

BANDED ROAD USE CHARGING

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Introduction

Later this year, the Department of Transport will begin field trials of electronic equipment, with a view to charging tolls on Britain's motorways. If the equipment works, the plan is to apply the system nationwide before the end of the century. A very small charge, initially set at about a penny per kilometre, will raise a billion pounds or more per year. DoT says it will use this to help pay the costs of improving the motorway network. Tolls may, eventually, be varied by time of day, to reduce congestion and spread traffic demand more evenly throughout the day. They may also, eventually, be extended to other trunk roads and even to local roads.

Road use charging is the holy grail of transport economists. In theory, charging motorists for road space at the point of use should discourage inefficient road use and offer a long term and sustainable solution to congestion. It can also raise money that can be used to finance alternative transport provision, or go towards general revenue and, at least indirectly, towards reducing other taxes.

However, several questions must be asked about the Department of Transport's approach. Will the equipment work, to a sufficient level of reliability, to charge for the millions of motorway journeys that are made every day? Is it fair to charge specifically for motorway use? Will it discourage unnecessary trips, or merely divert traffic onto local roads, actually making the environment worse? Will it exclude occasional users from the nation's best roads, unless they purchase expensive equipment for their cars? Is it worth all the trouble, compared with alternatives such as simply raising petrol taxes (which Government says it will do in any case)? Is there an easier and more effective way to make motorists perceive the external costs of road use, and encourage them to consider alternatives such as public transport?

This paper sets out an alternative approach, requiring much less physical equipment and no equipment on individual cars (other than the license plates they already display). It avoids any need to set precise toll levels for different roads, or by time of day.

The existing Vehicle Excise Duty (VED), currently a flat £125 per year for private vehicles, would be replaced with banded charges reflecting actual road use and varying from perhaps £50 to £1,000 per year. All users would continue to have occasional access to any part of the network. Enforcement would be achieved spot checking actual use, electronically matching license plates against a register of paid-up users. This approach

should achieve the desired objectives of discouraging excessive road use, while raising funds for Government. It can be readily implemented with available technology.

Road Pricing

Road pricing, charging motorists for road space at the point of use, has long been recognised by economists as the ultimate solution to traffic congestion. Currently, motorists perceive only the direct costs of using their car, such as petrol and parking. Driving a car into central London also imposes massive costs in terms of delay to other motorists, and noise and pollution on other city dwellers. If motorists could be made to perceive not only their own costs, but those they impose on society, severe traffic congestion should disappear. Motorists would treat road space as a precious commodity, and use it more sparingly. Less important journeys would be shifted into the off-peak, made by public transport, combined with other journeys, or simply not made at all.

Road pricing has never been applied on a wide scale. The most obvious reason is the failure to find a simple way of charging motorists, at the point of use, without incurring the costs of constructing and operating physical toll barriers. It is easy to toll a single bridge, such as at Dartford. However, literally thousands of barriers would be required to toll the national motorway network, and tens of thousands to toll the trunk road system. It has always been much easier to raise money with simpler taxes. Fuel taxes and Vehicle Excise Duty together raise about £20 billion per year. This is about three times as much as is actually spent building and maintaining the road network. Government happily spends the extra revenues on other good works like schools, hospitals, benefits, and parks.

The second reason road use charging has not been introduced is purely political. Car drivers are, predominantly, middle class taxpayers and voters. They are used to roads being "free," even if road taxes actually generate a large surplus. This attitude may, however, be changing. As with any scarce resource that is being squandered, nobody benefits from free but overcrowded roads.

A third reason is the difficulty of setting charges at the "correct" level, where supply will equal demand, so roads will be used to their efficient level. Prices would need to vary throughout the day, for different roads, and perhaps even according to the weather. If charges are set too high, road capacity will be wasted or traffic may be diverted to other routes causing environmental problems. Most roads are not, in fact, congested, most of the time. In many areas of Britain road congestion is still very rare. So any "flat" charge high enough to seriously deter urban commuting would be far too high for rural areas, where the marginal cost to society of allowing an extra car on an empty road is practically nil.

A fourth reason, which would be an issue with any sophisticated electronic tolling system, is the perceived need to preserve anonymity. This has been accepted as something that needs to be assured, at least for those desiring it, in an open democratic

society. Obviously, nobody objects to requiring motorists to display a unique identity code, also known as a number plate. However one can easily imagine a police state abusing an electronic system that could continuously monitor everyone's movements. Government has stated that anonymity must be provided, but depending upon the system it might require payment of a higher charge.

There are a few successful applications of urban road use charging. Oslo has installed toll barriers at the entrance to the city centre, with a flat charge to pay for road improvements. Singapore long ago introduced a system of permits, essentially a supplementary road tax, which must be purchased and displayed by any car entering the city centre during weekday mornings. Some cities have parking taxes, however these can be difficult to enforce and do not deter through traffic.

Tolls are of course charged on many motorways and estuarial crossings throughout the world. Several toll roads in the USA, and the Dartford Crossing near London, now have electronic tolling systems. Regular users with special equipment on their vehicles can pass through a gate without stopping, although they must slow down and drive in a specific lane. Non-subscribers stop and pay at a physical gate.

ELECTRONIC CHARGING FOR MOTORWAYS

The British government is now seeking to obtain technology that can charge tolls to motorway users, without requiring them to slow down or indeed even to drive in a specific lane as they pass a tolling point. Various technical approaches are being considered.

"Closed" tolling points would be at each entry and exit point of the tolled network, requiring only the recording of the identity of each car. Charges would be calculated and billed monthly or quarterly based on actual use. This would be similar to a phone bill.

"Open" tolling points would be located between every motorway junction, charging a set toll for each segment. Motorists would pre-purchase units on a "smart card" or "tag", which could be similar to a phone card. This would be inserted into an on-board device, from which tolls would be deducted electronically as the car passed each tolling point.

"Closed" tolling with periodic billing seems technically feasible, since vehicles generally slow down and drive in a specific lane when entering or leaving a motorway. The equipment for such a system was installed in Hong Kong, for the cross-harbour tunnel, however monthly billing was not introduced because of concerns about anonymity. Pre-payment would be difficult to combine with closed tolling, because tolls would need to be calculated and deducted for each vehicle, during a very short period of time as it leaves the network.

"Open" tolling satisfies the need for anonymity but is more technically challenging. It will be necessary to deduct the appropriate charge, once and only once, from an on board unit inside a vehicle moving 90 miles per hour, weaving in crowded traffic.

The Government's programme is ambitious. Even if the technology can be made to work, it is likely to have a significant cost both to install and operate. Assuming a cost of about £100 per on-board device, with 25 million registered motor vehicles in Britain it would cost about £2.5 billion to equip every one. There are some 700 "sections" of motorway, each of which will require a separate tolling point if charges are to be levied against both short and long distance trips. Total costs, including capital charges and management of the billing process, could easily reach £500 million per year. This will be offset by revenues, estimated to be in the order of £700 million for an initially low per-mile charge, although obviously the net proceeds could easily be increased by raising the charges.

An enforcement system will be required. This could entail cameras recording license plates of cars not equipped with a valid "tag". Presumably a fine would then be levied, equivalent to the "penalty fares" now charged on the railways. However, there are serious practical problems. Rail passengers can be personally stopped and asked to show their ticket, randomly and perhaps once or at most twice per journey. Cars will be charged once at every tolling point, potentially 50 times or more on a long motorway journey. Each of these times there is an opportunity for error. With "open" tolling, there would be more than ten million "transactions" per day. Reliability must be extremely high, if there is not to be a flood of errors or spurious violation reports. Even if successful charging can be achieved 99.99% of the time, there could be 300,000 spurious violation notices per year. Given the technical demands of communicating with an on-board device at speeds of 90 mph on a congested road, reliability of 95% or less seems more likely. This implies 100 million potential violations or more per year! Most violations will of course be simple errors, but there will be no easy way of sorting out the technical errors from the cheaters. This could quickly turn into an administrative nightmare.

Even if the technology can be made to work, there are other problems with the electronic tolling approach. It can be argued that the approach is unfair to drivers who do not make frequent use of the motorway network. All cars using tolled roads would need to be equipped with on-board devices. If this equipment is expensive, then it will only be worth equipping cars that frequently use motorways. The Department of Transport has argued that most motorists are not frequent motorway users, and so most drivers will not pay anything extra. In fact, infrequent drivers may suffer a great deal if they lose access to the motorway network entirely. This would be extremely unpopular, and might force Government to pay the cost of installing, and perhaps even maintaining, equipment on all cars.

If electronic motorway tolling is not seen as fair, there is a real risk of civil disobedience. Many motorists might decide to simply ignore the law and drive on motorways without paying tolls. Government would be quickly overwhelmed by the number of violations

and could have no choice but to abandon the system. The experience of the poll tax might not be irrelevant.

Any scheme to toll only the motorway network is bound to cause diversion onto other trunk and local roads. There will be increased environmental damage and also, potentially, an increase in accidents. It is not at all clear that tolling only the motorway network would produce a net environmental gain, and it could well make congestion worse overall. "Open" tolling could be extended to the trunk road network, although this would require tens of thousands more tolling points because the network is so much more extensive and complex.

The DoT's proposals do not suggest any means to set the economically "correct" charge. Indeed, the approach seems to imply a flat national per-mile charge. Clearly, this is easiest to set and administer. However, demand varies by time of day, and is different on each road. It is hard to see how any fixed charge per mile can reflect true marginal cost, which is often nothing but sometimes much, much more. "Correct" charging would need to vary in real time, reflecting local traffic and even weather conditions. A flat charge will be too low on some roads, thus there will still be congestion, while too high on other roads, thus discouraging efficient use. A flat charge offers few advantages over simply increasing fuel taxes. It would have many disadvantages (except for the companies who hope to make and service the elaborate tolling equipment that would be required).

The DoT's approach is technically driven, focusing on means of charging motorists for each time they use the road. It treats road space as a commodity that must be sold to customers, by the "unit". This is clearly wrong for a "public good", with marginal cost that is often zero but sometimes very much higher. DoT is also proposes a single system for all road users, which is wrong when their willingness to pay and consumption patterns vary widely.

Every car passing a tolling point pays the same, fixed unit charge, as if road space were a discrete commodity that was manufactured, stored, and sold. This is how apples and potatoes are sold, and how the principles of pricing and market theory is explained to undergraduate economics students. However, commercial infrastructure and service operators often use very different pricing structures, to increase revenues but also often to actually simplify the mechanics of toll collection. Telecom service providers are, increasingly, introducing flat rate or banded charge systems reflecting low variable costs after providing a connection. Water companies are moving towards metering, but also often levy a fixed standing charge. Public transport operators offer season passes, recognising that costs relate mostly to peak capacity. Fast food outlets offer selective discounting and "bundling", effectively a form of price discrimination where a fixed rather than proportional margin is accepted in order to attract more price sensitive customers.

An Alternative Approach: Banded Road Use Charges

An alternative to the DoT's motorway tolling proposals, would be to improve on the existing vehicle excise duty (VED), relating it more to how people actually use their cars. Rather than try to electronically charge for every journey, road charges could be "banded" according to use, with a system of intermittent or "spot" checking for enforcement.

Most drivers do not make frequent long journeys on the congested national road network. They can register to pay a low fixed charge, with occasional access to the national road network and no requirement to fit their cars with expensive equipment. This charge might be a reduction on the existing VED, from £125 to say £100 per year.

Heavy road users (the stereotypical company car driver) would pay a higher road charge, for the right to drive anywhere, anytime. "High use" would need to be defined in some way, perhaps driving more than 200 miles per week on designated inter-urban routes (including all busy trunk roads and motorways) for four or more consecutive weeks. There are a million or so drivers in this category, and a surcharge of say £1,000 per year would raise an easy billion or two each year for Government. In the first instance, motorists would "self assess", declaring themselves as high use drivers when they pay their registration charges.

Enforcement need not be terribly difficult. The complete list of license numbers for paid-up "high use" cars can be stored on a single hard disk drive. Electronic video monitoring equipment can now read license plates on moving vehicles. Units combining a video camera, microprocessor, and a hard disk can be located along the road network, checking registrations against the list of paid up heavy users. This process can be completely automatic. Numbers observed that are not on the "high use" list would be recorded and transmitted, perhaps by digital radio, to a central computer. Any car regularly observed using the national trunk network, on a frequent, rather than occasional basis, and at geographically separated locations, would face the higher road charge.

Vehicle charges might be paid by direct debit, so that movement from the "light user" to the "heavy user" category would be automatic (although car owners would need to apply to move in the opposite direction). In fact, the Driver and Vehicle Licensing Agency (DVLA) has recently announced plans to move towards continuous licensing of motor vehicles. This is primarily to reduce evasion, which currently is thought to cost in excess of £100 million per year in lost revenues. Payment by Direct Debit, and banding of high and low use drivers could be introduced at the same time at relatively little additional cost.

For data capacity reasons, the camera units would not normally record actual photographs of each vehicle, so there might be some difficulty obtaining a conviction against a motorist who denied frequent use. However in extremis it would be a simple matter to monitor subsequent vehicle use of a suspected violator. The driving behaviour of most motorists is difficult to conceal, since cars are large objects which are difficult to use without being seen. Police can easily check whether someone is using their car to travel

from home to work. It would also be possible to load a "challenge" list into each camera unit, which would then retain a digital image of selected cars for use in obtaining a conviction.

As with income tax and rail season tickets, most people would comply voluntarily and most cheaters would, eventually, get caught. It should be noted that most company car drivers already declare their mileage, to claim tax benefits, so a high degree of initial compliance can be expected. Some motor vehicle insurers offer reduced price car insurance to low mileage drivers, again with self-declaration. The requirement for anonymity is achieved for anyone paying the "high use" charge, since their number would never be recorded or transmitted from a camera site.

Price signals would be imperfect, but probably less so than with the electronic tolling proposals. Frequent users would still be paying a flat annual fee, and thereafter road use would be free. But electronic road tolls of 1p or even 10p per mile seem unlikely to have a major effect on road use by most high use drivers, given that it already costs 50p per mile or more to drive a 2.0 litre saloon. However, with banded charging drivers on the threshold between low and high use would have an incentive limit their driving to avoid crossing into the "high use" category. A high use charge of £1000 per year should persuade many borderline motorists to make one less trip per week.

Since monitoring units need not be located at fixed intervals, fewer units would be required than for open tolling. Units could even be mobile, at changing locations on the road network, as with railway ticket inspectors. So charging could readily cover trunk roads as well as motorways, and limiting the potential for diversion and subsequent environmental problems. It will not penalise light users by forcing them to purchase expensive equipment or lose access to the best roads in the country. It should be at least as efficient as the current proposals for electronic motorway tolling, and also be perceived as fair and equitable.

Since enforcement is by spot checking, and motorists are only "upgraded" to the high user charge after repeated observation, equipment reliability is not critical. Several manufacturers already offer equipment capable of reading vehicle license plates, in all light and weather conditions. While 100% reliability is unlikely to be achieved, with banded charging it is also not required. As with ticket inspection on trains, or speed limit enforcement on motorways, a reasonable chance of being caught will achieve an acceptable level of compliance. Frequent drivers will have their license plates scanned many times every day, so high users who are not paying the high user charge will get caught. Overall, banded charging should be far simpler to implement and operate, and raise at least as much money, as electronic motorway tolling.

Extending Charges to Commuter and Local Journeys

Unlike electronic tolling, one can fairly easily see how banded charging could be extended into urban areas, to achieve something approaching true congestion charging. This could bring enormous environmental benefits, reducing noise and air pollution, cutting pedestrian injuries, and increase demand for and therefore financial viability of improved public transport.

Two groups of urban road users could be identified, commuters and frequent local drivers.

Commuters make the same journey, usually to and from a workplace, on a daily basis. They are the major contributors to urban peak hour congestion. They often have viable alternatives, such as public transport or ridesharing, which they should be encouraged to consider. However, this would not be achieved by motorway tolling. Journeys are often entirely on local streets. If commuters use the motorway network at all, it is usually for very short distances so the toll would be very small, And there are often non-motorway routes available.

Banded charges could be readily extended to commuters, using the same system of self-assessment and enforcement. Commuting might be defined as making the same journey three or more times per week, for four consecutive weeks. Persons who occasionally use the car to travel to work would not face a charge.

As with heavy users, commuters and frequent local drivers would be asked to declare their category when they pay their road tax. Compliance would be achieved using the same spot checking, with license-reading video cameras installed on major routes and "cordons" at the entry points into employment centres.

Commuters could pay a fixed annual charge, perhaps set for each urban area. As a starting point it might, in London, be a flat £2 per day or £500 per year. However, given the wide variation in length of commuter journeys, and the highly peaked nature of urban traffic congestion, a somewhat more complex system might be appropriate. Different commuter charges could be set for different routes, and even for different times of the day. Or charges might be set at some fraction or multiple of the public transport fare for the journey.

A more sophisticated, but also more complicated approach would be to use transport models to match supply and demand on each route, within say half hourly time bands. As with trunk roads, the correct charge levels would achieve free flow road conditions without limiting efficient use. Again, motorists would in the first instance declare their commuting journey when registering for the vehicle charges. Over time the monitoring system would identify drivers travelling more or further than they had declared.

Motorists would be giving up some privacy, but no more than rail passengers already do when they purchase a season ticket. Anyone who did not want to declare their commuting habits to the Highways Agency could instead simply pay the charge for a high use

national road user. As noted above, high use license numbers would never be recorded, being discarded automatically whenever observed at a monitoring point.

In some highly congested urban areas (e.g. London suburbs), another charge band might be set for frequent use of a car, even for short journeys. Frequent local drivers include parents taking children to school, running errands, delivery services, and minicabs. Frequent local use might be defined as more than five trips per week during daytime hours, although there is no reason why the definition might vary from place to place depending upon local conditions. The charge might be £250 per year. Monitoring cameras could be located at major traffic generators such as High streets, schools and shopping centres.

Local use charging is likely to be controversial, and would probably only be introduced after extensive trials and on a local "opt-in" basis. The national system would provide a framework for applying and enforcing local charges. National high-use motorists would of course still be able to drive anywhere, anytime, but commuters and local drivers would have a financial reason to consider alternatives. Some of the local charge revenues could be returned immediately to pay for environmental improvements. One can imagine that local use charging would be particularly attractive to inner London boroughs, which suffer serious blight from through traffic rat-running on local streets.

Commuter and frequent local user banded charging will bring real environmental benefits, in a way that may never be practical with electronic charging. It will discourage car use on congested roads even for short local journeys. It will encourage ride sharing, staggered hours and public transport use. Even so, both commuter and local frequent use charges are likely to be controversial, and might only be introduced at local option.

Commercial Vehicles

As it happens, Government already levies a form of banded road use charges, with Vehicle Excise Duty (VED) varying for several different classes of commercial vehicles. Heavy Goods Vehicles (HGVs) pay up to £5,000 per year, while highway and city coaches pay lesser charges but still several times the VED levied on passenger cars. These charges reflect the wear-and-tear costs each class of vehicles impose on the road network., on the assumption that most commercial vehicles are in fairly constant use.

However, exceptions are made for "showmen's vehicles", such as portable ferris wheels and merry-go-rounds, and farm vehicles. They pay a much lower VED on the assumption that they do not travel many miles on the public road network. There is no real enforcement mechanism, and presumably no need for one as nobody would want to drive these sorts of vehicles any further than necessary.

With development of an electronic monitoring system, it would be possible to offer banded charges to commercial vehicles, based on actual rather than assumed level of use.

No doubt, most HGVs and highway coaches would continue to be charged a high VED reflecting the intensive use they make of the road network. However, it would be possible to distinguish vehicles that do limited mileage or are used only a few hours each day, such as milk tankers, and do not impose the same costs on the road network. Discounts might even be offered for HGVs that operate primarily outside of Britain, travelling only on a limited number of routes to and from the ferry ports. This would help level the playing field with continental HGV operators who do not currently pay British VED.

How to use the revenues

Government has suggested that motorway toll revenues will be used to pay for road construction, and the Green Paper was titled quite explicitly "Paying for better motorways". While it is politically attractive to suggest that a new revenue source would be used to benefit those who pay, it seems unlikely that the funds would, in fact, be spent on additional roads. Nor would it necessarily be good public policy to do so.

The sensible opportunities to build new roads in Britain are rapidly running out. New roads, whether an urban route such as the Limehouse Link, or a town bypass in the shires, can now be enormously expensive. They often face local opposition for environmental reasons. Proportional both to area and population, the country already has one of the best road networks in the world. Although there is congestion in peak hours, traffic flows freely on most roads, most of the time, and there is massive spare capacity outside daytime hours. There are some worthy road schemes still to be completed, but the era of "paying for better motorways" is in the past, not the future. It is, frankly, hard to imagine the "better motorways" that the DoT wants to build. Perhaps they are planning an overseas expansion programme?

Banded road use charging will encourage more efficient use of the road network we already have. If it reduces peak traffic on the M25 by as little as 10%, it may eliminate the need for any major widening.

Nor is it necessary to raise more money from motorists to pay for better roads. Road users already pay far more through fuel taxes and motor vehicle registration than is spent on road construction and maintenance. Road taxes are, quite reasonably, used as a source of general revenue. The British civil service has tried, with commendable success, to avoid "hypothecation" of tax revenues towards a particular type of expenditure. This would undermine the general revenue base available for other worthy calls on the public purse. Education and defense, for example, do not have an obvious revenue source which could be hypothecated. Spending road taxes on building road makes as much sense as spending liquor taxes on building new pubs, or taxing cemeteries or baby clothes to pay for hospitals.

Good public policy is to design taxes that are perceived as fair and equitable, and cause the least damage to the economy as a whole. While income tax is an easy way to raise money, it has the undesirable effect of reducing individual incentives to work.

Consumption taxes, including petrol taxes and VED, are a more efficient way to raise money, as they do not greatly deter investment or employment in wealth-generation activities. Banded road user charges would raise even more money, and (quite exceptionally) would give positive incentives to make better use of the road network. With introduction of commuter and frequent local use charge bands, revenues would grow to several billion pounds per year. This could allow a one or two percent reduction in the base rate of income tax. The banded VED charge for low users might also be reduced further, say to £50 per year. This would benefit several million motorists.

Experience in North America suggests that motorists support higher road taxes if the excess funds are spent, not on more roads, but on improved public transport as an alternative. While it would be bad public policy to explicitly dedicate a revenue source to a particular type of expenditure, it might be pragmatic to commit a share towards this end at least as a transitional measure. Road user charges will anyhow encourage greater use of the railways, and thus increase the potential for investment on a purely commercial basis. The transport industry as a whole will benefit from better price signals. Instead of subsidising one mode, the railways, to correct for under-charging in the other, highways, we will have "first best" pricing in both modes. This should lead to efficient customer choices, without the need for ongoing bureaucratic intervention, regulation, or subsidy.

Prototype Application in a Smaller City

Banded road use charging could first be tested in a compact city centre such as Bristol or Leeds, or in a London suburb like Croydon. Initially, a flat charge of say £200 per year could be levied for regular city centre access during weekday hours. Regular access could be defined as entering the city centre three or more days per week, during more than four consecutive weeks. The system could then be gradually extended to other areas on a local "opt-in" basis, similar to the spread of controlled parking zones. Occasional access would still be free so there would be nothing to discourage shopping and business visitors.

In Bristol, a city centre access charge of £200 per year could raise some £30 million per year. The new revenues could be used to offset local council taxes, or could finance alternative transport improvements. Income of £30 million per year could pay for a very extensive light rail and busway system. The road charge system would not only help to finance the light rail network, but would also encourage its use.

Conclusions

Banded road use charging may be a practical method of encouraging more efficient use of our road network, while raising funds for the exchequer and allowing reductions in taxes. Unlike electronic motorway tolling, banded charges can be applied readily to the entire trunk road network and not just to motorways, thus avoiding the problems of traffic diversion. Banded charges could be extended readily onto urban and local roads. Alternatively, banded charges might be introduced first, on an experimental basis, in a smaller city and then extended nationally.

Banded charging would be much easier to enforce than electronic tolling. Although both systems would make use of new video scanning technology, banded road use charging is much less demanding in terms of equipment reliability.

Banded charges would not charge every motorist for every trip, based on theoretical marginal cost. However, no charging system is perfect. Banded charging, properly targeted, should send robust signals to frequent road users, to encourage them to consider alternatives such as public transport or simply making fewer trips. It should increase traffic and revenues on public transport, while significantly reducing road congestion and reducing the need for further road system expansion.

Unlike motorway tolls, banded charges would be targeted at high use motorists and most drivers would actually see a reduction in their VED payments. As the system is extended to urban areas, it could bring real environmental benefits both in traffic reduction and by releasing funds for public transport and environmental improvements.

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