values of 14.5 and 11.7 km per litre (41.0 mpg and 33.1 mpg respectively for cars and vans).

6 Private correspondence with Professor Martin Snaith OBE, Emeritus Professor of Highway Engineering at the University of Birmingham.

8. Vans

Data on van traffic is very limited, so it is not possible to carry out even the simpler calculation that has been done for HGVs.

At present there are 3.224 million vans (DfT, 2010b: Table 3.2) covering 66.6 billion km per year (ibid.: Table 3.1). Fuel burned amounted to 5.754 billion litres in 2008 and with fuel duty currently at 57.95p per litre this would yield £3.334 billion annually. VED on vans is £130 per year for vehicles with engines under 1.55 litres and £215 per year for vehicles with engines sized 1.55 litres or more with higher rates for six months registration (DVLA, 2011). As the majority of vans have engines of capacity exceeding 1.55 litres, an average VED rate of £180 yielding a total revenue of £580 million per year has been taken. On this basis, fuel duty and VED together for vans would generate a revenue of £3.914 billion. Only the broadest of estimates can be produced for van charge revenues under a PAYG scheme, but taking the average figure of 7.16 p/km (from Table 5) for vans, the yield would be £4.769 billion per year – an increase of about 23%. Again, allowing for a 5% suppression the yield would be £4.53 billion, or a 17% increase over current taxes.

9. Overview

The PAYG distance-based road charging system described above would increase the payments made by road users above that paid through the current fuel duty/VED scheme as shown in the table below:

Table 15: Estimates of the receipts from a PAYG charging scheme compared with existing fuel duty and VED (£ billion)

Type of user	Current taxes	PAYG charges	Difference
Cars	21.2	23.3	2.1 (+10%)
Vans	3.87	4.43	0.56 (+14%)
Heavy Goods Vehicles	5.35	6.30	0.95 (+18%)
All	30.4	34.0	3.6 (+12%)

On this basis there would be a gross surplus of £3.6 billion per year from which the costs of operating the scheme and additional improvements to the road network could be funded. This scenario is one of many, and it would be possible to increase or reduce the surplus by varying the tariff structure. It is also possible that VAT payments would increase if all PAYG charges were within the scope of VAT-related items. At 20% the VAT of fuel duty raises £5.3 billion per year; the PAYG revenue of £34 billion would provide a VAT yield of £6.8 billion – an additional £1.5 billion a year. The Exchequer is likely to benefit also from the reduced need for public transport financial support.

Whilst road users would pay more, they would in return benefit from improved traffic conditions in the short term, and from both reduced congestion and better roads in the longer term. The scale of short-term improvements can be gauged from the findings of the Eddington study. In this it was estimated that marginal social cost pricing would lead to welfare benefits of £28 billion per year in 2025; the study also predicted that it would raise GDP by around £14–15 billion in 2025 and that congestion could be reduced by 50% (DfT, 2006: 50). If this 50% is applied to the £20 billion annual cost of road congestion that is assumed in this paper, then the road users' additional payment would be more than compensated for by more freely flowing traffic.

The costs and benefits of a PAYG scheme would not be evenly spread. The greatest increase in costs would be in the large towns and cities, but it is here that the congestion benefits would also be greatest. People living in small towns and rural areas would pay less than at present and receive some benefits from easing of localised peak congestion. Low-income car-owning households would pay significantly less than the better off (the lowest-income quintile paying less than 60% of that paid by the upper quintile). This differential would change slightly from that under the current tax regime, and the increase in wealthier households' payments under PAYG would be proportionately less than those for poorer households (whilst above-average income households' payments would barely change, below-average income households' payments would increase by about £90 per year). Wealthier

motorists make more and longer car journeys than poorer car users and so would also benefit more from improved road conditions. However, the improvements to bus services would benefit lower-income and non-car-owning households, thus offsetting, to a degree, these effects.

Vans and lorries would pay more under a PAYG scheme than they do at present – 14% in the case of vans and 18% in the case of lorries. As heavy users of the road system (vans travel 21,000 km per year and HGVs 64,000 km per year, compared with an average figure for cars of 15,000 km per year), commercial vehicles would benefit most from the improvements to traffic conditions that PAYG would bring. Moreover, the time and operating costs savings from reduced congestion are significantly higher for commercial vehicles than for cars, so the higher charges would almost certainly be more than compensated for by the benefits of reduced congestion and better journey reliability, which is of particular importance to commercial vehicle operations.

10. Conclusions

Comprehensive pay-as-you-go (PAYG) road charging would almost certainly require a complete overhaul of the current system of motoring taxation. This would have varying impacts on different types of road users, and getting a feel for these is important for the purpose of understanding who is likely to benefit and who is likely to be worse off. A major change in charging for something as important and ubiquitous as road use is bound to raise concerns about equity and other issues – and recognising these at the policy formulation stage should help to guide scheme design and the development of complementary measures.

This paper addresses the matter of financial impacts. Important as these are, the main purposes of a rational PAYG charging scheme are to reduce congestion, improve reliability, reduce environmental, accident and climate change impacts, and provide funds for worthwhile improvements to the road and wider transport system. A well-crafted PAYG scheme will produce annual benefits measured in billions of pounds, in addition to the financial receipts it generates. This increase in economic welfare provides an opportunity for government to remedy any unwanted effects of a PAYG scheme that cannot be addressed effectively through the design of the scheme itself.

Road users pay tens of billions of pounds in taxes as a result of driving and riding on the nation's roads, of which about £30 billion per year are in the form of direct motoring taxes. A comprehensive PAYG scheme is assumed to replace these by a differentiated distance-based charge which would vary by location, road type and time of day. The PAYG scheme considered is based on the principle of marginal social cost (MSC) pricing, in which the charges levied reflect the costs imposed on other road users and society at large from road use. Estimating these costs is complex and uncertain, and this analysis uses data from earlier studies (adjusted to reflect current conditions) which in aggregate produce a higher average charge than existing taxes – by almost a quarter. It is, of course, a political choice as to what the charge level should be, and a lower average charge could be used whilst still retaining substantial benefits.

This paper describes the derivation of differentiated charges ranging from 10 p/vkm on congested single carriageway main roads down to 2 p/vkm on rural dual carriageways (these figures being averages across all areas of differing settlement type based on population size), as compared with an average tax rate of about 6.3p at present. As for the different types of area, this would mean average charges (across all applicable categories of road) of only 4 p/vkm in lightly populated Wales rising to 19 p/vkm in congested London.

This paper also provides estimates of the effects of these proposed charges on different income groups, typified by average household income quintile, and

compares this with the existing tax burden on these groups. The existing tax regime is rather progressive, with the highest-income quintile paying almost three times as much in direct motoring taxes as the lowest (see Table 10). The PAYG scheme considered would be less progressive, with households in the highest-income quintile paying only 2.4 times that of the lowest quintile (see Table 12).

This PAYG scheme (or any other using MSC principles) would have much more marked impacts on what is paid in different types of area. Under the current regime motoring tax payments do not vary very much between different types of areas, as fuel duty and vehicle excise duty are the same throughout the country. The differences in taxes paid mainly reflect the greater use of cars in smaller towns and rural areas than in large towns and cities (and also differences in the vehicle mix – something that it has not been possible to take into account in these estimates) and, consequently, the level of motoring taxes paid in large towns and cities is effectively less than in quieter, more rural areas.

This would change markedly with PAYG as a result of the high external costs of motoring (mainly in the form of congestion) in heavily urbanised areas. The outstanding change would be in London where, although charges would be much lower than for the existing congestion zone which it is envisaged would be superseded and replaced by PAYG charges, they would be over 50% higher than the national average. The differential would be much smaller elsewhere, with PAYG charge rates being fairly close to the national average in larger towns and cities and slightly lower in small towns. In deeply rural areas charges would be at their lowest, falling to two thirds of the average – and only 70% of current rates (see Table 13). Again, it would be possible to revise the tariff structure to reduce these differentials – with some loss of economic efficiency and a reduction in environmental benefits.

As the costs imposed by vans, and even more so heavy goods vehicles (HGV), on others are greater than cars, the charges paid by these types of vehicles should be higher. It has not been possible to produce anything other than very imprecise estimates of the financial impacts on these classes of vehicles, but the calculations suggest that HGVs should be charged at 3.75 times the rate for cars, which would result in their paying 15% more than under the current tax regime. For vans it is estimated that they would pay about 20% more than at present. Because of the greater distance, relative to cars, travelled by vans (which average over 20,000 vkms per year) and particularly HGVs (65,000 vkms per year), these types of vehicle would benefit significantly more than the average vehicle from improved road conditions.

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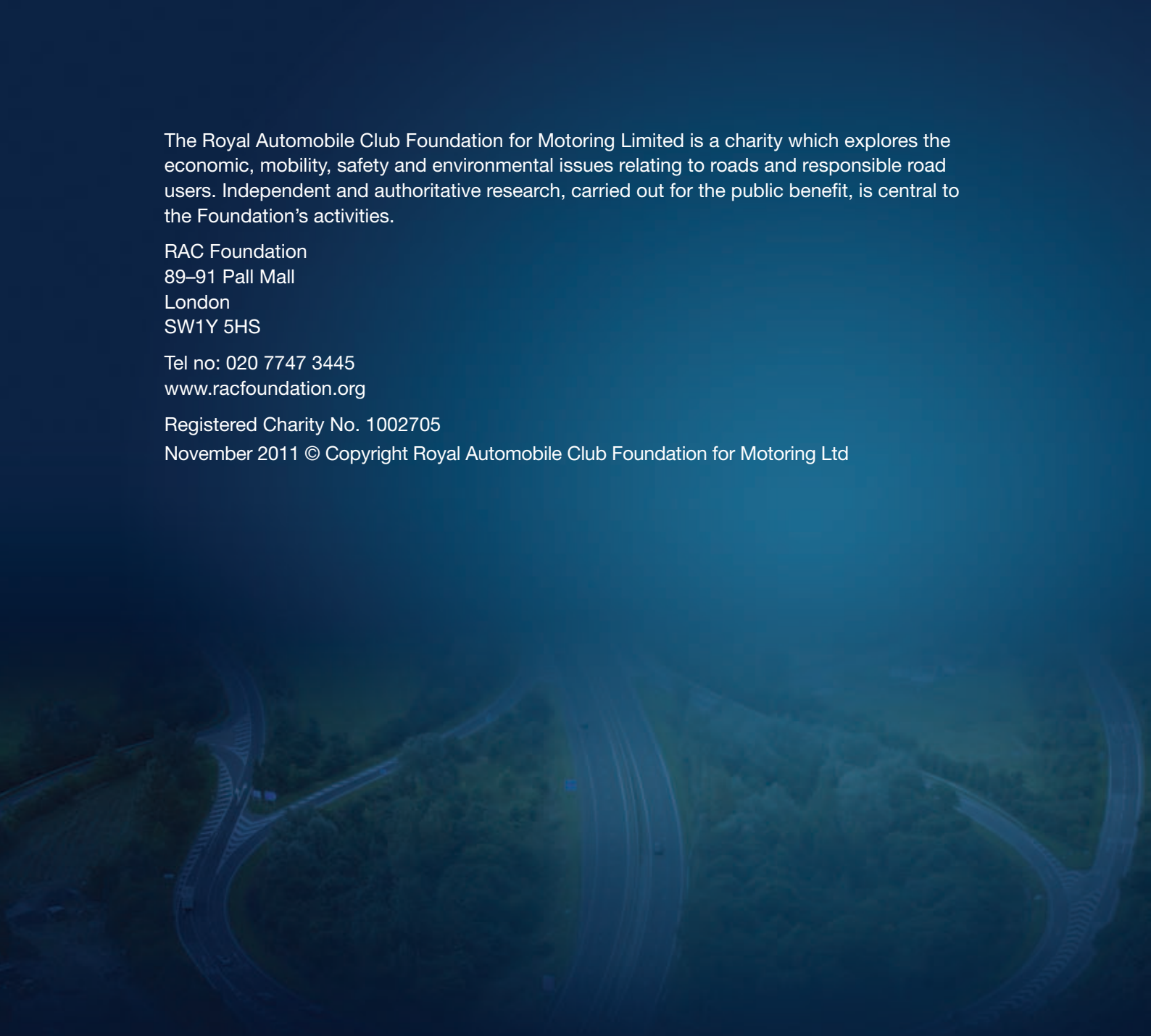

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